Innovation and export performance: do young and old innovative firms differ?[1]

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Abstract

The relevant literature is conflicted about the direction of causality between innovation and exports. In this paper we attempt to shed light on this relationship by setting a theoretical framework where a two-way causality is hypothesized to exist between these two firm activities. In addition, the role of firm age is highlighted as firms at different stages of their life cycle may face different prospects and constraints and thus develop different strategies to survive and grow. Such differential patterns may be even more intense due to the different knowledge and capabilities portfolio possessed by young and old firms. Employing a sample of Greek Manufacturing R&D active firms we estimate a multi-group path analysis for young and old firms. Even though empirical results do not support the existence of a two-way causality between innovation and export performance, when we account for the moderating role of age it becomes evident that the direction of causality differs between young and old firms. Also the indirect and direct effect of firms' R&D stock is confirmed as an intermediate link within the innovation-export nexus.

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1. Introduction

Firms of European small open peripheral economies, such as Greece, face an increasing globalization of markets, a strengthening of global value chains, a well documented knowledge and technological gap and all these in conjunction to the current crisis at least in the southern part of Europe. These conditions compose a demanding and complex environment within which firms attempt to grow and survive. In this direction, boosting exporting activities and investments in innovation, are considered of the outmost importance since they are seen as drivers of productivity, growth and competitiveness. Especially with respect to Greece's economic outlook, as it has been documented in several European policy documents and analyses, the

country's innovation performance has been consistently characterized as "moderately following" (IUS, 2013) the EU's innovation leaders. The same picture is sketched with respect to Greek firms' export performance (European Competitiveness Report, 2012).

Examining more closely the relationship between firms' exporting activities and innovation dynamism, the theoretical and empirical evidence suggests that firms which are presenting innovation activities are more likely to export, more likely to export successfully, and more likely to generate growth from exporting than non-innovating firms (Golovko and Valentini, 2011; Love and Roper, 2013). In other words, innovation and export performance are directly linked with the creation of a sustainable competitive advantage and are considered as a primary precondition for economic growth. It is worth mentioning that exporting activities are considered as the primary internationalization mode (Johanson and Valhne, 1977; 2009) and firms' knowledge and learning processes are expected to play a pivotal part in the internationalization process; firms need to be in a position to apprehend and assimilate new knowledge in order to compete and grow in highly competitive markets in which they have little or no previous experience (Autio et al. 2000).

At the same time, *the causality direction*, too closely related to endogeneity issues, between exporting and R&D activities has not been yet addressed adequately. The relevant literature has documented two distinct hypotheses, namely the *Self Selection* (SSH; Wagner 2007) and the *Learning by Exporting* (LEH; Clerides et al., 1998; Salomon and Shaver, 2005) hypotheses which assume inverse causality direction between innovation and exporting activities. More specifically, the *SSH* favours the argument that exporters have superior performance characteristics than non-exporters while the *LEH* argues that exporting firms' access to foreign markets provides them with feedback from their suppliers and/or customers, which gives them the opportunity to transform this knowledge into innovation. Both the above hypotheses seem plausible and have been empirically but the relevant literature has provided contradictory results. However, it would only make sense to assume that this causality direction may be not so straightforward since causality may run in both directions that is a two-way linkage between a firm's exporting and innovating activities may exist (Filipescu et al. 2013; Arvanitis et al., 2014).

However, the investigation of such a potentially endogenous relationship should take into consideration that firms differ in many respects and an appropriate context should be adopted. In this line, the relevant literature has devoted much attention on the influencing role of *firm age* and *size* in determining firms' strategic orientation and behavior. Despite the vast theoretical evidence on the role of *firm size* in determining firms' innovative behavior there is considerably much less research effort put in the direction of investigating if and how *firm age* determines firms strategic choices (Coad et al., 2013). Especially with respect to firms' innovation performance, firm age seems to play a determining role since it is closely associated with firms' business and product life cycle (Klepper, 1996; Huergo and Jaumandreu, 2004; Coad et al., 2013) and it has been argued that young firms need to be more innovative than incumbents in order to establish themselves and increase the probabilities to survive in the meso-long run (Audretsch, 1991; Bartelsman et al., 2005). At the other end, and considering the potential effect of firm age on firms' exporting orientation, the relevant literature has provided mixed results. On one hand, it is has been suggested that firms begin their internationalization strategy in a stepwise manner as they grow in size and age (Johanson and Wiedersheim-Paul, 1975); on the other hand, it has been documented that some small firms engage in exporting activities shortly after their establishment, also known as 'born globals' (Knight and Cavusgil, 2004).

In this direction, we argue that young and old innovative companies behave differently, since they face different production possibility sets and pursue different strategies, and thus, the relationship between export and innovation performance needs to be investigated under this light. More importantly, young and old firms may differ with respect to knowledge and capabilities which in turn is reflected in their firm size and technology vintage. Hence, *the main focus of this paper lies on the idea that both these activities may influence each other and therefore, is focused on the investigation of the existence of a two-way causality between innovation and export performance in young and old innovative companies.* In addition, firms' size and knowledge capital are considered as important determinants of both innovation and export performance. We employ a unique cross-section dataset of Greek Manufacturing R&D active firms for the period, and conduct *multiple group an*alysis in the context of Structural Equation Modelling (SEM). More specifically we simultaneously estimate for both young and old firms the same structural model in order to identify differences with respect to our key hypotheses.

