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THE IMPACTS OF PATENT AND R&D EXPENDITURES ON THE HIGH-TECH EXPORTS OF NEWLY INDUSTRIALISED COUNTRIES: A PANEL COINTEGRATION ANALYSIS

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The Impacts of Patent and R&D Expenditures on the High-Tech Exports of Newly Industrialised Countries: A Panel Cointegration Analysis

Robert Ackrill[1] and Rahmi Cetin[2]

Abstract

In this paper, we have sought to complement the extensive literature analysing firm level data on the links between innovation and exports, with an exploration of whether these variables are related at the country-level, for a group of eight NICs. We have been particularly interested with innovation in and export of high-tech products. At the outset, we identified seven hypotheses for testing. Our findings are that, for our panel of eight NICs over the period 1996-2014, patents and R&D expenditures both exert a significant positive effect on these countries' exports of high-tech goods.

This Working Paper presents work in progress.

The authors would welcome comments and feedback on the current state of the research presented here.

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1. Introduction

The benefit of exports to economies, via their impact on economic growth, has become an article of faith in recent decades. This has been seen in practical terms with a growing number of erstwhile developing countries exporting their way to the status of Newly Industrialised Countries (NICs).[3] The reorientation of individual countries' economic focus outwards has been complemented and enhanced by progressive liberalisation of trade globally. Conceptually, this shift has been seen through the rise of the export-led growth paradigm, followed by many hundreds of empirical studies exploring trade-growth links[4]. Given the macro-level benefits to be had from exporting, considerable attention has thus been paid to the drivers of exports.

Traditional theories and models of international trade focus on prices, influenced internally by costs and externally by exchange rates (eg Landesmann and Pfaffermayr, 1997; Branstetter and Kwon, 2018). Over time, more emphasis has been placed on non-price drivers of exports, such as innovation, primarily on the supply side (Madden *et al*. 1999). This evolution in the theoretical framing of export drivers has reflected the evolution of economic theories of growth, from theories where technological change was exogenous (eg Solow, 1956), to theories of endogenous growth (Romer, 1986; Lucas, 1988). The latter emphasise the positive impacts of technological change that has been driven proactively by economic actors undertaking innovation activities (eg Licandro and Navas-Ruiz, 2007).

The factors identified above are clearly linked in critical ways, with innovation central to much of this. Thus, investment in innovation can influence efficiency, productivity, and costs at the firm level, influencing their price competitiveness; but also, such innovation can enhance product range and quality, influencing firms' non-price competitiveness. There is

[3] We describe our focus countries below as NICs, rather than as emerging economies, to reflect our analytical interest in industrialisation in general, and the growth of exports in high-tech goods in particular.
[4] 672, according to the Econlit database on 9 July 2019. Google Scholar finds nearly 39000 hits for 'export led growth'.

also a chicken-and-egg question that many studies have addressed – do those firms export who are productive enough to be able to ('self-selection'), or do firms export and, thereby, learn, adopt and/or copy from others through the dynamics of international trade and competition ('learning-by-exporting')? That said, many studies have looked for links without exploring the possibility of there being one- or two-way causality (Damijan et al, 2010; Filipescu et al., 2013).

At a more disaggregated level again, the types of good towards which innovation is directed can have differentiated impacts on trade and growth. For example, high-tech sectors, with higher income elasticities of demand, have been found to offer greater export and growth opportunities (eg Tebaldi, 2011). Additionally, it has long been acknowledged that a high level of technological embeddedness offers greater scope for the product differentiation that underpins the intra-industry patterns of trade predicted by new trade theory (*inter alia*, Lee 1987). This enhances still further non-price competition.

Within this extensive and multi-faceted literature, however, we know of very few studies that seek to take a step back from this microscopic analysis of the drivers of exports, to look at how innovation drives exports at the aggregate level (see, notably, Braunerhjelm and Thulin, 2008. Tebaldi, 2011; and Sandu and Ciocanel, 2014, offer related analyses). Bringing together a number of the key ideas from the aforementioned literature, the purpose of the present paper is to explore how innovation activities drive high-tech exports at the level of the national economy, given all of those firm-level decisions that much of the literature concerns itself with. We contribute what we believe to be the first paper in this small literature to focus on the NICs. These countries were found, even in the early days, to have had their growth and development driven by exports (Chow, 1987). That said, doubts have been raised about their ability to undertake innovation effectively (Oura et al., 2016). In the context of endogenous growth theory, therefore, understanding countries' ability to innovate and thus achieve sustained economic development is of critical importance.

