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Abstract

This paper investigates the link between innovation and export market participation using Australian small and medium enterprises (SMEs) data. The results show that export and innovation are positively linked. Depending on the industry and the type of innovation (process or product), innovation may lead to export and, to a lesser extent, export may lead to innovation. Firms in the primary sector (agriculture and mining) show the strongest evidence that innovation leads to export. From firms in the services sector, there is indication that only process innovation leads to export. Also, only in this sector, there is evidence that export may lead to (process) innovation.

JEL classification: F14, O12, O14, O31

Keywords: Innovation, export, small and medium enterprises, propensity score matching

I Introduction

This paper empirically investigates the direction of causality between innovation and export market participation using firm level data of Australian small and medium enterprises (SMEs) employing 200 or fewer workers. A better understanding of the effects of globalisation on economic performance, particularly on the performance of firms, is important to ensure that relevant public policy attains its optimum benefit. One potential benefit of globalisation that could serve for the rationale of such policy comes in the form of productivity improving mechanism resulting from the participation in the international market such as the export market.

Existing empirical evidence and theoretical predictions indicate that, instead of being a "by-product" of the hypothesised learning-by-exporting effects, the productivity advantage of exporting firms relative to non-exporting firms comes from their pre-export differences in performance (Aw et al, 1997; Bernard and Jensen, 1999 and 2004; Melitz, 2003). This puts the assertion of the productivity improving benefits of export market participation into question. However, recent studies have analysed the intermediate role of innovation and investment in Research and Development (R&D) in the export and performance relationship more closely. They have found evidence of possible learning effects from participating in the export market via that intermediate channel (Crespi et al. 2008; Damijan et al., 2010; Girma et al., 2003 and 2008; MacGarvie, 2006; Fernandes and Paunov, 2010; Bustos, 2011).

Thus, if the role of learning from exporting is really important as the above studies seem to suggest, then a failure in recognising it could lead to suboptimal policy formulation for taking advantage of globalisation. However, due to firm and country-level heterogeneity, we still need further evidence on the importance of innovation in determining the direction of causality between globalisation and economic performance. In other words, we need additional studies which focus on the role of the intermediate step, namely innovation.

This paper contributes to the existing literature by evaluating the link between exports and innovation in a similar fashion to recent studies such as Damijan et al. (2010) and Crespi et al. (2008). However, unlike these and many of the existing studies which concentrate on medium and large manufacturing firms, we utilise data from a sample of small and medium firms from all industrial sectors: primary (agriculture, fishery and forestry, and mining), secondary (manufacturing), and tertiary (services). Our more specific contribution for the relevant literature in the case of Australian economy is that this paper provides further insights to those established by existing studies such as Palangkaraya and Yong (2007; 2011)

on the relationship between international trade and productivity by looking at innovation as the likely intermediate step.

More generally, this paper contributes to debate on the benefits of pro-globalisation policy to small and medium firms from across different sectors. A confirmation of the learning-by-exporting hypothesis, for example, indicates that export market participation improves small and medium firms' performance through the stimulation of innovative activities. Thus, the potential benefits from policies designed to improve global market activities (particularly in the export market) would be higher than in the case when there is no learning effects and that such policies may be more effective if coordinated with innovation policy. Furthermore, the findings of this paper could also demonstrate how the learning effects are generated given existing differences in the types of innovation involved. With a better understanding of these issues, the government would be in a better position in designing policies that can address any market failure which may lead suboptimal resource allocations on different types of innovative and export market activities.

To achieve our objective, in this paper we apply the propensity matching score (PSM) methodology on firm level panel data obtained from the Australian Bureau of Statistics' Business Longitudinal Database 2004/05 to 2006/07. The panel data cover approximately 3000 firms with 200 employees or less. These small and medium businesses operate in all sectors of the Australian economy except Government administration, Education, Health, and Utilities which have been excluded from the database. The rest of the paper is structured as follows. Section 2 provides a brief discussion on recent related studies and the institutional backgrounds (Australian SMEs export and innovation activities in general and case-study inspired illustrations of the link between export and innovation from SMEs in Australian wine industry and those which have received Australian Exporter Award between 2001 and 2010). Section 3 discusses the empirical framework and the data. Section 4 presents and discusses the results. Section 5 summarises the finding and discusses some of the policy implications.

II Literature Review

(i) Export and Innovation

The link between export and productivity has been the subject of many different studies for many years due to its important implications on the benefits of globalisation and the inter-link between industrial and innovation policy and trade policy. As the availability of large, firm-level, longitudinal data has improved over the last fifteen years, our ability to evaluate two major competing hypotheses (which are not mutually exclusive) behind the export-

productivity relationship has also improved in terms of details and sophistication. The first hypothesis of interest is called the 'self-selection' hypothesis and it is based on the idea that "better" or more productive firms self-select into export market because of the potentially high extra costs for entering the foreign markets. These transaction costs of exporting may include, for examples, transportation costs, distribution or marketing costs, or the costs to tailor the products for foreign consumers. Because of such entry barriers, firms may exhibit forward looking behaviour by taking actions for improving their productivity before entering any foreign market. As a result, any cross-sectional performance difference between exporters and non-exporters can be explained by the *ex ante* differences between the two types of firms.

The competing hypothesis, the learning-by-exporting hypothesis, argues that export market participation provides the opportunity for exporters to improve their performance due to a higher level of market competition and the potential for knowledge flows from international consumers. Wagner (2007), for example, surveys more than 40 studies based on firm level data from more than 30 countries and finds that a majority of the studies supports the self-selection hypothesis while participation in the export market does not appear to lead to improved productivity.

The lack of support for the learning-by-exporting hypothesis is further shown by a number of recent theoretical and empirical models which emphasise the role of firm heterogeneity and R&D. For example, Constantini and Melitz (2008) endogenises firm's decision to export and innovate and shows that the export-productivity link can be explained by the decision to innovate before the export market entry. Recent empirical studies, such as Aw et al. (2008), look at the relationship in more details by incorporating R&D investment or innovation decision and also find evidence for the self-selection hypothesis. Other recent studies which also support the self-selection hypothesis include Kirbach and Schmiedeberg (2008) and Chada (2009). The latter is interesting because it finds that innovation can act as a strategic tool to gain market share in the world markets and thus it is important for firms to innovate to enter the export market. Finally, Long et al. (2009) explores the effects of trade liberalization on the incentives for firms to innovate and on productivity. They find that trade liberalization's impact is dominated by the self-selection effects and the effects of trade on innovation or incentive to spend in R&D depend on the costs of trade.

Nevertheless, other studies such as Crespi et al. (2008), Damijan et al. (2010), Girma et al. (2003; 2008), MacGarvie (2006) and Fernandes and Paunov (2010) provide evidence that globalisation may feed back into improved domestic performance through the learning effects

from global market participation on innovation. The last two studies mentioned above show the learning effects occur through imports while the other studies show the effects occur through export market participation. Furthermore, De Loecker (2007) and Ito (2011) find that firms which export more to higher income and more technologically advanced regions exhibit stronger learning-by-exporting effects; this is consistent with the notion that export market participation provides benefits through better access to best practice technologies (Girma et al., 2003).