Empirical findings suggest that while the two-way causality is not confirmed, young and old firms exhibit different causality directions. More specifically, for young firms we provide empirical evidence supporting the Learning by Exporting Hypothesis, while for old firms empirical results confirm the Self Selection Hypothesis (SSH). In addition, cumulative investments in R&D are found to indirectly influence both young and old firms' export performance, thus highlighting the filtering role of both group of firms' knowledge base.

The rest of this paper is organized as follows; Section 2 reviews the relevant literature on the relationship between export and innovation performance as well as the role of age and knowledge capital in determining this, formulating testable hypotheses in the context of an extended structural model. Section 3 presents the adopted methodological

approach while Section 4 presents the information employed for estimation of the multi-group analysis. Section 5 is devoted in presenting and discussing the estimation results and Section 6 concludes this paper.

2. Literature Review, Theoretical Underpinnings and Hypotheses Formulation

A considerable amount of research effort has been devoted in the investigation of the export-innovation nexus. In the heart of this research lies the investigation for the direction of causality between these two firm strategic activities. On one hand the 'self-selection' (Wagner, 2007) hypothesis (SSH) stipulates that more robust firms self-select into export markets since they can afford the associated (sunk) costs with their decision to export. From this perspective exporting firms are expected to exhibit higher innovation performance, compared to their non-exporting counterparts, which is a determining factor to their exporting decision and performance. At the other end the 'learning by exporting'(Clerides et al, 1998) hypothesis (LEH) argues that export market participation provides an opportunity for exporting firms to improve their performance due to knowledge flows from international sources.

Recently, Constantini and Melitz (2008) put forward a theoretical framework which endogenized firm's decision to export and engage in innovation activities. Such an endogenous relationship is then reflected in firms' productive performance differentials. Therefore, the decision to export may be driven from the current state of the firms' competencies and capabilities but it may also affect their future development in the sense that patterns of innovation also affect firm's productive performance (Harris and Li, 2009; Gkypali et al., 2012; Antonelli and Scellato, 2013; Mohnen and Hall, 2013). In this line, the mechanism which integrates the relationships among R&D investments, productive performance gains, and exporting orientation, has been introduced (Lileeva and Trefler, 2010; Cassiman et al., 2010; Aw et al., 2011, Máñez et al., 2015). However, in all these approaches it is implicitly assumed that (i) the differential gains of R&D investments are symmetrically distributed among innovators and (ii) export orientation is solely dependent on the productive performance gains induced by R&D activities. Gkypali and Tsekouras (2015) provided empirical evidence suggesting that low-tech R&D active firm's endogenous self-select (ESS) into an exporting status based on the anticipated net benefits from such a decision in terms of R&D based productive performance gains.

Nevertheless, it would only make sense to assume that this causality direction between innovation and exports may also run the other way. Specifically, Crespi et al. (2008) provide qualitative and quantitative empirical evidence that exporting firms do learn from foreign clients which is in turn reflected in their productivity gains but the reverse does not apply. In addition, Love and Ganotakis (2013) employ a sample of UK high-tech SMEs and provide empirical evidence of the learning by exporting effects. Hence, the causality direction between export-innovation performance may not be so straightforward since causality may run in both directions that is a two-way linkage between a firm's exporting and innovating activities may exist (Filipescu et al. 2013; Arvanitis et al., 2014).

More specifically, export performance has been considered as a crucial part in firm's strategy, because it results in widening of the penetrated markets and thus, augmenting innovation's yields and experience growth (Kylaheiko et al. 2011). In addition, being engaged in exporting activities extends the pool of sources for new ideas, know-how and other important knowledge resources from which the firm can draw the necessary elements for its innovation process (Korbin, 1991; Kafouros et al., 2008). It could also be suggested that innovation performance influences export performance since it is the outcome of firms' efforts to diversify, compete and distinguish themselves from competitors and create or sustain their competitive advantage. Hence the following hypothesis is formed:

H1: Firms' export and innovation performance present an endogenous two-way relationship

However, it is reasonable to assume that firms face different production possibilities sets, strategic priorities and constraints depending on the stage of their life cycle. In this respect, the relationship between export and innovation performance potentially gains a different context for younger and more mature firms or for smaller and larger firms. Despite the vast theoretical evidence on the role of *firm size* in determining firms' innovative behavior there is considerably much less research effort put in the direction of investigating if and how *firm age* determines firms strategic choices (Coad et al., 2013; Quevedo et al 2014). Especially with respect to firms' innovation performance, firm age seems to play a determining role since it is closely associated with firms' business and product life cycle (Klepper, 1996; Huergo and Jaumandreu, 2004; Coad et al., 2013) and it has been argued that young firms need to be more innovative than incumbents in order to establish themselves and increase the probabilities to survive in the meso-long run (Bartelsman et al., 2005).