From this, we obtain our primary research question: how does innovation activity impact on a country's exports? Specifically, we apply panel cointegration and Granger causality methods to annual data from 1996 to 2014 for eight NICs, to explore a series of potentially-causal relationships between research and development (R&D) expenditures, patent applications and exports of high-tech goods. This gives us seven hypotheses that we address in our main analysis.

First, we seek to determine whether there is a long run relationship between innovation and exports:

H1: Patents and R&D expenditures affect high-tech exports positively and significantly.

We then seek to explore in detail the six possible causal relationships:

H2: There is causality running from high-tech exports to R&D expenditures

H3: There is causality running from R&D expenditures to high-tech exports

H4: There is causality running from high-tech exports to patents

H5: There is causality running from patents to high-tech exports

H6: There is causality running from patents to R&D expenditures

H7: There is causality running from R&D expenditures to patents.

The rest of the paper is organised as follows. The next section presents a brief review of some of the literature that sets the scene for our study. We then describe the data and econometric methods employed. Next, we present the empirical results, before offering our concluding thoughts on the results and their implications for policy, in our focus countries and beyond.

2. Literature Review: the links between innovation and exports

There is an extensive range of literatures that explore the possible links between innovation and exports. That said, certain themes and approaches stand out. Almost all of the literature that explores directly the link between innovation and exports does so using firm-level data. Moreover, as made clear below, many of these studies focus on a single country, which allows for the disaggregation of export drivers. This first feature of the research naturally raises the question, as noted above, of the direction of causality: do we see firms export through 'self-selection', having innovated, enhancing productivity and competitiveness; or do firms export in order to learn, that is, by exporting do they seek to adopt, adapt, learn, copy or otherwise innovate, based on their experiences in foreign markets?

Despite their various settings, a number of studies find evidence of both self-selection and learning by exporting (see Kiriyama, 2012, for a concise review). These include Yang and Chen (2012), Gkypali et al. (2015), Martins et al. (2015), Oura et al. (2016), Rodil et al. (2016) and Yang (2018). The results of Yang and Chen (2012) confirm both hypotheses for their sample of Indonesian firms. Gkypali et al (2015) also find evidence supporting both hypotheses, for Greek firms, but the findings differ by age of firm, with older firms self-selecting, younger firms learning by exporting (as might be expected, *a priori*). Martins et al (2015) focus on the engagement of Colombian entrepreneurs with innovation activity. Oura et al. (2016) also focus on a Latin American country – Brazil – and find that learning by exporting was more significant than self-selection in explaining export performance. Rodil et al. (2016) look just at firms in the Spanish region of Galicia and find evidence supporting both hypotheses. Yang (2018: 1066) is critical of the econometric approach taken by many studies, as they ignore 'the endogenous decision of exporting behavior'. Accounting for this, Yang (2018: 1079) still finds evidence of both self-selection and learning by exporting for a sample of Chinese firms, arguing that even self-selecting firms undertake more R&R as a result of their exporting activity.

Other studies focus on or find evidence only for exporting by learning. Salomon and Shaver (2005) start by noting that much of the literature at that time found evidence supporting self-selection. For a sample of Spanish manufacturing firms seek – and find – evidence of learning by exporting. Liu and Buck (2007), noting the same modelling concern as Yang (2018) above, find evidence for learning by exporting for their sample of Chinese firms. Damijan et al. (2010), meanwhile, find evidence only of learning by exporting for a sample of Slovenian firms.

From this, some studies seek to differentiate between price and nonprice factors enhancing trade. Price factors can be external, notably via the impact of exchange rate movements on R&D spending (eg Landesmann and Pfaffermayr, 1997; Branstetter and Kwon, 2018). Internal price factors come via innovation that enhances productivity (eg Magnier, and Toujas-Bernate, 1994; Madden et al., 1999; Tebaldi, 2011; Falk and Figueira de Lemos, 2019). Studies also explore the notion of innovation in more detail, distinguishing specifically between product and process innovation (eg Landesmann and Pfaffermayr, 1997; Cassiman et al., 2010; Denicolai et al., 2015; Azari et al, 2017; Yang, 2018; Radicic and Djalilov, 2019). In this literature, links are sometimes made with the self-selection versus learning by exporting literature, for example where 'learning' refers to processes (eg Damijan et al., 2010). There is also an extensive literature analysing the links between the robustness of Intellectual Property Rights regimes and trade, but this sits beyond the scope of the present paper.

The few studies that focus primarily on the links between innovation and exports, in particular for high-tech goods, typically use R&D spending and/or patent count data as a proxy for innovation. Evidence suggests that the exports of older Greek firms are explained in part by patent activity (Gkypali et al., 2015). French high-tech firms are not necessarily more innovative *per se* than non-high-tech firms, but the latter tend to focus more on process than product innovation (Enjolras et al., 2019). At the country-level, R&D expenditures have been found to boost both OECD countries' high-tech exports (Braunerhjelm and Thulin, 2008) and EU countries' high-tech exports (Sandu and Ciocanel, 2014).