However, given the reliance of most of the studies cited above on data from medium and large enterprises and, particularly, from the manufacturing sector, we need further complementary evidence based on SMEs. For reasons such as the costs of acquiring legal protections on innovation and their enforcement, it has been argued that SMEs may have a lower propensity to innovate than larger firms (for examples, Acs and Audretsch, 1988 and Arundel and Kabla, 1998). Furthermore, Jensen and Webster (2006) argue that the implication of underinvestment in innovation activity by SMEs can potentially be more significant than realised given that SMEs may hold a significant share of overall economic activity. In other words, a better understanding of the innovative patterns of SMEs is crucial for an effective innovation policy in order for it to generate economic growth in the most optimal way. For example, SMEs may lack the necessary absorptive capacity to tap from world's best practice technology in the global market, reducing the learning by exporting effects (Ito and Lechevalier, 2010). Similarly, individual SME's export revenues may not be large enough to induce the firm to invest in new technologies, an important channel for trade liberalization to lead to growth following their entrance to the export marker argued by Bustos (2011).

In addition, we also need further analysis of firms in industrial sectors other than manufacturing and the role of different types of innovation. First, the extent of market failure in innovation activities vary by industrial sectors and the effectiveness of instruments to combat such market failure including the provision of intellectual property rights (IPRs) protection also vary by sectors (see, for example, Mansfield et al., 1981 as cited in Jensen and Webster, 2006). Second, the type of innovation activities may well vary across industrial sectors because of the multifaceted nature of innovation.

Finally, Schumpeter (1934), for example, discusses innovation in terms of product innovation, process innovation, organisation innovation and market innovation. If we recognise that the variation in the types of innovation activities as classified above correlate with the characteristics of the products or the markets in which a firm operates, then we may

find certain firms in certain industries to be more concerned with product innovation while other firms in other industries to be more concerned with process innovation. Consequently, we expect the link between innovation and export may depend on the type of innovation activity. Furthermore, IPRs protection such as patent or trade mark may be more effective for product innovation than process innovation, leading to varying patterns of innovative activities and export-innovation relationships across industrial sectors as well.

(ii) Institutional Background

Australian SMEs' export and innovative activities

The Australian SMEs present an interesting case to study the determinant of firm level innovative activities including the link between export and innovation. As in most other countries, SMEs are an important component the Australian economy accounting slightly more than 60 per cent of total employment and 50 per cent of value added (ABS, 2001). Because of these, Australian SMEs have received a lot of government's attention in terms of the various policies and incentives targeted at them in order to help them improve their productive and innovative performance.

Naturally, the importance of SMEs varies across industries (ABS, 2008). The highest share of value added contribution can be found from SMEs in the "Agriculture, forestry and fishing" (97 per cent of the industry value added in 2006/07), "Rental, hiring and real estate services" (90 per cent of the industry value added), and "Accommodation, cafes and restaurant" (75 per cent of value added). In contrast, the lowest share of value added can be found from SMEs in "Retail trade" (56 per cent of industry value added), Manufacturing (45 per cent), and "Information media and telecommunication" (17 per cent).

Similarly, the role of SMEs in Australia's export activities also varies by industries. Overall, in 2005-06, SMEs account for 90 per cent of the number of Australian businesses which participate in the export market. However, as found in other countries, they account for less than 10 per cent of value of the goods exported (ABS, 2006). Furthermore, a recent statistical report, ABS (2010), shows that based on the value of goods export, by the financial year of 2008-09 SMEs' share is the highest in the following sectors: "Construction" (37 per cent), "Transport, postal and warehousing" (23 per cent) and Wholesale trade (16 per cent). Thus, we probably will not learn much on the link between export and innovation of Australian SMEs if we only look at the manufacturing industry.

On innovation, according to the latest ABS Innovation Survey conducted in 2005 (ABS, 2007), there are approximately 141,300 businesses[1] operating in Australia and around 34 per cent of them businesses undertake innovation by introducing either new product, new operational process, and/or new organisational processes.[2] As expected, the extent of innovativeness varies by business size with around 58 per cent of very large businesses (250+ employees), 46-48 per cent of medium businesses (20-99 employees), and 25-34 per cent of small businesses (5-19 employees) reported as innovators. It also varies by industry with the leading industries include "Electricity, gas and water supply" (49 per cent of businesses are innovators), "Wholesale trade" (43 per cent) and "Manufacturing" (42 per cent). It is also worth noting that, according to the innovation survey, for Australian SMEs operational process innovation is the most important type of innovation compared to the other two. Thus we may expect that if there is any link between SMEs' export and innovation activities, process innovation would be relatively more important.

Finally, in terms of the contribution to the degree of sales turnover, 65 per cent of the innovating businesses report that their product innovation account less than 10 per cent of their turnovers (ABS, 2007). In other words, in general, product innovation is not a significant revenue generator for Australian businesses. However, the contribution of production innovation on total revenues varies across industries with businesses in most services industry reported less than 10 per cent share. This result is understandable given the nature of the "product" in the service sector. In contrast, for businesses in the "Mining" and "Manufacturing" industries, the share of product innovation on total revenues range from 10 per cent to as high as 50 per cent. Also, when we look at variation across business size, it is interesting to note that none of the large businesses (100+ employees) reports that product innovation contributes more than 50 per cent of business turnovers. In contrast, 12 per cent of small businesses with 5–19 employees reported that more than 50 per cent of their turnovers can be attributed to product innovation. In other words, innovation appears to be more important for the livelihood of smaller businesses, again highlighting the importance of a study of SMEs to complement the studies based on data on large enterprises.

[1] The ABS uses the term "Businesses" while in this paper we use the term "enterprises" to be consistent with the term (that is, SME) used in the existing literature.
[2] Here, 'new' may refer to 'new to the business' (74 per cent of product innovation), 'new to the industry' (10 per cent), 'new to Australia' (10 per cent), or 'new to the world' (6 per cent).

Case studies

Given the anonymity of the firms in the BLD panel data we use, to help in interpreting the estimation results we discuss briefly the case of Australian wine industry and SMEs which are the recipients of the Australian Exporter Award given annually.[3] The first, based on an in depth study of Aylward (2004; 2006), illustrates the relationship between innovation and export for Australian wine producers. The second case highlights some important characteristics of SMEs and how they relate to export performance, particularly for SMEs in the Service sector.

The most important lesson for these two case studies which will be discussed below is that export market participation appears to be driven by the firms' ability to continuously come up with better processing technology via skill and technology updating to deliver their services.[4] Thus, it appears export market participation depends more on process innovation than on product innovation. Furthermore, how business owners or managers view the importance of innovation matters.