At the other end, and considering the potential effect of firm age on firms' exporting orientation, the relevant literature has provided mixed results. On one hand, it is has been suggested that firms begin their internationalization strategy in a stepwise manner as they grow in size and age (Johanson and Wiedersheim-Paul, 1975); on the other hand, it has been documented that some small firms engage in exporting activities shortly after their establishment, also known as 'born globals' (Knight and Cavusgil, 2004). Based on the

above the following hypothesis is formed:

H2: The endogenous relationship between innovation and export performance is moderated by firm's age

While various empirical studies (Willmore, 1992; Wakelin, 1998; Wagner, 2001; Lachenmaier and Woessmann, 2006; Pla-Barber and Alegre, 2007;Girma et al, 2008, Esteve-Perez and Rodriguez, 2013) have acknowledged technology and innovation as major factors contributing to facilitating entry into global markets, and thereafter maintaining competitiveness and boosting export performance, there is considerably less attention devoted in identifying the intermediating links between them. In this respect, while it is widely acknowledged that R&D capital plays a role in determining export and innovation activities, Harris and Moffat (2011) note the lack of empirical evidence at the micro level, in the identification of the role of R&D capital within the export and innovation performance nexus.

More specifically, R&D capital is considered as a vital input in the innovation process but also, R&D investments are undertaken not just to support innovation performance but also to increase the firm's knowledge assets, and thus, the firm's ability to assimilate and internalize external knowledge (Rosenberg, 1990). In other words R&D investments affect positively absorptive capacity (Cohen and Levinthal, 1989;1990). More recently, Gkypali et al. (2012) argue that in the case of the global R&D leaders firm's knowledge capital serves as the filtering, and storing mechanisms of outside information stimuli. In addition R&D capital may not be as important to old and established firms compared to newer ones due to organizational agility and ambidexterity (March, 1991). In line with this consistent finding we aim at testing the following hypothesis:

H3: Firm's knowledge capital indirectly and distinctively determines export performance in young and old firms

Summarizing, Figure 1 below sketches the theoretical framework and presents figuratively the abovementioned testable hypotheses. It becomes evident that the structural relationships among firms are quite complex and an appropriate methodology needs to be employed that can model simultaneous relationships and non-recursive models and control for firm level heterogeneity. In this line, multi-group analysis is adopted in order to investigate and test the abovementioned hypotheses.

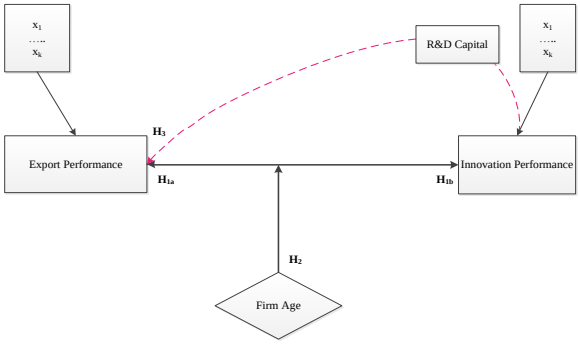

Figure 1. Graphical representation of the structural model with respect to young and old innovative companies

3. Methodology

In order to model the moderating effect of firm's age two subsamples $(g = new, old)$ are defined and form two groups, the young and the old firms (Bollen, 1989; p.355), where the relationship between export and innovation performance is modeled for both young and old firms as follows[2]:

$$y_{ip}^{g} = a_{ip} + B_{ep}^{g} y_{ep}^{g} + \Gamma^{g} x_{ip}^{g} + \varepsilon_{ip}^{g} \quad (1)$$

$$y_{ep}^{g} = a_{ep} + B_{ip}^{g} y_{ip}^{g} + \Gamma^{g} x_{ep}^{g} + \varepsilon_{ep}^{g} \quad (2)$$

Eq. (1) models firm's innovation performance $\left(y_{ep}^{g}\right)$ as a function of the firm's export performance $\left(y_{ep}^{g}\right)$ and a set of control variables $\left(x_{ip}^{g}\right)$ with an error term $\left(\varepsilon_{ip}^{g}\right)$ both for young and old firms. Further, Eq. (2) models firm's export performance $\left(y_{ep}^{g}\right)$ as a function of the firm's export performance $\left(y_{ip}^{g}\right)$ and a set of control variables $\left(x_{ep}^{g}\right)$ with an error term $\left(\varepsilon_{ep}^{g}\right)$ both for young and old firms. It should be noted that Eq. (1) and (2) form a non-recursive system of equations where the $\mathbf{B}^{g}$ matrix in not lower triangular and the covariance matrix of the error terms $\mathbf{\Psi}^{g}$ is not diagonal for young and old firms respectively.