Concerns have been raised about how to measure innovation, however. R&D expenditure, it has been argued, does not of itself reflect innovation. Hao et al. (2016) prefer to use new products, whilst Gorodnichenko et al. (2010: 199) highlight multiple potential problems with both patents and R&D spending as indicators of innovation – although most of these are relevant primarily to the firm level. Gorodnichenko et al. (*ibid.*) raise a concern that a small number of other studies have also explored. Firms in emerging economies are more likely to engage in imitation and adaptation of existing technologies 'than generating new inventions or expending resources on R&D.' With, imitation, adaptation and technology transfer based on vertical specialisation along global value chains, it is plausible to suggest that the relationship between innovation and high-tech exports is a statistical anomaly (Mani, 2000; Srholec, 2007).

Mani (2000) draws on data that are now over 20 years old, however, thus his cautionary note that innovation activity and high-tech exports in developing countries are fast catching-up developed countries can be seen as particularly prescient. Moreover, whilst Srholec (2007: 248) finds that much of the trade in high-tech products can be attributed to the development of global supply chains, where 'developing countries typically attract manufacturing-based fragments of global production networks in electronics, while technology-intensive activities remain concentrated elsewhere.' That said, Srholec (2007: 249) admits to a notable limitation in his study, that 'the cross-sectional nature of the analysis […] prevents us from capturing dynamic effects related to increasing alignment of countries to the global production networks.' Given all of the analyses outlined earlier that reflect the crucial dynamics of both self-selection and, perhaps more importantly, learning by exporting, the 'statistical anomaly' argument is perhaps weaker now than in earlier decades.

In drawing this review of relevant extant literature to a close, it is important to reflect on the main themes. First, almost all of the studies analysed use firm-level data. Second, strong interlinkages are to be found across themes – so that, for example, several studies exploring whether firms are self-selecting exporters or seeking to learn by exporting, also differentiate between product and process innovation. Similarly, several of these studies also analyse whether the factors underlying the ability to export are derived from price or nonprice innovations or developments. Some studies have specifically questioned whether or not patents and/or R&D spending actually reflect successful innovation activity. What has been shown to be severely lacking from the extant literature, however, is analyses of how these factors play out at the country-level. It is to this question that we now turn.

3. Data and Methodology

The main objective of this study is to investigate empirically both the long-run and causality relationships of patents and R&D expenditures on high-tech exports in the eight NICs for 1996-2014 period: Brazil, Mexico, Malaysia, China, South Africa, India, Thailand and Turkey.[5] We use panel cointegration and panel Granger causality testing procedures. Following the literature (see Shan and Sun, 1998; Cetin, 2016), the long-run multivariate relationships between high-tech exports, patents, and R&D expenditure are set as follows:

$$lhx_{it} = \mu_0 + \phi_1 lrd_{it} + \phi_2 lpt_{it} + \varepsilon_{it} \quad (1)$$

[5] All bar India are classified by the World Bank for 2019/20 as upper middle income countries (India is a lower middle income country): https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

where lhx, lrd, and lpt represent the logarithms of high-tech exports, R&D expenditures and the number of patent applications respectively; i represents the eight NICs, our cross-sectional variable here; and ε's are the error terms. In equation (1), the coefficients of R&D expenditures (ϕ_1) and patents (ϕ_2) are expected to have positive signs according to the above literature.

Data on high-tech exports, patents and R&D expenditures have been collected from the World Bank official website. All three variables used in our model are in log form, so the coefficients of the independent variables are interpreted as elasticities. High-tech exports are measured as the percentage of total exports; and R&D expenditure is calculated as a share of GDP. Patents are measured by the number of patent applications. The data for high-tech exports, obtained from the World Bank, World Development Indicators, refer to the products with high R&D intensity, such as aerospace, computers, pharmaceuticals, scientific instruments and electrical machineries.