Australian Wine Industry

According to Aylward (2004; 2006), Australia was the fourth largest exporter of wine in terms of value sharing around forty per cent of global wine exports to the United States in 2004. The Australian wine industry consists of two major clusters (South Australia and New South Wales & Victoria). However, while the South Australian cluster only accounted for around twenty five per cent of wineries, its shares of Australian's total wine production and export were fifty and sixty per cent respectively. More interestingly, Aylward's studies find a close link between the South Australian wine cluster's higher productivity and propensity to export and explain that the differences between the two clusters in terms of the business owners or managers' beliefs on the importance of innovation. For example, sixty six per cent of wine producers in South Australia responding to Aylward's interview thought there was a strong link between their innovation and export performance. In contrast, only forty two per cent of the respondents from the New South Wales & Victoria clusters believed the same. The interviewees also differed in terms of how they defined innovation, the extent of their firm's collaboration, and the use of Australian wine industry's research and analytical

[3] The Australian Export Awards has run for 48 years and provided recognitions and honors to exceptional Australian exporters based on the criterion of sustainable export growth achieved through innovation and commitment. See http://www.exportawards.gov.au/default.aspx (accessed March 11, 2011) for more details.

[4] See the case studies for the award winners provided by Australian Export Awards website mentioned in the previous end note.

services. One other finding to note from the study is that while there was negligible difference in how the firms in both clusters define product innovation, they differ significantly in defining what they thought a process innovation entailed. This last finding points to the possibility that process innovation is probably more important than product innovation in explaining the link between export and innovation in the industry.

Australian Exporter Award Winners in Services Sector

In the last forty eight years, the Australian government has given awards to businesses deemed to have exceptional performance in the export market every year. The awards are given to businesses belonging in various categories such as agribusiness, arts and entertainment, emerging exporter, and large and advanced manufacturer. For the purpose of this study, two categories of particular interest are the emerging exporter and small and medium businesses in services categories. Between 2001 and 2010, twenty four businesses received the emerging exporter awards, ten of which were from the services sector. In the same period, sixteen businesses received the small and medium exporter in services awards. In terms of their product characteristics, a majority of these award recipients in the services sector operated in information technology related field (ten businesses), highly specialized engineering design and prototype manufacturing operation (eight businesses), and specialized manufacturing and industrial consultancy services for the mining industry (four businesses). For example, one these businesses which operated in information technology services and employed around fifty was considered as the largest specialist provider of independent information security consulting services in the region. Its consumers came from more than twenty countries such as Singapore, Malaysia, South Korea, Japan, the United States, and France. One other Australian small business that excelled in the export market sold maritime simulation, training and consultancy services to the international maritime and defence industries. Unfortunately, there is no detailed case study similar to Aylward (2004; 2006)'s to help us in understanding the importance of innovation to these services exporters.

III Empirical Model and Data

(i) Empirical Model

To address our research questions, we need the ability to make causal inference as opposed to simply test for the existence of correlation between innovation and export. We adopt an empirical methodology which can produce unbiased estimates of the relevant treatment effects (from being an exporter or being an innovator) by assuming that that we have

observables to explain firms' propensity to either export or innovate to control for unobserved confounding factors. In particular, we follow the approach used in similar studies such as Becker and Egger (2010) and Damijan et al. (2010) by adopting the propensity score matching (PSM) method.

As argued by an extensive literature on the PSM methodo such as Dehejia and Wahba (2002), the estimation of causal effects based on a comparison of treatment group with a 'non-experimental' comparison group may suffer from the problem of self-selection or other systematic biased relating to the sample selection. Under certain assumptions, the PSM method corrects the sample selection bias by pairing treatment and comparison units according to observed characteristics. The method provides a natural weighting scheme that ensures the unbiasedness of the estimated treatment effects.

In this study, there are two treatment effects of interest: innovation effects and exporting effects. We ask if innovators are more likely to become exporters than non-innovators after we control for their propensity to innovate. Similarly, we investigate the reverse direction of causality by asking if exporters are more likely to be innovators than non-exporters who exhibit a similar propensity to become exporter.

We identify non-innovators which exhibit a similar propensity to innovate and non-exporters which exhibit a similar propensity to export as by estimating the following innovation and export propensity models (Damijan et al., 2010):

$$\Pr[I_{it}=1]=f(X_{it-1})+\varepsilon_{it} \quad (1)$$

and

$$\Pr[E_{it}=1]=f(Z_{it-1})+\eta_{it} \ . \quad (2)$$

In both equations (1) and (2), in each period t firm i's propensities to innovate ($\Pr[I_{it}=1]$) and to export ($\Pr[E_{it}=1]$) are expressed as a function of observed (exogenous or predetermined) previous period characteristics such as productivity, size of employment, capital intensity and import status. Based on the estimated propensity to innovate (equation 1), we 'match' innovators and non-innovators at period t. Similarly, based on the estimated propensity to export (equation 2) we obtain a list of matched exporters and non-exporters. These two pairs represent our treatment and control groups.

We investigate the "innovation effects" on export propensity using all kind of innovation, product innovation or process innovation and for firms in three separate

subsectors (Primary, Manufacturing, Services). Specifically, using the list of matched innovators in period *t*, we estimate the average treatment effects of innovation (that is, the average treatment of the treated) on export market participation by comparing their probabilities to become exporters in period *t* and in period *t+1* separately. We expect period *t+1*'s comparison suffer less from the problem of unobserved contemporaneous shocks than the period *t*'s comparison. Similarly, we also investigate the reverse case. That is, using the resulting matched exporters in period *t*, we estimate the average treatment effects of export market participation on innovation by comparing their probabilities to become innovators (product and/or process) in period *t* and in period *t+1* separately.

We also conduct the above analyses on a subsample of our data where we only consider exporters (innovators) at period *t* who were <u>not</u> exporters (innovators) in period *t-1*. That is, we investigate an even stronger test of the direction of causality by asking if current period innovation (export market participation) leads firms to become "new" exporters (innovators) in the current or next period. However, due to sample size limitation, we do not estimate the effects at the subsector level.

(ii) Data

To estimate the models described above, we use firm level data from the first confidentialised unit record file (CURF) edition of the Business Longitudinal Database (BLD) produced by the Australian Bureau of Statistics. The first CURF edition of the BLD that we use contains data from two panels with a combined sample size of around 3,000 Australian small and medium businesses employing 200 or fewer workers each year. The first panel in the data contains annual business level data from the financial years from 2004–05 to 2006–07. The second panel covers the period between 2005–06 and 2006–07. Overall, the actual number of businesses covered by the BLD panel data with useable observations is 1,826 for 2004–05, 3,486 for 2005–06 and 3,314 for 2006–07 for a total of 8,626 firms across the years. The broad sectoral distribution of these firms by type of innovation and the firms' export status is provided in Table 1.