Taking into account that the basic hypothesis of the general structural equation modeling is $\mathbf{\Sigma}^{g} = \mathbf{\Sigma}^{g}\left(\boldsymbol{\theta}^{g}\right)$, where $\mathbf{\Sigma}$ is the population covariance matrix written as a function of the model parameters in $\boldsymbol{\theta}^{g}$. This hypothesis implies that each element of the covariance matrix is a function of one or more model parameters. $\mathbf{\Sigma}^{g}\left(\boldsymbol{\theta}^{g}\right)$ is decomposed in three

[2] The notation *i* denoting the *i*-th observation is suppressed for reasons of simplicity

components: (i) the covariance matrix of $\mathbf{y}^g$, (ii) the covariance matrix of $\mathbf{x}^g$ with $\mathbf{y}^g$ and (iii) the covariance matrix of $\mathbf{x}^g$. Let us consider first $\mathbf{\Sigma}_{\mathbf{y_{ip}y_{ep}}}\left(\boldsymbol{\theta}^g\right)$ for each group g, that is the implied covariance matrix of $\mathbf{y}^g$:

$$\begin{aligned}
&\mathbf{\Sigma}^g_{\mathbf{y_{ip}y_{ep}}}\left(\boldsymbol{\theta}^g\right) = E^g\left(\mathbf{yy'}\right)\\
&= E^g\left[\left(\mathbf{I}-\mathbf{B}^g\right)^{-1}\left(\mathbf{\Gamma}^g\mathbf{x}^g+\boldsymbol{\varepsilon}^g\right)\left(\left(\mathbf{I}-\mathbf{B}^g\right)^{-1}\left(\mathbf{\Gamma}^g\mathbf{x}^g+\boldsymbol{\varepsilon}^g\right)\right)'\right]\\
&= E^g\left[\left(\mathbf{I}-\mathbf{B}^g\right)^{-1}\left(\mathbf{\Gamma}^g\mathbf{x}^g+\boldsymbol{\varepsilon}^g\right)\left(\mathbf{x}^{g'}\mathbf{\Gamma}^{g\prime}+\boldsymbol{\varepsilon}^{g'}\right)\left(\mathbf{I}-\mathbf{B}^g\right)^{-1'}\right]\\
&= \left(\mathbf{I}-\mathbf{B}^g\right)^{-1}\left(E^g\left(\mathbf{\Gamma}^g\mathbf{x}^g\mathbf{x}^{g'}\mathbf{\Gamma}^{g'}\right)+E^g\left(\mathbf{\Gamma}^g\mathbf{x}^g\boldsymbol{\varepsilon}^{g'}\right)+E^g\left(\boldsymbol{\varepsilon}^g\mathbf{x}^{g'}\mathbf{\Gamma}^{g'}\right)+E^g\left(\boldsymbol{\varepsilon}^g\boldsymbol{\varepsilon}^{g'}\right)\right)\left(\mathbf{I}-\mathbf{B}^g\right)^{-1'}\\
&= \left(\mathbf{I}-\mathbf{B}^g\right)^{-1}\left(\mathbf{\Gamma}^g\mathbf{\Phi}^g\mathbf{\Gamma}^{g'}+\mathbf{\Psi}^g\right)\left(\mathbf{I}-\mathbf{B}^g\right)^{-1'} \qquad (3)
\end{aligned}$$

where $\mathbf{\Phi}^g$ is the covariance matrix of $\mathbf{x}^g$ and $\mathbf{\Psi}^g$ is the covariance matrix of $\boldsymbol{\varepsilon}^g$. In this line, the covariance matrix of $\mathbf{x}^g$, $\mathbf{\Sigma}_{\mathbf{x_{ip}x_{ep}}}\left(\boldsymbol{\theta}^g\right)$ is equal to $\mathbf{\Phi}^g$ or

$$\begin{aligned}
&\mathbf{\Sigma}^g_{\mathbf{x_{ip}x_{ep}}}\left(\boldsymbol{\theta}^g\right) = E^g\left(\mathbf{xx'}\right)\\
&= E^g\left[\mathbf{x}^g\left(\left(\mathbf{I}-\mathbf{B}^g\right)^{-1}\left(\mathbf{\Gamma}^g\mathbf{x}^g+\boldsymbol{\varepsilon}^g\right)\right)'\right]\\
&= \mathbf{\Phi}^g\mathbf{\Gamma}^{g'}\left(\mathbf{I}-\mathbf{B}^g\right)^{-1'} \qquad (4)
\end{aligned}$$

Combining Eq. (3) and (4) the implied covariance matrix of $\mathbf{y}$ and $\mathbf{x}$ is

$$\mathbf{\Sigma}^g\left(\boldsymbol{\theta}^g\right) = \begin{bmatrix} \left(\mathbf{I}-\mathbf{B}^g\right)^{-1}\left(\mathbf{\Gamma}^g\mathbf{\Phi}^g\mathbf{\Gamma}^{g'}+\mathbf{\Psi}^g\right)\left(\mathbf{I}-\mathbf{B}^g\right)^{-1'} & \left(\mathbf{I}-\mathbf{B}^g\right)^{-1}\mathbf{\Gamma}^g\mathbf{\Phi}^g \\ \mathbf{\Phi}^g\mathbf{\Gamma}^{g'}\left(\mathbf{I}-\mathbf{B}^g\right)^{-1'} & \mathbf{\Phi}^g \end{bmatrix} \quad (5)$$