In order to obtain the panel cointegration vector based on the panel dynamic ordinary least squares (DOLS) estimator, the following model is estimated as follows.

$$lhx_{it} = \mu_0 + \phi_1 lrd_{it} + \phi_2 lpt_{it} + \sum_{k=K_i}^{K_i} \alpha_k \Delta lrd_{it} + \sum_{k=K_i}^{K_i} \beta_k \Delta lpt_{it} + \varepsilon_{it} \qquad (2)$$

The strong assumption of homogenous β in the LLC test is difficult to satisfy given that the fact that cross-sectional units may have different speeds of adjustment towards the long-run equilibrium. By relaxing this assumption, Im et al. (2003) proposed a panel unit root test which allows β to vary across all i. Therefore, in the Im et al. (2003) testing procedure, Equation (2) is re-written as follows:

$$\Delta y_{it} = \alpha_{it} + \beta_i y_{it-1} + \sum_{j=1}^{k} \delta_j y_{it-j} + \varepsilon_{it}$$

Testing for a unit root in the panel is undertaken using the Augmented Dickey Fuller (ADF) statistic, averaged across groups. The null hypothesis of $\beta_i = 0$ for all i is tested against the alternative hypothesis of $\beta_i < 0$ for at least one i. The null hypothesis accordingly implies that all series have a unit root, while the alternative hypothesis suggests that some of the series in the panel are assumed to be stationary.

According to Granger's representation theorem, if there is cointegration there must be Granger causality in at least one direction and therefore one can reformulate the VAR model as a VEC model, in which an error correction term is included. Using the three variables of interest, high-tech exports (lhx), patents (lpt) and R&D expenditures (lrd), and following Johansen and Juselius (1990), we formulate the VEC model to obtain the following system of equations.

$$\Delta lhx_{it} = \alpha_{1i} + \sum_{p=1}^{k} \beta_{11i} \Delta lhx_{t-p} + \sum_{p=1}^{k} \beta_{12i} \Delta lrd_{t-p} + \sum_{p=1}^{k} \beta_{13i} \Delta lpt_{t-p} + \varphi_{1i} ec_{it-1} + \varepsilon_{1it} \quad (4)$$

where Δ is the first difference operator, k is the optimal lag length, ec_{it-1} is the residuals from the cointegrating equations, φ is the error correction coefficients and ε is the error terms

This specification for Granger causality allows us to investigate both the long-run and short-run causalities between the variables of interest. Long-run causality is determined by the statistical significance of the t-statistics on the error correction coefficient φ. When the coefficient is negative and statistically significant, it means that the independent variables Granger cause the dependent variable in the long-run. Short-run causality between pairs of variables, such as from R&D expenditure to high-tech exports, is tested by the Wald test, by imposing $\beta_{12i} = 0$.

4. Empirical Results

In our panel cointegration and causality analysis, first, the unit root test determines whether the relevant variables, high-tech exports, patents, and R&D expenditures, are stationary. If not, the estimation of the model yields spurious results (Baltagi, 2005). There are two types of unit root tests; a common unit root test and individual unit root tests for each panel member. In this study, we use and report only the common unit root test proposed by Im et al. (2003). The lag length for the unit root tests was selected based on the Schwarz information criteria, with estimation of an initial three lags on the first-differenced dependent variable. The results of the common unit root tests are reported in Table 1. The results do not provide a uniform conclusion that the null hypothesis of a unit root can be rejected at appropriate levels. However, the test statistics for first-differences strongly reject the null hypotheses, implying that the variables are stationary in first-difference form. From the unit root analysis, we therefore conclude that the variables are integrated of order one, indicating the existence of a possible long-run cointegrating relation among high-tech exports, patents, and R&D expenditures.

Table 1: Results for the Panel Unit Root Tests

	Levels		**First Differences**	
	Constant	**Constant + trend**	**Constant**	**Constant + trend**
lhx	-0.753 (0.225)	-1.233 (0.108)	-6.299^{***} (0.000)	-4.876^{***} (0.000)
lrd	-1.141 (0.126)	-1.609^{*} (0.053)	-8.579^{***} (0.000)	-3.834^{***} (0.000)
lpt	-3.070^{***} (0.001)	-1.449^{*} (0.073)	-11.45^{***} (0.000)	-8.039^{***} (0.000)

Notes: Superscripts *** and * show 1% and 10% significance level, respectively. Values in parentheses are probabilities.

The next step is to test whether there is a long-run relationship between the variables. There are different tests for cointegration, such as Kao (1999), Pedroni (1999, 2004) and a Fisher-type test using an underlying Johansen methodology (Maddala and Wu, 1999). In this study Pedroni's (2004) cointegration test is employed, to check whether there is a cointegrating relationship between the variables. The results are provided in Table 2. This test uses seven test statistics; four for 'within dimension' and three for 'between dimension'. From the estimation of Equation (2) with an intercept and a trend, six out of eleven test statistics are found to be statistically significant at the 1% significance level. This means that we can reject the null hypothesis of no cointegration and assert that there is a long-run relationship between high-tech exports, patents, and R&D expenditures.

