THE UNIVERSITY OF MELBOURNE

Melbourne Institute Working Paper Series

Working Paper No. 4/07

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MELBOURNE INSTITUTE
of Applied Economic and Social Research

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Melbourne Institute Working Paper No. 4/07

ISSN 1328–4991 (Print)

ISSN 1447–5863 (Online)

ISBN 978 0 7340 3234 8

February 2007

*This paper is an outcome of research activities funded through an ARC Linkage Grant (LP0348635) involving as partners the IBISWorld, the Australian Bureau of Statistics, the Productivity Commission, Austrade and the Victorian Department of Treasury and Finance. We thank John Creedy for valuable inputs and comments and Rissa Raymundo and Charles Tran for data analysis supports. All errors are ours.

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Abstract

We study the link between exporting and productivity using unpublished establishment level data of the Australian manufacturing from 1994 to 2000. We find there is significant difference in the first moment as well as the whole distribution of productivity between exporters and non-exporters. At the mean level, the average productivity differentials between Australian exporters and non-exporters are comparable to that of, for examples, the United States, Germany, or Taiwan. More importantly, as also found in almost all other countries, we find that the bigger and more productive firms appear to self-select into the export market. In addition, we also find that a higher intensity and longer period of export market exposure is associated with a higher level of productivity, indicating a possible learning-by-exporting effect.

JEL Classification: D21; F21

Keywords: Productivity; Exports, Australia; Manufacturing; Establishment.

1. Introduction

In this paper we utilise unpublished Australian manufacturing establishment census data covering the period of 1994 to 2000 to study the link between firm productivity and participation in export markets. More specifically, we investigate whether or not exporting management units (MU) are significantly more productive before and/or after entering the export market. That is, we seek to see whether or not self-selection rather than learning from exporting is the main explanation of exporters higher than average productivity. While there is a lot of evidence based on firm and establishment level data from various developed and developing countries, little is known for the case of Australia.

Whether or not economic trade openness promotes economic growth in the domestic economy has been at the centre of research activities for quite a while. In particular, the possibility for export market exposure in increasing productivity has received increased attention in the empirical literature, especially since researchers have better access to often unpublished, highly confidential, micro-level data. Wagner (2005), for example, in a recent survey, reviews as many as 45 empirical studies in this fertile research area based on various data from 33 different countries, covering both the developed (such as US, UK, and Germany) and the developing (such as Chile, Columbia, and China) regions.[1]

One main focus of this growing literature is related to the question whether or not exporters are more productive than non-exporters and, more importantly, what causes the productivity differentials. There are two competing hypotheses for explaining the possible cause of the productivity differentials. First, the 'better' or more productive firms self-select to become exporters. This arises mostly from the existence of a possible sunk entry cost that a potential exporter needs to pay. Second, the exporting firms are more productive because they may learn better production technology from their export market.[2] Understanding which of the two hypotheses are more likely is important since it

[1] See also Greenaway and Kneller (2005).

[2] The first hypothesis can be inferred more formally from Hopenhayn's (1992) model of firm dynamics as described in Aw *et al.* (2000). The second hypothesis is usually modelled following Clerides *et al*. (1998). It should be noted, however, that these two hypotheses are not necessarily mutually exclusive. There might be firms which self-select into export markets and at the same time learn to become more productive as they export.

would help in evaluating whether or not export promotion strategy is beneficial to the economy.[3]

So far the existing evidence from various micro-level studies using non-Australian data seems to indicate that exporters are the 'better' firms to begin with. That is they self-select into the export market instead of becoming better after they start exporting.[4] However, given some variations in data and methodologies as well as other difficulties faced in those studies, Wagner (2005) cautions that it might be too early to take these findings as stylised facts. In other words, we think it rather unfortunate that, despite the large number of micro-level studies summarised above, there is currently no similar study done using Australian data.[5] Thus, we also think that it is still important to conduct a similar study analysis for the case of Australia.

Therefore, the main contribution of this paper is to fill the lack of comparable analysis using Australian data. More specifically, we use the Australian Bureau of Statistics' (ABS) unpublished, manufacturing establishment level data from 1994 to 2000 and compare the average productivity of exporting and non-exporting establishments.[6] Our other contribution is in our use of Li's (1996) non-parametric test of "equality" between two distributions which is, as far as we know, the first of such application in this setting.[7] With Li's test, we are able to compare the whole distribution of exporter and non-exporter characteristics in addition to the usual first-moment of the distribution. We believe a

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[3] Greenaway and Kneller (2005) argue that such "targeted intervention to support exporting firms is subject to the same risks as identifying so-called infant industries".