TABLE 1

Distribution of Firms by Sector, Innovation and Export Status (%)

Type of innovation	Export status	Sector			
		Primary (n=2,330)	**Manufacturing (n=1,324)**	**Services (n=4,972)**	**Total n=(8,626)**
Product innovation only (7.8)	Non-exporter	82.7	66.9	78.7	77.3
	Exporter	17.3	33.1	21.3	22.7
	Subtotal	100	100	100	
Process innovation only (10.9)	Non-exporter	83.8	66.1	84.1	80.7
	Exporter	16.2	33.9	15.9	19.3
	Subtotal	100	100	100	
Product and process innovation (11.3)	Non-exporter	76.2	54.5	76.7	71.4
	Exporter	23.8	45.5	23.3	28.6
	Subtotal	100	100	100	
No innovation (70.0)	Non-exporter	88.1	77.7	91.7	88.8
	Exporter	11.9	22.3	8.3	11.2
	Subtotal	100	100	100	
Total (100)	Non-exporter	86.7	71.1	88.0	85.0
	Exporter	13.3	28.9	12.0	15.0
	Subtotal	100	100	100	

Note: Primary sector includes agriculture, fishing & forestry and mining. Services sector includes construction, wholesale trade, retail trade, accommodation, cafes & restaurants, transport & storage, communication services, property & business services, cultural & recreational services, and personal & other services.
Source: Processed from pooled panel data 2004/05, 2005/06 and 2006/07 of the CURF Business Longitudinal Database (ABS, 2009) by the author.

From Table 1 above, the Services sector appears to have the largest sample size with 4,972 businesses. However, we believe this reflects more of the sample design of the BLD data collection than the actual distribution of small and medium businesses in the Australian economy. In terms of export market participation, of the 8,626 businesses in the full sample, fifteen per cent are exporters. As expected, the proportion of exporters in the sample varies by sector with the manufacturing sector having the highest proportion at around twenty nine per cent, or double the rate of the each of the other sectors. In terms of innovation, Table 1 also shows that overall around thirty per cent of the sampled SMEs have either product or process innovation (7.8% product innovation only, 10.9% process innovation only, and 11.3% both product and process innovation). As in the case of export, the proportion of innovating SMEs also varies across sectors. For example, from Table 1 we can infer that businesses in the manufacturing sector have the highest proportion of innovators with around forty per cent of the businesses having either product or process innovation.

For estimation, we clean the data to make sure that each observation has non-missing values in the relevant variables. The result is an estimating sample of around 1,800 firms for

each sample year. A descriptive summary of the pooled clean sample for the 2005–06 and 2006–07 financial years is provided in Table 2.

TABLE 2

Descriptive Statistics

Variable	Description	t =2005/06			t=2006/07		
		N	Mean	Std. Dev.	N	Mean	Std. Dev.
$PRODINNOV_t$	=1 if had goods/service innovation at period t	3670	0.203	0.402	3365	0.188	0.391
$PROCINNOV_t$	=1 if had operational process innovation at period t	3688	0.263	0.440	3376	0.209	0.407
$INNOV_t$	=1 if had product/process innovation at period t	3668	0.341	0.474	3365	0.290	0.454
$EXPORT_t$	=1 if had any export income at period t	3440	0.156	0.363	3229	0.147	0.354
$EMPSIZE_{t-1}$	=number of employees at period t	1826	30.10	43.57	3764	31.49	44.74
$LLABPRODVA_{t-1}$	= log of value added (sales less non-capital purchases) per employee at period t	1594	10.25	1.354	3252	10.36	1.343
$LINVINT_{t-1}$	= log of capital purchase per employee in period t-1	1110	7.872	2.141	1559	10.70	1.534
$IMPORT_{t-1}$	= 1 if had any import purchase	1826	0.128	0.334	3476	0.169	0.374
MFG	=1 if industry division is manufacturing	4123	0.152	0.359	3764	0.152	0.359
SERVICE	=1 if industry division is services	4123	0.584	0.493	3764	0.579	0.494

Source: Processed from pooled panel data 2004/05, 2005/06 and 2006/07 of the CURF Business Longitudinal Database (ABS, 2009) by the author.

From Table 2, in 2005–06, approximately twenty per cent of the sampled SMEs are product innovators and twenty six per cent are process innovators. The proportion of those with either type of innovation is approximately thirty four per cent. These rates are comparable to the thirty per cent innovation rate in the full sample described earlier and, if we include organisational processes innovation, our cleaned sample provides similar rate of innovation produced by the Australian Innovation Survey data discussed in Section 2. Also, from the same table, the proportion of manufacturing SMEs is approximately fifteen per cent. This is about double the proportion of manufacturing SMEs according to the overall figure for Australian SMEs (ABS, 2001), indicating that our data oversample the sector. Finally, in terms of the propensity to export, approximately 15 per cent of the SMEs in our data reported

positive export income. This is significantly less than the overall proportion of exporting SMEs discussed earlier. Because of these sampling biases, particularly the one the underestimation of export propensity, we need to be cautious in interpreting the estimation results based on the export propensity equation.

IV Results

(i) Propensity to Innovate and to Export

Tables 3 and 4 present the estimated coefficients of the propensity to innovate and to export based on equations 1 and 2 respectively.[5] These estimates are based on pooled sample across all industrial sectors as well as for each of three major industrial divisions: manufacturing, services and resources.[6] In general, as shown in Tables 3 and 4, the estimated coefficients are statistically significant and of the expected sign; and in all cases they are jointly statistically significant.

For innovation, Table 3 shows that the propensity to innovate in the current period is positively correlated with the immediately preceding period's levels of employment, labour productivity and capital intensity and whether or not the businesses had any exposure to the import market. The positive relationships with size of employment and labour productivity appear to be non-linear, with diminishing effects. For export propensity, Table 4 shows that only employment and import variables are statistically significant. It should be noted however that our variable constructed using employment size is limited in the sense that the employment size figure is only provided in three discrete intervals: 1-5, 5-19, and 20-99. This might contribute to a larger standard error of the estimates and the statistically non-significant coefficient estimates.

[5] Marginal effect estimates were obtained using STATA's dprobit command.

[6] The coefficient estimates of the propensity to innovate equation estimated at the sector level are omitted for space consideration but they are available upon request. The three sectors are defined according to ANZSIC Version 1993, Primary is A (Agriculture, Forestry & Fishing) and B (Mining), Manufacturing is C (Manufacturing), and Services is E (Construction), F (Wholesale Trade), G (Retail Trade), H (Accommodation, Cafes and Restaurants), I (Transport and Storage), J (Communication Services), L (Property and Business Services), P (Cultural and Recreational Services), and Q = Personal and Other Services.