In practice the population covariances and variances or parameters remain unknown. The task is then to formulate estimates of the unknown parameters based on the observed sample covariance matrix $\mathbf{S}^g$. In this line, each group's sample covariance matrix $\mathbf{S}^g$ is the object of analysis. More specifically, the "closer" $\mathbf{\Sigma}^g\left(\boldsymbol{\theta}^g\right)$ is to $\mathbf{S}^g$ for both groups, the better the model fits. The fit function is a weighted combination of the fit for all groups:

$$F = \sum_{g=1}^{G}\left(\frac{N^g}{N}\right)F^g\left(S^g,\Sigma^g\left(\theta^g\right)\right) \qquad (6)$$

where F is a general fit function, N_g is the sample size of the i-th group and $F^g\left(S^g,\Sigma^g\left(\theta^g\right)\right)$ is the fit function for the young and old firms. The F_g is fitted employing a Full information maximum likelihood estimator with robust standard errors[3] that is robust to non-normality and non-independence of observations (MLR; Yuan and Bentler, 2000). One such approach is a two stage method (Brown, 1983; Finkbeiner, 1979). In the first stage of this approach, estimates of of $\boldsymbol{\mu}^g$ and $\mathbf{\Sigma}^g$ are obtained through the EM algorithm based on a multivariate normality assumption. The second case is to proceed with analysis as in the complete data case, treating $\bar{X}_n^g$ and S_n^g as the mean and covariance matrix of the sample groups. In this stage one obtain an estimate $\tilde{\theta}^g$ of θ_0^g by minimizing the likelihood ratio function based on a normality assumption

$$\begin{aligned}
F_{ML} &= tr\left(S_n^g\Sigma^{g^{-1}}\left(\theta\right)\right) - \log\left|S_n^g\Sigma^{g^{-1}}\left(\theta\right)\right|\\
&\quad + \left(\bar{X}_n^g - \mu^g\left(\theta\right)\right)'\Sigma^{g^{-1}}\left(\theta\right)\left(\bar{X}_n^g - \mu^g\left(\theta\right)\right) - p^g
\end{aligned} \qquad (7)$$

where p is the number of variables for both young and old firms. Let $\boldsymbol{\sigma}^g = vech\left(\Sigma^g\right)$ and $\beta^g = \left(\boldsymbol{\sigma}^{g'},\boldsymbol{\mu}^{g'}\right)$, in order to study the asymptotic distribution of $\tilde{\theta}$ the distributions of $\bar{X}_n^g$ and S_n^g need to be known. Since the E-step of the EM-algorithm is based on the normality assumption, the parameter estimate $\hat{\beta}^g = \left(\text{vech}'\left(S_n^g\right),\left(\bar{X}_n^{g'}\right)\right)'$ of $\beta^g = \left(\boldsymbol{\sigma}^{g'},\boldsymbol{\mu}^{g'}\right)$ actually minimizes the log likelihood function $l\left(\beta\right) = \sum_{i=1}^{n} l_i\left(\beta\right)$[4].

The advantage of adopting a group analysis approach, lies in the fact that it allows for testing equality or invariance of estimated coefficients across groups, and thus it enables the examination of whether different groups behave similarly (Hayduk, 1987). In other words, group analysis is a moderation model whereby the dichotomous groups are thought to moderate the endogenous relationship between innovation and export performance as well as the rest of exogenous independent variables. Essentially, in order to decide whether estimate coefficients differ across groups we test for similarity as follows:

$$H_{BI}: \quad \mathbf{B}^{(y)} = \mathbf{B}^{(o)}, \qquad \mathbf{\Gamma}^{(y)} = \mathbf{\Gamma}^{(o)} \qquad (7)$$

Similarity of estimated coefficients between the two groups is a matter of degree. In the extreme case where no statistically significant differences among coefficients were observed between two groups then the results are consistent with the assumption that the same model operates in both groups.

[3] Standard errors are computed using the Huber-White sandwich estimator.

[4] This is based on the direct maximum likelihood estimation which for reasons of avoiding further complexity is not mentioned here.

4. Data and Variables definition

The information employed in the present paper comes from the Greek Observatory of R&D Active firms' (GORDA) database[5]. GORDA database is the combination of an extensive survey at the national level which was carried out in 2011 and a balanced panel of firms' financial performance concerning the period 2001-2010. It provides rich information on Greek Manufacturing firms' R&D, exporting and financial performance. Such information can be decomposed in information about financial indices and R&D expenditures as they are drawn from firms' annual balance sheets and form a panel dataset; and comprehensive and detailed information about R&D and exporting activities at the firm level for the entire Greek Manufacturing sector. The sample consists of three hundred manufacturing firms of all ages that have been engaged in R&D activities either consecutively or intermittently within the period 2001-2010.