Table 2: Pedroni (2004) Residual Cointegration Test Results

Alternative hypothesis: common AR coefficients. (within-dimension)				
	t -Stat.	**Prob.**	**Weighted Stat.**	**Prob.**
Panel v-Stat.	-1.534	0.937	-2.886	0.998
Panel rho-Stat.	0.857	0.804	1.474	0.929
Panel PP-Stat.	-2.405	0.008^{***}	-3.438	0.000
Panel ADF-Stat.	-2.922	0.001^{***}	-3.681	0.000
Alternative hypothesis: individual AR coefficients. (between-dimension)				
	t -Stat.	**Prob.**		
Group rho-Stat.	2.670	0.996		
Group PP-Stat.	-3.468	0.000^{***}		
Group ADF-Stat.	-4.465	0.000^{***}		

Note: Superscript *** shows 1% significance level. The tests are carried out with one lag. Estimations are carried out using Eviews.

Once the cointegration relationship is established, the next step is to estimate the long-run coefficients of the relevant variables. The long-run coefficients are estimated by means of the dynamic ordinary least squares (DOLS) method developed by Pedroni (1999, 2004). In order to determine the appropriate lag length for the DOLS model, we use four information criteria, namely Final Prediction Error, Akaike Information Criteria, Schwarz Information Criteria, and Hannan and Quinn Information Criteria. For this purpose, we first estimate an unrestricted VAR model with a constant term for our three variables. Most of these lag selection criteria identify a lag length of 1. Results from the panel DOLS estimations are reported in Table 3. As can be seen from the table, both patent and R&D expenditure affect positively and significantly the performance of high-tech exports from the NICs, a finding in line with the theoretical framework. A 1 percent increase in the level of R&D expenditure causes a 1.09 percent increase in the level of high-tech exports, while a 1 percent increase in the number of patent applications is associated with a 0.41 percent increase in the level of high-tech exports.

Table 3: Results from Panel Dynamic Least Squares (DOLS) Method

Variable	**Coefficient**	**t -Stat.**	**Prob.**
lrd	1.093	2.213	0.032**
lpt	0.412	5.006	0.000***
R-squared	0.997	Mean dependent var	1.891
Adjusted R-squared	0.992	S.D. dependent var	1.160
S.E. of regression	0.102	Sum squared resid	0.477
Lon-run variance	0.003		

Notes: Lead and lags were set to one for the panel DOLS estimator. Superscript *** and ** show 1% and 5% significance levels respectively.

Having determined long-run cointegration, we now search for causality and directionality between all pairs of variables. The results of the pairwise Granger causality test are presented in Table 4, where the computed W-Statistics and Z-bar-Statistics, with their probabilities, are reported. The results of the analysis showed that high-tech exports have a bi-directional causal relationship with both patents and R&D expenditures for the NICs. This finding is consistent with the outcomes of panel DOLS estimation above, that patents and R&D expenditures contribute to the performance of high-tech exports from the NICs. The result also show that there are no causal relationships between patents and R&D expenditures.

Table 4: Results from Pairwise Dumitrescu-Hurlin Panel Granger Causality Tests

Sample: 1996-2014 Lags: 1 **Null hypothesis:**	**W-Stat.**	**Z-bar-Stat.**	**Prob.**
lhx does not homogenously cause lrd	3.902^{***}	3.697^{***}	0.000
lrd does not homogenously cause lhx	2.570^{*}	1.866^{*}	0.061
lhx does not homogenously cause lpt	3.235^{***}	3.197^{***}	0.001
lpt does not homogenously cause lhx	3.568^{***}	3.738^{***}	0.000
lrd does not homogenously cause lpt	1.539	0.448	0.653
lpt does not homogenously cause lrd	1.611	0.547	0.583

Note: Superscript *** and * show significance at 1% and 10% level respectively. The optimal lag length is determined using the Schwarz information criteria. Estimations are conducted using Eviews.

5. Discussion and Conclusions

In this paper, we have sought to complement the extensive literature analysing firm level data on the links between innovation and exports, with an exploration of whether these variables are related at the country-level, for a group of eight NICs. We have been particularly interested with innovation in and export of high-tech products. At the outset, we identified seven hypotheses for testing. First, we sought to determine whether there is a long run relationship between innovation and exports:

H1: Patents and R&D expenditures affect high-tech exports positively and significantly

Then whether there was causality between each pair of our key variables of interest:

H2: There is causality running from high-tech exports to R&D expenditures

H3: There is causality running from R&D expenditures to high-tech exports

H4: There is causality running from high-tech exports to patents

H5: There is causality running from patents to high-tech exports

H6: There is causality running from patents to R&D expenditures

H7: There is causality running from R&D expenditures to patents.