TABLE 3

Propensity to Innovate – All Sectors

	Product or process innovation or both $\Pr[INNOV_t = 1]$		**Product innovation** $\Pr[PRODINNOV_t = 1]$		**Process Innovation** $\Pr[PROCINNOV_t = 1]$	
	Coeff.	**dY/dX**	**Coeff.**	**dY/dX**	**Coeff.**	**dY/dX**
$EMPSIZE_{t-1}$	0.030***	0.011	0.027***	0.007	0.043***	0.013
	(0.009)		(0.001)		(0.010)	
$EMPSIZE^2_{t-1}$	-0.000***	-0.000	-0.000***	-0.000	-0.000***	-0.000
	(0.000)		(0.000)		(0.000)	
$LLABPRODVA_{t-1}$	0.357*	0.127	0.300	0.063	0.564**	0.170
	(0.195)		(0.226)		(0.276)	
$LLABPRODVA^2_{t-1}$	-0.019	-0.007	-0.018	-0.005	-0.029**	-0.009
	(0.010)		(0.011)		(0.014)	
$LINVINT_{t-1}$	0.064***	0.023	0.055*	0.015	0.072***	0.022
	(0.019)		(0.029)		(0.022)	
$IMPORT_{t-1}$	0.432***	0.162	0.625***	0.204	0.410***	0.136
	(0.087)		(0.106)		(0.104)	
$YEAR_{2006/07}$	-0.478***	-0.171	-0.396***	-0.113	-0.567***	-0.174
	(0.087)		(0.105)		(0.097)	
CONST	-3.089***		-2.363***		-4.391***	
	(0.997)		(1.144)		(0.339)	
Pr[Y=1]	0.329		0.224		0.251	
N. Obs.	1996		1501		1591	
Log pseudolikelihood	-1175.4		-720.6		-801.4	
Pseudo R^2	0.071		0.097		0.1067	

Note: (): standard errors. All probit regressions were estimated with 1-digit ANZSIC industry dummy variables when applicable and with robust standard error. ***,**,* indicates statistically significant at the 1, 5, and 10% level of significance.

TABLE 4

Propensity to Export

$\Pr[Export_t = 1]$	**All sectors**		**Primary**		**Manufacturing**		**Services**	
	Coeff.	**dY/ dX**	**Coeff.**	**dY/ dX**	**Coeff.**	**dY/ dX**	**Coeff.**	**dY/ dX**
$EMPSIZE_{t-1}$	0.004***	0.001	0.002	0.000	0.006	0.002	0.004***	0.001
	(0.002)		(0.001)		(0.017)		(0.001)	
$LLABPRODVA_{t-1}$	0.029	0.005	0.002	0.000	0.071	0.025	0.041	0.006
	(0.052)		(0.035)		(0.078)		(0.056)	
$LINVINT_{t-1}$	0.016	0.003	-0.036	-0.007	0.054	0.019	0.027	0.004
	(0.045)		(0.024)		(0.055)		(0.033)	
$IMPORT_{t-1}$	1.114***	0.309	0.886***	0.244	1.091***	0.398	1.178***	0.285
	(0.214)		(0.092)		(0.173)		(0.129)	
$YEAR_{2006/07}$	-0.121	-0.023	-0.040	-0.040	-0.106	-0.037	-0.206	-0.031
	(0.178)		(0.105)		(0.246)		(0.152)	
CONST	-1.857***		-0.994		-2.336***		-2.112***	
	(0.510)		(0.425)		(0.820)		(0.619)	
Pr[Y=1]	0.153		0.121		0.321		0.120	
N. Obs.	1993		502		324		1167	
Log-likelihood	-667.2		-174.6		-166.8		-321.9	
Pseudo R^2	0.2178		0.0596		0.1799		0.2480	

Note: (): standard errors. All probit regressions were estimated with 1-digit ANZSIC industry dummy variables when applicable and with robust standard error. ***,**,* indicates statistically significant at the 1, 5, and 10% level of significance.

(ii) The Effects of Innovation on Export Market Participation

Based on the estimated coefficients summarized in Tables 3–4 (and Tables A.1–3) and the resulting innovation propensity score, each SME which innovated in period *t* (the treated firm) is matched to one or more of the non-innovating firms (the untreated firms) using the nearest neighbour propensity score matching methodologies.[7] The resulting matching

[7] In addition, we also conduct the matching process using the radius matching method. The results (available upon request) are roughly similar to the results presented in the paper based on the nearest neighbour approach; except, the radius approach tends to produce estimates with weaker statistical significance due to fewer matched samples obtained. We refer to Imbens (2004) and the cited references there in for an excellent survey of the implications of the different matching approaches. Unfortunately, due to data access restrictions put on place by the Australian Bureau of Statistic which required us to access the data indirectly via an online STATA do file submission and limited the types of STATA commands that we could issue to only built in statistical analysis command (programming commands such as the FOR loop command and non-standard ADO files were not allowed), we were not able to conduct other more sophisticated propensity matching estimation techniques, such as the kernel density based matching or bootstrapping for standard errors.

estimators for the effects of innovation on export market participation are summarised in Table 5 below.[8]

TABLE 5

Does Innovating Lead to Export?

Outcome: export ***Treatment: innovation***	**Average treatment effects on the treated**					
	$Innovation_t \rightarrow \Pr[Export_t]$			$Innovation_t \rightarrow \Pr[Export_{t+1}]$		
	ATT	SE	N	ATT	SE	N
ALL SECTORS						
Innovation type						
Product	0.168***	0.035	(334/334)	0.131**	0.061	(153/143)
Process	0.090***	0.034	(399/399)	0.114**	0.056	(201/200)
Product/process	0.104***	0.026	(655/655)	0.116***	0.043	(313/305)
PRIMARY						
Innovation type						
Product	0.222***	0.071	(45/45)	0.174**	0.810	(23/24)
Process	0.055	0.059	(73/73)	0.144*	0.079	(42/43)
Product/process	0.027	0.061	(110/110)	0.083	0.092	(60/60)
MANUFACTURING						
Innovation type						
Product	0.123	0.098	(73/73)	0.156	0.273	(28/22)
Process	0.120	0.091	(100/100)	0.137	0.208	(46/37)
Product/process	0.140**	0.069	(143/143)	0.118	0.160	(61/54)
SERVICES						
Innovation type						
Product	0.070	0.048	(214/214)	0.022	0.081	(104/106)
Process	0.098**	0.040	(225/225)	0.133*	0.062	(112/111)
Product/process	0.108***	0.030	(397/397)	0.066	0.056	(190/186)

Note: *,**,*** denote statistically significant at 10%, 5%, and 1% respectively. The standard errors are computed based on Lechner (2001) approximation. In the parentheses are the numbers of treated and matched control (possibly not unique) observations obtained using the nearest neighbour criterion.

In the first part of Table 5, under the "$Innovation_t \rightarrow \Pr[Export_t]$" heading, the estimated effects of current innovation on current export market participation are presented. While the estimated rate differentials in export market participation are based on matched innovators–non-innovators using previous period conditions, because of their contemporaneous nature these estimates may not 'truly' indicate direction of causality. There may still some unobserved confounding factors that explain the positive correlation. The

[8] The balancing property tests (omitted due to space constraints but are available upon request) support the validity of the results of the matching process when all sectors are pooled. Despite the relatively weak estimates of the propensity models, the results of the matching process appear quite reasonable in identifying valid matched control observations. In other words, the balancing property tests appear to be satisfied for almost all nearest neighbor matching exercises (similar covariate balance results, available upon request, are also obtained for the sector level estimation). Furthermore, it appears that the balancing property of the results based on radius matching method is weaker compared to that of the nearest neighbor results. Similar covariate balance results are also obtained for the sector level estimation.

second part of Table 5 provides a clearer indication of whether or not innovation leads to export.