A central issue of the theoretical and methodological framework sketched in previous sections, illustrated in Figure 1, is the distinction between young and old firms. Given the main research question of this research, an age threshold needs to be established, so as to divide the full sample into young and old firms. From the descriptive statistics presented in the upper part of Table 1 below, it becomes evident that firms entailed in the sample are exhibiting a right skewed distribution. Hence, we opted to define the age threshold at 15 years, in order to obtain a good degree of representativeness in the subsample of young firms, albeit without increasing the age threshold too far. The full sample of Greek R&D active Manufacturing firms $(n = 300)$ is therefore divided in young firms $(n = 74)$ and old firms $(n = 226)$.

Table 1. Variables definition and Descriptive Statistics

		Young firms Group		Old Firms Group	
		Descriptive Statistics			
	Definition	Average[6] (St. Dev.)	Min (Max)	Average (St. Dev.)	Min (Max)
Grouping Variable					
Firm Age		10.622 (3.342)	3 (15)	35.407 (18.794)	16 (110)
Dependent Variables (y_i)					
Export Performance	The percentage of firm sales from its foreign activities as a percentage of its total sales	0=40,5% 1=37,8% 2=9.50% 3=5.40% 4=6.80%	-	0=15.0% 1=48.7% 2=12.4% 3=11.5% 4=12.4%	-
Innovation Performance	The percentage of the firm's total sales that is due to significantly improved or new products or created due to firms' R&D activities	0.426 (0.314)	0.000 (1.000)	0.421 (0.310)	0.000 (1.000)
Independent Variables (x_i)					
Export Market Spread Eurozone	The percentage of exports destinated to Eurozone Countries	0.312 (0.403)	0.000 (1.000)	0.349 (0.318)	0.000 (1.000)
Export Market Spread Rest of Europe	The percentage of exports destinated to European Countries outside Eurozone	0.127 (0.270)	0.000 (1.000)	0.181 (0.238)	0.000 (1.000)
Export Market Spread North America	The percentage of exports destinated to the Region of North America (including Canada)	0.039 (0.128)	0.000 (0.775)	0.047 (0.112)	0.000 (0.700)
Firm's size	Firm's size: log of total number of employees	1.550 (0.551)	0.477 (3.176)	1.900 (0.617)	0.477 (3.699)
R&D stock	The accumulated 'knowledge' stock as it has been approximated by firms' yearly R&D expenditures	0.115 (0.290)	0.000[7] (2.067)	0.115 (0.217)	0.000 (1.642)
Tehnological Intensity	Dummy variable which takes the value 1 if the firm belongs to High and Medium-High tech sectors and 0 otherwise	1=33.8% 0=66.2%	-	1=40.3% 0=59.7%	-
Absorptive Capacity	Firm's absorptive capacity defined as the ratio of employees with tertiary education to total number of employees	0.280 (0.252)	0.000 (1.000)	0.261 (0.189)	0.000 (1.000)
Patent Application	A dummy variable that takes the value of 1 if the firm has applied for a patent and 0 otherwise	1=16.2% 0=83.8%	-	1=23.5% 0=76.5%	-

Focusing on the causal and reciprocal relationships

[5] Gkypali and Tsekouras (2015) present a detailed account of the survey design and methodology.

[6] In the case of binary and ordinal variables the relative frequencies are presented.

[7] Actually smaller that 0.001

between innovation and export performance variables of young and old firms, the former is a continuous variable indicating the revenues due to innovation activities as a percentage of total revenues; while the latter is an ordered categorical variable with five categories ranging from no exporting activities to exporting the entire production abroad. In order to control for potential confounding effects on the relationship of innovation and exporting performance we have included in the estimated model control variables following the dictations of the relevant literature. Two criteria have guided the identification of the best model describing the determinants of firms' innovation and exporting performance. Firstly, we looked for a meaningful and informed set of explanatory variables among the available information. Secondly, we looked for the model with the best econometric properties among alternative models. This implies that some variables with no statistical significant results have been included in our final model, as they are also regarded to be an important finding. In the lower part of Table 1, control variables' definitions along with some basic descriptive statistics are presented.

At this point some important issues regarding the present empirical application need to be addressed. First of all, one limiting factor, common to most studies on small firms, is that the dataset employed is a cross section, and thus, we have no possibility to include lagged variables directly in order to investigate a potential influence of path-dependence for both firm activities. Furthermore, the information refers to firms' belonging to the Manufacturing sector and being engaged in R&D activities during the examined period.

5. Results and Discussion

The non recursive system of equations was estimated using MPlus 7.3 software in a single and multiple-group framework, where we estimated all path coefficients simultaneously, controlling for covariates for the total sample and by subgroups, respectively. In this respect we were able to examine and test whether differences in the structural parameters across groups were statistically significant. The non-recursive system of equations was fitted by the robust maximum likelihood (MLR) estimator for continuous variables, accounting for missing data, heteroskedasticity and non-normality. A threefold advantage of the adopted approach is that it allowed us to investigate *(i) the existence of feedback loop in the relationship between innovation and export performance, (ii) the moderating effect of firm age not only with respect to a key variable but with respect to the overall model specification and (iii) the indirect effect of firms R&D capital on export performance through its direct influence on innovation performance.* Table 2 below presents estimation results for the full sample of Greek Manufacturing R&D active firms where there is no moderating role of age.