[4] See Clerides, Lach and Tybout (1998) and Bernard and Jensen (1999) for two of the earliest evidence. Also see later empirical studies cited in Wagner (2005) and Greenaway and Kneller (2005).

[5] Mostly this is because there is no comparable published Australian data to allow for similar analyses to be conducted. It should be noted however that Gabbitas and Gretton (2003) have access to and use firm-level export data, but they address a different set of questions. Similarly with Austrade and ABS (2000) and Harcourt (2000), which compare Australian exporters and non-exporters using the 1994/95 – 1997/98 Business Longitudinal Survey.

[6] Unlike the earlier Australian studies (Austrade and BS (2000) and Harcourt (2000)), our paper focuses only on manufacturing. This could help in controlling for any possible inter-industry heterogeneity in the propensity and procedure to export.

[7] Kumar and Russell (2002) use the same test to compare productivity distribution of countries over time.

comparison of the whole exporters and non-exporters' distributions of productivity level is useful given that the relevant theoretical predictions are not limited to the first moment of the distribution.[8]

In Section 2 we describe our research questions and discuss the empirical framework used to answer those questions following the methodologies of some important existing studies. In Section 3 we describe the productivity measures and the data we use. In Section 4 we summarise and discuss the results. Finally, Section 5 concludes.

2. Empirical framework

We start by asking if there is any significant difference between exporting and non-exporting firms both conditionally and unconditionally. The conditional comparison takes into account the possibility of self-selection, differences between exporters and non-exporters and conduct formal statistical tests of their statistical significance. For the unconditional differences, we conduct formal statistical tests of differences in means and in distribution of current period values of size of output, capital inputs, employment, average wage, and Total Factor Productivity (TFP). We use regression analysis and t-tests to compare conditional and unconditional differences at the mean-levels. In addition, we use Li's (1996) test of the closeness of two distributions to compare the distributions. The Li's test is a nonparametric test based on the kernel density method as used recently by Kumar and Russell (2002) in comparing productivity distribution of countries across time.[9]

Following the existing literature reviewed in Wagner (2005) and Greenaway and Kneller (2005), the conditional differences or the so-called exporter *premia* are estimated using the following pooled-linear regression model:

$$\ln TFP_{kt} = a_0 + a_1 Export_{kt} + aX_{kt-1} + e_{kt} \qquad (1)$$

where $Export_{k,t}$ is a binary variable indicating export status of firm k at time t and $X_{k,t-1}$ is a set of lagged values of firm characteristics such as TFP and size as well sectoral and year dummy variables. Here, by using the simple linear regression specification shown in (1) and later equations, we simply want to compare the average productivity of exporters and

[8] See, for example, Hopenhayn (1992).

[9] See Appendix B for more details.

non-exporters after taking into account their past performances. The linear in log form is chosen for simplicity of interpretation of the difference.

We also investigate if the differentials exist before the exporting establishments become exporters. We estimate both the unconditional and conditional differences between non-exporters and future exporters. We define future exporters as those establishments which do not export in period *t* and become exporters in period *t+1*. We then estimate the differences in productivity based on the current period values of TFP conditioning on the previous period values of the control variables listed above. Thus, in essence, we estimate the following pooled-regression equation:

$$\ln TFP_{kt} = b_0 + b_1 \text{Pre}Export_{kt} + bX_{kt-1} + u_{kt} \tag{2}$$

where, for each possible pair of time periods *t* and *t+1*,

$$\text{Pre}Export_{kt} = \begin{cases} \text{1 if k exports in t} + \text{1 but not in t} \\ \text{0 otherwise} \end{cases} \tag{3}$$

If $\hat{b}_1 > 0$ then we have an indication that exporters self-select into the export market. That is, the more productive establishments become exporters while the less productive establishments stay with their domestic markets. In other words, exporting *per se* may not make any establishment more productive than it would be had it not become an exporter.

As mentioned earlier, the other hypothesis is that because of exposure to the export market, exporting establishments may be forced or have more opportunities to learn newer technology and stay competitive and thus become more productive than if they had not been exposed to such market environment. To see if this is the case, we compare the unconditional and conditional differences between exporters of different export intensity and export experience. If there is any learning effect from exporting, then establishments which export more intensively or those which have been in the export market longer would exhibit a higher average level of productivity. We test these hypotheses by estimating the following pooled-regression equation:

$$\ln TFP_{kt} = c_0 + c_1 \text{Low}Exp_{kt} + c_2 MedExp_{kt} + c_3 HiExp_{kt} + cX_{kt-1} + v_{kt} \tag{4}$$

where the three different groups of exporters are represented by three binary variables $LowExp_{k,t}$ (for those management units which export 0-25% of their sales of produced outputs), $MedExp_{k,t}$ (for those with export shares of 25-75%) and $HiExp_{k,t}$ (for those with more than 75% exported outputs).[10] Each of these groups is then compared to the non-exporters and among themselves as captured by the estimated values of c_1- c_3 coefficients.