For example, from Table 5, if we lump all sectors together, current innovating firms have around 9–17 percentage points higher propensity to be in the export market. This effect is also significant in magnitude given that, as discussed earlier, the overall proportion of exporting SMEs in our sample is only around 15 per cent. Furthermore, the variation in the estimates across innovation type and sector suggests that the relationship between innovation and export differs across industrial sectors as well as across the different types of innovation. For example, for the Primary sector, the contemporaneous relationship between product innovation and export market activities is the strongest (0.222). In contrast, for the Service sector, the relationship between current innovation and export is slightly stronger in terms of process innovation (0.098) than product innovation (0.070).

To further investigate the direction of causality in the relationship between innovation and export, we estimate the effects of current period innovation on the propensity to have any export income in the next period. The results of the estimation are provided in the second part of Table 5's columns under the heading "$Innovation_t \rightarrow \Pr[Export_{t+1}]$". As can be seen from the table, when all sectors are pooled together, there is clear evidence that Australian SMEs' innovative activities, either product or process, leads to export. Unfortunately, the sample size is approximately halved when the analysis is performed at the sector level, possibly resulting in many of the sector estimates as statistically insignificant. The estimates for Manufacturing, for example, show reasonable positive magnitude but none of which is statistically significant. Nevertheless there is indication that process innovation leads to services export and that either product or process innovation leads to primary product export.

(iii) The Effects of Export Market Participation on Innovation

Table 6 provides a summary of PSM estimates of the possibe reversed direction of causality running from export market participation to innovative activities. Using the estimated propensity to export presented in Table 4, we match current exporters ("treated" SMEs) to current non-exporters ("untreated" SMEs) and estimate the average treatment effects on the treated of export on their propensity to have product innovation, process innovation, or a combination of both types of innovation.

TABLE 6

Does Exporting Lead to Innovation

Outcome: export ***Treatment: innovation***	**Average treatment effects on the treated**					
	$Export_t \rightarrow \Pr[Innovation_t]$			$Export_t \rightarrow \Pr[Innovation_{t+1}]$		
	ATT	**SE**	**N**	**ATT**	**SE**	**N**
ALL SECTORS						
Innovation type						
Product	0.122**	0.058	(219/221)	0.077	0.317	(26/24)
Process	0.166***	0.054	(242/246)	0.178*	0.105	(104/106)
Product/process	0.129**	0.053	(299/303)	0.153	0.110	(131/128)
PRIMARY						
Innovation type						
Product	0.043	0.101	(46/46)	0.158	0.109	(25/24)
Process	0.055	0.091	(47/50)	-0.073	0.159	(25/24)
Product/process	0.251***	0.085	(54/58)	0.179	0.131	(28/28)
MANUFACTURING						
Innovation type						
Product	0.065	0.119	(70/69)	0.132	0.245	(39/36)
Process	0.264***	0.094	(91/91)	0.036	0.271	(39/36)
Product/process	0.062	0.102	(104/103)	-0.026	0.256	(39/36)
SERVICES						
Innovation type						
Product	0.225***	0.080	(102/102)	0.201	0.145	(46/47)
Process	0.279***	0.078	(104/104)	0.303**	0.123	(47/49)
Product/process	0.194**	0.077	(139/139)	0.167	0.147	(62/66)

Note: *,**,*** denote statistically significant at 10%, 5%, and 1% respectively. The standard errors are computed based on Lechner (2001) approximation. In the parentheses are the numbers of treated and matched control (possibly not unique) observations obtained using the nearest neighbor criterion.

From Table 6, the estimated links from export to innovation also vary by industry and by type of innovation. The SMEs in the Services sector show the strongest and most robust positive relationship between export market participation and current innovation. More importantly, the second set of columns in Table 6 under the heading of "$Export_t \rightarrow \Pr[Innovation_{t+1}]$" provide clear evidence that export leads to innovation, but only for process innovation and only in Services sector. For other types of innovation and other sectors, the evidence is not as clear. In other words, the benefits from exporting, such as the technology upgrading effects arising from the exposure to best practice technology such as found by Girma et al. (2003), appear to be rather limited to SMEs in the Services sector.

(iv) New Exporters and New Innovators

To get an even more definitive indication of the direction of causality between export and innovation further, we repeat the propensity matching analysis on a subsample of firms

which we can identify as 'new' exporters or 'new' innovators. This allows us to investigate how likely innovation can lead a business to switch from having been outside the export market before it innovates to having participated in the export market in the next period. Similarly, we ask how likely export market participation can lead a business to switch from being a non-innovator before it participates in the current export market to becoming an innovator. Thus, we define "new exporters" as firms with no export income in period *t-1;* similarly, we define "new innovators" as firms without any innovation in period *t-1*.[9]

The matching estimators of the average treatment effects on the treated are summarised in Table 7. However, due to the limitation of the resulting sample size, we only perform the analysis at the overall industry level. From the upper half of the table, it appears that current innovators, especially product innovators, which are non-exporters in the previous period, are more likely in 'becoming' an exporter in the current period compared to current non-innovators. On the other hand, if we look at the probability of becoming a new exporter in period *t+1*, the relationship is strongest for the process innovators.[10] Thus, it appears that the processes that result in product innovation leading to a switch to become exporters work faster than the processes associated with process innovation leading to export. To some extent this finding is quite intuitive: when a firm has introduced a new product, then it might play as a market leader and enters the export market at around the same time. On the other hand, having innovated in production process is not as strongly related to an immediate market leadership position.

[9] Ideally, we would want to condition all other preceding periods (t-2, t-3, and so on) to identify new exporters more accurately. However, this is not possible with our limited data period. Hence our analysis rests on an assumption of that there is enough persistence in the export market.

[10] It should be noted, however, these findings are not robust in terms of matching method, with none of the results based on the radius matching method is statistically significant. Also, other studies employing a similar methodology such as Damijan et al. (2010) are also sensitive to the matching methods used.

TABLE 7

New Exporters and New Innovators

	Average treatment effects on the treated					
Outcome: export	$Innovation_t \rightarrow \Pr[NewEXPORTER_t]$			$Innovation_t \rightarrow \Pr[NewEXPORTER_{t+1}]$		
	ATT	**SE**	**N**	**ATT**	**SE**	**N**
Innovation type						
Product	0.054***	0.020	(242/242)	0.007	0.039	(114/110)
Process	0.021	0.020	(288/288)	0.074***	0.025	(148/147)
Product/process	0.027*	0.014	(490/490)	0.027	0.027	(239/225)
Outcome: innovation	$Export_t \rightarrow \Pr[NewINNOVATOR_t]$			$Export_t \rightarrow \Pr[NewINNOVATOR_{t+1}]$		
	ATT	**SE**	**N**	**ATT**	**SE**	**N**
Innovation type						
Product	0.052	0.061	(129/132)	0.009	0.120	(57/59)
Process	0.176***	0.058	(143/144)	0.156	0.111	(68/71)
Product/process	0.155**	0.063	(157/162)	0.174	0.114	(76/77)

Note: *,**,*** denote statistically significant at 10%, 5%, and 1% respectively. The standard errors are computed based on Lechner (2001) approximation. In the parentheses are the numbers of treated and matched control (possibly not unique) observations obtained using the nearest neighbor criterion. "New exporters" are defined by conditioning on $EXPORT_{t-1} = 0$. "New innovators" are defined by conditioning on $INNOVATION_{t-1} = 0$.