Our findings are that, for our panel of eight NICs over the period 1996-2014, patents and R&D expenditures both exert a significant positive effect on these countries' exports of high-tech goods. Of our other six hypotheses, however, we only find evidence to support hypotheses H4 and H5. In reflecting on why this might be, we return to the earlier literature review, starting with the observations made in several previous studies about the nature of innovation, the implications and impact of R&D and the relevance of patent data.

The main arguments expressed are that whilst R&D is the main means of knowledge production (Braunerhjelm and Thulin, 2008), not all innovations arise from R&D spending

(Gorodnichenko et al., 2010). In turn, patents are not a perfect measure of R&D, but they do reflect its technological effectiveness (Cincera, 1997). Relatedly, whilst it has been argued that product and process innovation need to be analysed jointly (Szutowski and Szułczyńska, 2017), product innovation is found to enhance productivity, but not process innovation (Cassiman et al., 2010). Although some have argued that in the not-too-distant past, emerging economies engaged more in imitation and adaptation than innovation (Gorodnichenko et al., 2010), with limited resources for R&D to enhance their innovation capacity (Oura et al., 2016), in the last decade or so more patents have been filed with the China's Intellectual Property Office than any other (Cheng, 2019).

Linked to this, it has been argued that the development of global value chains has resulted in a 'statistical illusion' (Srholec, 2007). High-tech exports from 'developing countries' (Mani, 2000; Srholec, 2007) are found in the data because of the presence of developing countries within the value chains of high-tech products. Mani (2000: 53) argues that evidence from a small number of countries suggests 'it may not be very prudent to write off this performance as a mere statistical artifact [sic]', although Srholec critiques Mani's approach by exploring the import side of high-tech trade.

So where does this leave us with our own findings? First, it is important to observe that the foregoing illustrates how much the basis of trade has evolved. Thus arguments that were made two or more decades ago have now been overtaken by events. Indeed, a comparison of Gorodnichenko et al. (2010) and Cheng (2019) suggests that even in the last decade firm-level activities have evolved significantly. Second, the major difference between these cited studies and our own is that they look at firm-level activity, whilst we reflect on those relationships as they play out at the macro level. We thus have almost no other studies to compare with directly.

The only similar study, that by Braunerhjelm and Thulin (2008), also finds a significant causal link from R&D spending to high-tech exports, for OECD countries. This is consistent with one part of H1. We are not aware of any other study that includes both R&D spending and patents in such an analysis as ours. Given that we find evidence supporting H1, it is then important to observe that we find no evidence supporting H6 and H7. That is, whilst R&D spending and patents both drive high-tech exports at the national level, this finding is not muddied by possible causal connections between R&D spending and patents.

The other findings are that exports and patents are causally linked (H4 and H5), but exports and R&D spending are not (H2 and H3). Moreover, the results supporting H4 and H5 indicate that there is bidirectional causality between exports and patents (in the extensive literature reviewed earlier). If we consider first the exports-patents relationship, our findings highlight two critically important features of high-tech trade – especially when compared with the findings on exports and R&D spending. The first feature, that patents have a causal link with high-tech exports but R&D does not, reflects and reinforces the view that not all innovations arise from R&D spending (Gorodnichenko et al., 2010). Moreover, even if it is the case that R&D is the main means of knowledge production (Braunerhjelm and Thulin, 2008), knowledge needs to be applied effectively to generate innovations capable of being patented. These observations also offer support to the findings relating to H2 and H3 The second feature, of bidirectional causality, is particularly interesting because, in relation to the extensive firm-level literature discussed earlier, it provides evidence consistent with both the self-selection and learning-by-exporting hypotheses.

Our reseach overall therefore offers important findings that complement the extensive firm-level literature on innovation and exports. Moreover, it offers important updates on what has been shown, through reflection on a literature spread across at more than two decades, to be the fast-moving nature of firm-level innovation and its impact on macro-level aggregates –

exports in this case. We have provided evidence that supports the argument that the NICs have seen their high-tech exports boosted in the long-run by both R&D spending and patent activity. This is a significant finding, not least because it suggests that in contrast with firm-level findings of even a decade or so ago, innovation activities in the NICs have advanced considerably, with considerable positive consequences for exports.

Our findings regarding causal relationships between our three primary variables then add more nuance. Importantly, the absence of evidence for a significant causal link between patents and R&D spending reinforces the robustness of the findings about the long-run impact each of them has on high-tech exports. Meanwhile, our other findings provide a set of complementary results to the arguments, present in the firm-level literature, regarding the nature of R&D and patents, and their relationship with innovation.