Table 2. Empirical results for the full sample estimation, i.e no moderation model

Ful sample			
Export Performance		*Innovation Performance*	
	2.955***		0.041
INNPERF	(1.136)	EXPPERF	(0.031)
	0.211***		0.196***
SIZE	(0.060)	RDSTOCK	(0.061)
	1.097***		-0.029**
MSPREURO	(0.205)	SIZE	(0.014)
	0.951***		-0.038
MSPROE	(0.224)	ABSCAP	(0.058)
	2.728***		0.079**
MSPRNAM	(0.716)	PATAPP	(0.038)
	0.456***		-0.056
TECHINTENS	(0.155)	TECINTENS	(0.037)
	-1.528***		0.477***
Cons	(0.591)		(0.063)
		$Cov(e_{ip}, e_{ep})$	-0.302***
			(0.113)

– ***, and ** denote statistical significance at 1%, and 5% level respectively.
– Standard errors are reported in parentheses.

Based on the estimation results *the existence of a feedback loop between innovation and exporting performance is not confirmed.* On the contrary, the Self Selection Hypothesis is supported by the empirical results.

In order to investigate whether firm age moderates the export-innovation nexus the multi-group analysis allows for testing for cross-group invariance by comparing two nested models: (1) a baseline model wherein no constraints were specified thus, across groups *all* structural parameters differ, and (2) a second model where critical structural parameters were constrained to be invariant between the two groups. Comparison of the two models is performed with a Wald test imposing equality restrictions in structural parameters. However, before proceeding with estimating the two nested models, we need to ensure that the same model fits separately the full sample as well as the samples of young and old firms respectively. In Table 3 below model fit indices for the separate estimations of the full and both sub-samples of young and old firms as well group model are presented. All estimated model specifications indicate a good fit and therefore, we can proceed with the examination of the moderating role of age in firms' export-innovation performance nexus. Essentially, the Wald test indicates whether age has a moderating effect on Greek Manufacturing firms by testing for equality constraints of the structural coefficients between the group of young and old firms respectively. Equality constraints were imposed to the estimated coefficients of innovation and export performance, R&D stock and export market spread.

Table 3. Model fit indices for the young and old firms' model, the no moderation model and the moderation model

	Ch.Sq., df	p-value	CFI	TLI	RMSEA
Young firms	1.051, 4	0.902	1.000	1.252	0.000
Young firms'	4.796, 4	0.309	0.985	0.935	0.030
No moperation	2.226, 4	0.694	1.000	1.046	0.000
Moderation model	4.699, 8	0.790	1.000	1.138	0.000
Wald test for equality restrictions	10.148, 5 (0.071)				

The Wald test statistic indicates that the equality constraints imposed are statistically significant, thus rejecting the hypothesis that the restricted (invariant) model matches the data. Hence, *estimation results are consistent with the assumption that firm age moderates the export-innovation performance nexus.*

Based on the estimation results of the multi-group analysis presented in Table 4 below, the causality direction between innovation and export performance differentiates with respect to firm age. While innovation performance is not a determining factor for export performance for young firms, the contrary holds for old firms. In *other words, for young Greek Manufacturing R&D active firms empirical evidence supports the Learning by Exporting Hypothesis (LEH) while for old firms, the Self Selection Hypothesis (SSH) is confirmed.*

In terms of the rest of the determining factors influencing the export-innovation performance relationship it is interesting to note that a differentiating pattern with respect to young and old firms emerges. In particular, for the group of young firms export market destination is found to play a positive and significant role in determining their export performance thus, suggesting that for young firms, export market destination is an important component in the context of their internationalization strategy. Shifting to old firms' group, while export market destination is a statistically significant determinant for export performance, the magnitude of the exerted influence is less compared to corresponding influence of these variables in the group of young firms. In addition, size and sectoral technological intensity exert a statistically significant and positive influence in export performance, suggesting that in the context of industrial dynamics the firms belonging to a routinized regime may exploit their size in order to enhance their exporting performance (Audretsch, 1991; Malerba and Orsenigo, 1993;1997).

Turning to the determining factors of young and old firms' innovation performance, young firms exhibit a rather idiosyncratic behavior in terms of the determining factors of their innovation performance. Specifically, export performance seems to be the only driving factor of their innovation performance. This finding may suggest that relatively young firms with immature knowledge bases –R&D capital is not a statistical significant driving factor- rely heavily on knowledge flows from abroad in order to improve their innovation performance. However, such knowledge flows contribute in inducing localized technical change (Gkypali et al., 2012) or in other words and quite surprisingly, young Greek Manufacturing R&D active firms rely heavily on their exploitation capabilities in order to boost their innovation performance (Choi and Shepherd, 2004;Cavusgil and Knight, 2004; 2014).