In the lower half of Table 7, we provide the estimates relevant for addressing the second question: is current export participation associated with a higher probability of becoming a "new" innovator in the current or the next period? The answer is that, unlike in the case when innovation is the treatment discussed above, none of the estimated relationships between current export and the propensity to become new innovator in period *t+1* is statistically significant. However, current export appears to lead to a switch to becoming a process innovator in the same period.

Altogether, our nearest neighbour estimates provide different characterisation of the link between innovation and export for Australian SMEs. For example, for small firms like Australian SMEs – which most product innovation involve products which are not new to the world and who are more likely to be financially constrained relative to large firms – the type of innovative activities which appears to matter the most with regards to export market participation is process innovation. Also, consistent with the argument in Damijan et al. (2010), our results indicate that the positive effects of current product innovation on the probability of becoming an exporter in the current period shown in the upper half of Table 7 appears to support earlier findings such as Cassiman and Golovko (2007), Cassiman and

Martinez-Ros (2007) and Becker and Egger (2010) that product innovation is crucial for entering the international market successfully. On the other hand, the strong positive relationship between current export market activity and the probability of becoming a 'new' process innovator in the current period shown in lower half of Table 7 appears to be consistent with the findings that once in the export market, firms need to conduct process innovation to stay competitive.

V Conclusions and Policy Implications

In this paper we addressed the questions of whether or not exporting firms learned from their participation in the export markets and thus they became more innovative than those which focused only on the domestic markets (learning-by-exporting hypothesis) and whether or not firms introduced innovation before they entered the foreign markets (self-selection hypothesis). Looking at Australian small and medium enterprises (SMEs) employing 200 or fewer workers, we assessed if existing evidence mostly based on data from medium and large firms and firms in the manufacturing sector could be generalised into the cases of small firms and firms from the primary and services sectors utilising the propensity score matching methodology.

Depending on sector and type of innovation, we found innovation lead to export and, with weaker evidence, export lead to innovation. For example, perhaps reflecting the strength of Australia's primary (mining and agriculture) sector in the international market, the primary sector exhibited the strongest statistical evidence that innovation lead export. For the service sector, we found that only process innovation lead export and only in this sector we found statistically significant evidence that export lead to process innovation.

We also found current product innovator had higher probability of becoming new exporter in the same period and current process innovator had higher probability of becoming new exporter in the next period. On the reverse direction, current exporters were more likely to become new process innovators in the same period but not in the future period. Furthermore, for small and medium sized firms such as Australian SMEs–whose most product innovation involve products which are not new to the world and who are more likely to be financially constrained relative to large firms–the type of innovative activities which appears to matter the most with regards to export market participation is process innovation. Such higher relative importance of process innovation as a key to enter the export market seems to be consistent with the findings of Iacovone and Javorcik (2010).

In summary, the findings highlight that in order to enter the export market SMEs may need to first discover or create their own comparative advantage (Rodrik, 2004).[11] As also found in other countries[12], the Australian SMEs in this study did this by introducing product and/or process innovation before entering the export market. Intuitively, the former seems to be more important for firms in the goods producing sector (primary and manufacturing) and the latter for firms in the service sector. Thus, if there is any market failure that results in inefficient resource allocation during the process of comparative advantage creation, there may be a role for the government to complement the private sector by taking into account inter-sectoral differences.

Also, the evidence that exporters are more likely to become process innovators in the same period suggests for the existence of externalities from the comparative advantage discovery process. Such externalities and the strong link between innovation and export and their two-way causality call for industrial policy which encompasses both innovation policy and international trade policy. If businesses are not able to export because they are not innovative (in terms of either product or process innovation), then traditional government policies aimed at facilitating export market entry (such as export promotion programs or free trade agreements) would be less effective.

In other words, trade liberalisation policies which focus only on taking advantage of existing comparative advantage and ignore the necessity for comparative advantage discovery may fail to produce the promised sustained economic growth (Rodrik, 2004). Such failure is possible, even if trade liberalisations result in "better resource" allocation to traditionally comparative advantaged sectors, when the increase in export revenues fail to induce investment in new technology (Bustos, 2011).[13] On the other hand, the design of innovation policy would also need to address factors that hinder the ability of innovating firms to create comparative advantage and enter the export market in the first place. In either case, a closely coordinated effort between the government and the private sector to identify the bottlenecks that takes into account the fact that the government does not know and can not do everything and the private sector has its own incentive to capture all gains from favourable government policy is needed (Rodrik, 2010).

In closing, while we believe that the findings of this study contribute to our understanding of the link between innovation and export, there are a number of limitations

[11] The author would like to thank an anonymous referee for raising this point.
[12] For recent examples, see Iacovone and Javorcik (2010) and Bustos (2011).
[13] This, however, does not mean that the traditional comparative advantage sectors should be ignored because export market discovery can also occur in these sectors (Klinger and Lederman, 2004).

that can potentially be fruitfully addressed in the future. For example, we did not model the joint determination of the different types of innovation. Redoing the analysis following a similar methodology such as used by Egger and Becker (2010) may yield further insights on the inter-link between product innovation, process innovation, and export. In addition, our empirical analysis suffers from data related limitations including short time period, small sample size at the sector level and, most importantly, restrictive data access method. An extension of this study that incorporates the newly released BLD panel data covering a period of 2004–05 to 2009–10 (ABS 2011) with a better method for accessing the data would be able to address the time dynamics better, to say the least. For example, the longer data period enables the investigation of what happens to the new exporters and new innovators after the switch. We leave all of these for future research.

REFERENCES

ABS (Australian Bureau of Statistics) (2001) *Small Business in Australia.* ABS Catalogue No. 1321.0.

ABS (Australian Bureau of Statistics) (2006) *Number and Characteristics of Australian Exporters.* ABS Catalogue No. 5368.0.55.006.

ABS (Australian Bureau of Statistics) (2007) *Patterns in Innovation in Australian Businesses 2005.* ABS Catalogue No. 8163.0.

ABS (Australian Bureau of Statistics) (2008) *Australian Industry, 2006–07*, ABS Catalogue No. 8155.0.

ABS (Australian Bureau of Statistics) (2009) *Business Longitudinal Database, Expanded CURF, Australia 2004–05, 2005–06 and 2006–07*. Technical Manual, Catalogue No. 8168.055.002.

ABS (Australian Bureau of Statistics) (2010) *Characteristics of Australian Exporters 2008-09.* ABS Catalogue No. 5368.0.55.006.

ABS (Australian Bureau of Statistics) (2011) *Business Longitudinal Database, CURF, Australia, 2004–05 to 2009–10*. Technical Manual, ABS Catalogue No. 8168.0.55.002.

Acs, Z.J., Audretsch, B. (1988), 'Innovation in Large and Small Firms: An Empirical Analysis', *American Economic Review*, **78**, 678–90.