We remain surprised by the lack of research exploring these relationships at the country-level. We therefore hope that this study will stimulate more research on this topic. What do the findings suggest for emerging economies in waves of development following the NICs in our sample? Might there be other factors influencing these relationships at the macro level that we have not considered? As more macro level studies are undertaken, how exactly do these findings relate to the many firm-level studies? And what might the answers to that question imply for government policy? What can governments do in terms of creating a facilitating environment for firms to enhance their innovation activity, that then feeds back into macro-level exports? And what, as a result, might that all mean for promoting economic transformation and export-led growth?

References

Azari, M.J., Madsen, T.K. and Moen, Ø. (2017) Antecedent [sic] and Outcomes of Innovation-Based Growth Strategies for Exporting SMEs. *Journal of Small Business and Enterprise Development*, 24, 733-752.

Baltagi. B.H. (2005) *Econometrics Analysis of Panel Data*, 3. Chichester: John Wiley & Sons.

Branstetter, L.G. and Kwon, N. (2018) South Korea's Transition from Imitator to Innovator: The role of external demand shocks. *Journal of the Japanese and International Economies*, 49, 28-42.

Braunerhjelm, P. and Thulin, P. (2008) Can Countries Create Comparative Advantages? R&D expenditures, high-tech exports and country size in 19 OECD countries, 1981-1999. *International Economic Journal*, 22, 95-111.

Cassiman, B., Golovko, E. and Martínez-Ros, E. (2010) Innovation, Exports and Productivity. *International Journal of Industrial Organization*, 28, 372-376.

Çetin, R. (2016) Yeni Sanayileşen Ülkelerde Ar-Ge Harcamaları ve Yüksek Teknoloji Ürünü İhracatı Arasındaki İlişkinin Panel Veri Analizi Yöntemi ile İncelenmesi. *İktisat Fakültesi Mecmuası*, 66, 30-43.

Cheng, W. (2019) China Engages with the [sic] Global Intellectual Property Governance: The recent trend. *The Journal of World Intellectual Property*, 22, 146-161.

Cincera, M. (1997) Patents, R&D, and Technological Spillovers at the Firm Level: Some evidence from econometric count models for panel data. *Journal of Applied Econometrics*, 12, 265-280.

Chow, P.C.Y. (1987) Causality between Export Growth and Industrial Development: Empirical evidence from the NICs. *Journal of Development Economics*, 26, 55-63.

Damijan, J.P., Kostevc, Č. and Polanec, S. (2010) From Innovation to Exporting or Vice Versa? *The World Economy*, 33, 374-398.

Denicolai, S., Hagen, B. and Pisoni, A. (2015) Be International or be Innovative? Be Both? The role of the entrepreneurial profile. *Journal of International Entrepreneurship*, 13, 390-417.

Enjolras, M., Camargo, M. and Schmitt, C. (2019) Are High-Tech Companies More Competitive Than Others: An empirical study of innovative and exporting French SMEs. *Technology Innovation Management Review*, 9, 33-48.

Falk, M. and Figueira de Lemos, F. (2019) Complementarity of R&D and Productivity in SME Export Behavior. *Journal of Business Research*, 96, 157-168.

Filipescu, D.A., Prashantham, S., Rialp, A. and Rialp, J. (2013) Technological Innovation and Exports: Unpacking Their Reciprocal Causality. *Journal of International Marketing*, 21, 23-38.

Gkypali, A., Rafailidis, A. and Tsekouras, K. (2015) Innovation and Export Performance: Do young and old innovative firms differ? *Eurasian Business Review*, 5, 397-415.

Gorodnichenko, Y., Svejnar, J. and Terrell, K. (2010) Globalization and Innovation in Emerging Markets. *American Economics Journal: Macroeconomics*, 2, 194-226.

Hao, L., Qiu, B. and Cervantes, L. (2016) Does Firms' Innovation Promote Export Growth Sustainably? Evidence from Chinese manufacturing firms. *Sustainability*, 8 (11), 1173: https://doi.org/10.3390/su8111173.

Im, K.S., Pesaran, M.H. and Shin, Y. (2003) Testing for Unit Roots in Heterogeneous Panels. *Journal of Econometrics*, 115, 53-74.

Johansen, S. and Juselius, K. (1990) Maximum Likelihood Estimation and Inference on Cointegration – with Applications to the Demand for Money. *Oxford Bulletin of Economics and Statistics*, 52, 169-210.

Kao, C. (1999) Spurious Regression and Residual-Based Tests for Cointegration in Panel Data. *Journal of Econometrics*, 90, 1-44.