Table 4. Estimation Results of the multi-group path analysis, i.e. the moderation model

	Young Firms Group	Old Firms Group
Export Performance		
	2.173	**3.457****
INNPERF	**(1.453)**	**(1.849)**
	0.108	0.224***
SIZE	(0.113)	(0.075)
	1.275***	1.019***
MSPREURO	(0.420)	(0.328)
	1.421***	0.581*
MSPROE	(0.569)	(0.335)
	1.222***	0.126*
MSPRNAM	(0.516)	(0.068)
	0.152	0.449**
TECHINTENS	(0.259)	(0.201)
	-0.988	-1.515
Cons	(0.787)	(0.975)
Innovation Performance		
	0.107**	**-0.007**
EXPPERF	**(0.047)**	**(0.067)**
	0.197	0.200**
RDSTOCK	(0.147)	(0.093)
	-0.030	-0.022
SIZE	(0.027)	(0.018)
	-0.029	-0.086
ABSCAP	(0.077)	(0.099)
	0.060	0.090*
PATAPP	(0.071)	(0.049)
	-0.052	-0.034
TECINTENS	(0.076)	(0.047)
	0.420***	0.518***
Cons	(0.114)	(0.095)
$Cov(e_{ip}, e_{ep})$	-0.279**	-0.296
	(0.145)	(0.190)

– ***, ** and * denote statistical significance at 1%, 5% and 10% level respectively.
– Standard errors are reported in parentheses.

On the contrary, for old firms' group, it seems that cumulative investments in new knowledge are an important determining factor for increasing innovation performance. In this line, patent applications play a positive and statistically significant role in determining innovation performance. These findings suggest that old Greek Manufacturing firms rely on their innovation capabilities and invest in new technology vintages which force them to devote resources in protecting the outcome of their innovation activities (Audretsch 1996; Kafouros et al., 2008). *In sum, empirical results reveal very different patterns between young and old firms with respect to innovation-export nexus. This in turn suggests that age indeed plays a moderating role and firms at different stages of their life cycle face different prospects and constraints and thus, exhibit different strategic orientation.*

In the context of the multi group analysis, we have estimated the indirect effect of R&D stock on export

performance via its direct impact on innovation performance with the aim of unveiling a potential intermediating link between innovation and export performance. It should be noted that with respect to the estimation of indirect effects, MPlus uses the Sobel test to calculate indirect effects and employs the Delta method to calculate standard errors of the indirect effects. Simulation studies suggest parameter estimates and standard errors using MLR would be identical to those obtained with the bootstrapping procedure (Muthen and Muther, 2014). Table 5 presents estimation results of the estimated indirect effect both with respect to young and old firms group. In both groups, there is a statistically significant indirect influence of R&D capital on export performance, suggesting that the existence of an augmented knowledge base, reinforces the firms' competencies and capabilities required to succeed in foreign market penetration.

Table 5. Indirect effects of R&D Capital on Export performance

			Young firms Group	**Old Firms Group**
Source	**Mediator**	**Outcome**		
RDSTOCK	INNPERF	EXPERF	0.724* (0.406)	0.660** (0.281)

– ** and * denote statistical significance at 5% and 10% level respectively.
– Standard errors are reported in parentheses.

6. Conclusions

This paper contributes in the relevant literature as it investigates the innovation-export performance nexus by setting a theoretical framework where a two way causality direction is hypothesized to exist between the two firm activities. In this vein, the potentially moderating role of age has been highlighted were it is argued that firms at different stages of their life cycle may face different prospects and constraints and thus, may have different strategic orientation and goals. Firm's cumulative R&D investments are considered an intermediating link between innovation and export performance which provide filtering and ambidextrous capabilities to cope successfully with both activities at the same time.

We employ a sample of Greek Manufacturing R&D active firms, and adopt a multi-group analysis where a non-recursive system of equations is estimated simultaneously for two groups of firms, namely young and old firms. This econometric approach allowed us to address (i) the existence of a feedback loop in the relationship between innovation and export performance, (ii) the moderating effect of firm age not only with respect to a key variable but with respect to the overall model specification and (iii) the indirect effect of firms R&D capital on export performance through its direct influence on innovation performance.

Empirical results do not provide support for the existence of a two way causality between innovation and export performance, however, when accounting for the moderating role of firm age, differentiating patterns emerge with respect to this relationship. In particular, for the group of young firms empirical evidence supports the Learning by Exporting Hypothesis, while for the group of old firms, the opposite holds, that is empirical evidence supports the Self Selection Hypothesis. In addition, R&D capital is a strong link for innovation and export nexus for both young and old firms.

This research however suffers from some limitations. The data employed in the empirical investigations is of the cross section type while there is a potential selection bias as this research concerns firms who engage in R&D activities. Extension of our findings by using large sample panel data and widening the focus to include also the Services sector could examine the generalization of our results.

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