Arundel, A., Kabla, I. (1998), 'What Percentage of Innovations are Patented? Empirical Estimates for European Firms', *Research Policy*, **27** (2), 127–41.

Aw, B.Y., Chen, X., Roberts, M.J. (1997), 'Firm-level Evidence on Productivity Differentials, Turnover, and Exports in Taiwanese Manufacturing', Pennsylvania State University mimeo, June.

Aw, B.Y., Roberts, M.J., Xu, D. Y. (2008), 'R&D Investments, Exporting and the Evolution of Firm Productivity', *American Economic Review: Papers & Proceedings*, **98** (2), 451–56.

Aylward, D.K. (2004), 'Innovation-export Linkages within Different Cluster Models: A Case Study from the Australian Wine Industry', *Prometheus*, **22** (4), 423–37.

Aylward, D.K. (2006), 'Global Pipelines: Profiling Successful SME Exporters within the Australian Wine Industry', *International Journal of Technology, Policy and Management*, **6** (1), 49–65.

Becker, S.O., Egger, P. (2010), 'Endogenous Product versus Process Innovation and a Firm's Propensity to Export'", *Empirical Economics,* forthcoming.

Bernard, A.B., Jensen, J.B. (1999), 'Exceptional Exporter Performance: Cause, Effect, or Both?', *Journal of International Economics*, **47**, 1–25.

Bernard, A.B., Jensen, J.B. (2004), 'Exporting and Productivity in the USA', *Oxford Review of Economic Policy*, **20**, 343–57.

Bustos, P. (2011), 'Trade Liberalization, Exports and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinean Firms', *American Economic Review*, **101**, 304–340.

Cassiman, B., Golovko, E. (2007), "Innovation and the Export-Productivity Link', CEPR Discussion Papers no. 6411, London: CEPR.

Cassiman, B., Martinez-Ros, E. (2007), 'Product Innovation and Exports. Evidence from Spanish Manufacturing', mimeo, Madrid: IESE Business School.

Chadha, A. (2009), 'Product Cycles, Innovation, and Exports: A Study of Indian Pharmaceuticals', *World Development*, **37** (9), 1478–83.

Constantini, J.A., Melitz, M.J. (2008), 'The Dynamics of Firm-Level Adjustment to Trade Liberalization', in Helpman, E., Marin, D. and Verdier, T. (eds), *The Organization of Firms in a Global Economy*, Harvard University Press, Cambridge, MA.

Crespi, G., Criscuolo, C., Haskel, J. (2008), 'Productivity, Exporting, and the Learning-by-Exporting Hypothesis: Direct Evidence from UK Firms', *Canadian Journal of Economics*, **41** (2), 619–37.

Damijan, J.P., Kostevc, C., Polanec, S. (2010), 'From Innovation, to Exporting or Vice Versa', *The World Economy*, **33** (3), 374–98.

Dehejia, R.J., Wahba, S. (2002), 'Propensity Score-Matching Methods for Nonexperimental Causal Studies', *The Review of Economics and Statistics*, **84** (1), 151–61.

De Loecker, J. (2007), 'Do Exports Generate Higher Productivity? Evidence from Slovenia', *Journal of International Economics*, **73** (1), 69–98.

Fernandes, A.M., Paunov, C. (2010), 'Does Trade Stimulate Innovation? Evidence from Firm-Product Data', OECD Working Paper No. 286. Paris: OECD.

Girma, Sourafel, David Greenaway and Richard Kneller (2003), "Export Market Exit and Performance Dynamics: A Causality Analysis of Matched Firms", *Economic Letters* 80, no. 2: 181–187.

Girma, S., Görg, H., Hanley, A. (2008), 'R&D and Exporting: A Comparison of British and Irish Firms', *Review of World Economics*, **144** (4), 751–73.

Iacovone, L., Javorcik, B.S. (2010), 'Multi-Product Exporters: Product Churning, Uncertainty and Export Discoveries', *The Economic Journal*, **120** (544), 481–99.

Imbens, G. (2004), 'Nonparametric Estimation of Average Treatment Effects under Exogeneity: A Review', *The Review of Economics and Statistics*, **86** (1), 4–29.

Ito, K. (2011), "Sources of Learning-by-Exporting Effects: Does Exporting Promote Innovation", Working Paper.

Ito, K., Lechevalier, S. (2010), 'Why Some Firms Persistently Out-Perform Others: Investigating the Interactions between Innovation and Exporting Strategies', *Industrial and Corporate Change*, **19** (6), 1997–2039.

Jensen, P.H., Webster, E. (2006), 'Firm Size and the Use of Intellectual Property Rights', *The Economic Record*, **82** (256), 44–55.

Klinger, B., Lederman, D. (2004), 'Discovery and Development: An Empirical Exploration of 'New' Products', World Bank Policy Research Working Paper 3450, November.

Kirbach, M., Schmiedeberg, C. (2008), "Innovation and Export Performance: Adjustment and Remaining Differences in East and West German Manufacturing", *Economics of Innovation and New Technology*, **17** (5), 435–57.

Long, N.V., Raff, H., Stähler, F. (2011), 'Innovation and Trade with Heterogeneous Firms', *Journal of International Economics*, **84**, 149–159.

MacGarvie, M.J. (2006), 'Do Firms Learn From International Trade', *The Review of Economics and Statistics*, **88** (1), 46–60.

Mansfield, E., Schwartz, M., Wagner, S. (1981), 'Imitation Costs and Patents: An Empirical Study', in Mansfield E. (ed), *Innovation, Technology and the Economy. Selected Essays of Edwin Mansfield*, Edward Elgar, Aldershot, UK.

Melitz, M.J. (2003), 'The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity', *Econometrica*, **71**, 1695–725.

Palangkaraya, A., Yong, J. (2007), 'Exporter and Non-Exporter Productivity Differentials: Evidence from Australian Manufacturing Establishments', Melbourne Institute Working Paper 4/07. Melbourne, Australia: The University of Melbourne.

Palangkaraya, A., Yong, J. (2011), 'Trade Liberalisation, Exit, and Output and Employment Adjustments of Australian Manufacturing Establishments', *The World Economy*, **34** (1), 1–22.

Rodrik, D. (2004), 'Industrial Policies for the Twenty-First Century', John F. Kennedy School of Government, Harvard University, September.

Rodrik, D. (2007), 'Industrial Development: Some Stylized Facts and Policy Direction', in O'Connor, D. and Kjollerstrom, M. (eds), *Industrial Development for the 21st Century*, United Nations, New York, 7–28.

Pamukcu, T. (2003), 'Trade Liberalization and Innovation Decisions of Firms: Lessons from Post-1980 Turkey', *World Development*, **31** (8), 1443–58.

Schumpeter, J.A. (1934), *The Theory of Economic Development: An Inquiry into Profits, Capital Credit, Interests, and the Business Cycles*, Harvard University Press, Cambridge, MA.

Wagner, J. (2007), 'Exports and Productivity: A Survey of the Evidence from Firm-level Data', *The World Economy*, **30** (1), 60–82.