Kiriyama, N. (2012) Trade and Innovation: Synthesis report. OECD Trade Policy Papers No. 135. Paris: Organisation for Economic Cooperation and Development. Available at: https://www.oecd-ilibrary.org/trade/trade-and-innovation_5k9gwprtbtxn-en (last accessed 7 October 2019).

Landesmann, M. and Pfaffermayr, M. (1997) technological Competition and Trade Performance. *Applied Economics*, 29, 179-196.

Lee, Y.S. (1987) A Study of the Determinants of Intra-Industry Trade among the Pacific Basin Countries. *Weltwirtschaftliches Archiv*, 125, 346-358.

Licandro, O. and Navas-Ruiz, A. (2007) Trade Liberalization, Competition and Growth. EUI EUI Working Paper ECO 2007/19. Available at: https://cadmus.eui.eu/handle/1814/7106 (last accessed 7 October 2019).

Liu, X. and Buck, T. (2007) Innovation Performance and Channels for International Technology Spillovers: Evidence from Chinese high-tech industries. *Research Policy*, 36, 355-366.

Lucas, R.E. (1988) On the Mechanics of Economic Development. *Journal of Monetary Economics*, 22, 3-42.

Maddala, G.S. and Wu, S. (1999) A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test. *Oxford Bulletin of Economics and Statistics*, 61, 631-652.

Madden, G., Savage, S.J. and Thong, S.Y. (1999) Technology, Investment and Trade: Empirical evidence for five Asia-Pacific countries. *Applied Economics Letters*, 6, 361-363.

Magnier, A. and Toujas-Bernate, J. (1994) Technology and Trade: Empirical evidences [sic] for the major five industrialized countries. *Weltwirtschaftliches Archiv*, 130, 494-520.

Mani, S. (2000) Export of High Technology Products from Developing Countries: Is it real or a statistical artifact [sic]? United Nations University Institute for New Technologies Discussion Paper #2001. Available at:

http://archive.unu.edu/hq/library/Collection/PDF_files/INTECH/INTECHdp2001.pdf (last accessed 7 October 2019).

Martins, I., Goméz-Araujo, E. and Vaillant, Y. (2015) Mutual Effects Between Innovation Commitment and Exports: Evidence from the owner-manager in Colombia. *Journal of Technology Management & Innovation*, 10, 103-116.

Oura, M.M., Novaes Zilber, S. and Luiz Lopes, E. (2016) Innovation Capacity, International Experience and Export Performance of SMEs in Brazil. *International Business Review*, 25, 921-932.

Pedroni, P. (1999) Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. *Oxford Bulletin of Economics and Statistics*, 61, 653-670.

Pedroni, P. (2004) Panel Cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory*, 20, 597-625.

Radicic, D. and Djalilov, K. (2019) The Impact of Technological and Non-Technological Innovations on Export Intensity in SMEs. *Journal of Small Business and Enterprise Development*, 26, 612-638.

Rodil, Ó., Vence, X. and del Carmen Sánchez, M. (2016) The Relationship Between Innovation and Export Behaviour: The case of Galician firms. *Technological Forecasting & Social Change*, 113, 248-265.

Romer, P.M. (1986) Increasing Returns and Long-Run Growth. *Journal of Political Economy*, 94, 1002-1037.

Salomon, R.M. and Shaver, J.M. (2005) Learning by Exporting: New insights from examining firm innovation. *Journal of Economics & Management Strategy*, 14, 431-460.

Sandu, S. and Ciocanel, B. (2014) Impact of R&D and Innovation on High-Tech Export [sic]. *Procedia Economics and Finance*, 15, 80-90.

Shan, J. and Sun, F. (1998) On the Export-led Growth Hypothesis: The econometric evidence from China. *Applied Economics*, 30, 1055–1065.

Solow, R.M. (1956) A Contribution to the Theory of Economic Growth. *Quarterly Journal of Economics*, 70, 65-94.

Srholec, M. (2007) High-Tech Exports from Developing Countries: A symptom of technology spurts or statistical illusion? *Weltwirtschaftliches Archiv*, 143, 227-255.

Szutowski, D. and Szułczyńska, J. (2017) Exploring Companies' Innovation Policies in the Industrial Sector in Central and Eastern Europe. *Journal of Management and Business Administration. Central Europe*, 25, 158-176.

Tebaldi, E. (2011) The Determinants of high-Technology Exports: A panel data analysis. *Atlantic Economic Journal*, 39, 343-353.

Yang, C.-H. (2018) Exports and Innovation: The role of heterogeneity in exports. *Empirical Economics*, 55, 1065-1087.

Yang, C.-H. and Chen, Y.-H. (2012) R&D, Productivity, and Exports: Plant-level evidence from Indonesia. *Economic Modelling*, 29, 208-216.

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