The problem with the regression model in equation (4) is that it may still capture self-selection effect in the sense that the better firms self-select into even higher exposure to the export market. Thus, we also estimate the following pooled-regression model:

$$\ln TFP_{kt} = d_0 + d_1 Exp1_{kt} + \ldots + d_6 Exp6_{kt} + dX_{kt-1} + w_{kt} \qquad (5)$$

In this case, for all cohort of exporters, $Exp1_{k,t}$ is a dummy variable with a value of 1 for their first export year. Similarly, $Exp2_{k,t}$ is a dummy variable with a value of 1 for the second export year, and so on. Effectively, if a firm *k* is in the export market for six continuous years, then its values of $Exp1_{k,t} – Exp6_{k,t}$ are all one. Since the base group is the non-exporters, d_1 represents the average TFP differentials between exporters and non-exporters after one year of export, (d_1+d_2) represents the average TFP differentials after two years of export, (d_1+d_2+d_3) represents the average TFP differentials after two years of export, and so on.[11]

3. Data and productivity measure

3.1. Management units

We conduct our empirical analysis using unpublished, de-identified establishment level data collected from a series of ABS annual manufacturing establishment surveys from 1994 to 2000.[12] These surveys gather production activity statistics at the establishment level and business operations statistics at the management unit (MU) and enterprise group levels. For our purposes, we aggregate up the establishment level production statistics into the corresponding management unit level using a given serial number which identifies the

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[10] Here and in the regression model specified in equation (5), we are adopting Aw *et al.*'s (2000) model specification.

[11] By themselves, each of d_i coefficients represent how much the productivity differential changes with an additional year in the export market.

[12] More precisely, the reference periods of the surveys cover 1994/1995 to 1999/2000 financial years, where the 1996/1997 financial year is a census year.

establishments under each MU. [13] This aggregation is necessary due to data availability of some variables in some survey years which are limited to that level of analysis. Table 1 provides the count of MUs across the survey years and the division of MUs by single and multiple establishment MUs as well as the total values of turnovers, total employment, and total values of wages and salaries.

Table 1: Management units in the sample, 1995-2000

Year	Number of MU			Turnover	Employment	Wages ($M
	All	Single est.	Multi est.	($ millions)	(000)	($ millions)
1995	6048	189	5859	25668	473.9	17906
1996	6486	110	6376	25507	202.3	6820
1997	34128	223	33905	39044	299.5	10118
1998	7016	109	6907	23549	169.0	6085
1999	4666	75	4591	37302	207.6	8293
2000	3775	67	3708	22126	129.8	5516

3.2. Total Factor Productivity

We use the survey data described above to measure the total factor productivity (TFP) level of each management unit. The TFP measure we use is the multilateral index originally due to Caves, Christensen and Diewert (1982) and extended by Good, Nadiri and Sickles (1996) and used by, for example, Aw *et al.* (2000) in the similar analysis of Taiwanese and Korean firms. In this approach, the log value of *TFP* for firm or management unit *k* at period *t* is defined as:

$$\begin{aligned} \ln TFP_{kt} = {} & \left(\ln y_{kt} - \overline{\ln y_t}\right) + \sum_{s=2}^{t} \left(\overline{\ln y_s} - \overline{\ln y_{s-1}}\right) \\ & - \left[\sum_{n=1}^{N} \tfrac{1}{2} \left(S_{nkt} + \overline{S_{nt}}\right)\left(\ln x_{nkt} - \overline{\ln x_{nt}}\right) \right. \\ & \left. + \sum_{s=2}^{t} \sum_{n=1}^{N} \left(\overline{S_{ns}} + \overline{S_{ns-1}}\right)\left(\overline{\ln x_{ns}} - \overline{\ln x_{ns-1}}\right) \right] \end{aligned} \tag{5}$$

where S_n denotes cost share of a particular input x_n and $\overline{\ln y_t}$ represents the industry average value across firms in each time period *t*.

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[13] Thus, in some sense, an MU is closer to the definition of a firm than an establishment is. See ABS (1997) for more detailed descriptions of the survey data.

The basic intuition of this TFP measure is that it measures the proportional difference in total factor productivity for a given firm *k* in period *t* relative to the hypothetical average firm in the base period.[14] Furthermore, the TFP measure given in equation (6) can be thought of as the difference between the output and the input of the firm. For the output part, there are two components: the first component expresses firm *k*'s output in terms of deviation from the output of the reference firm. The second component aggregates the changes in output of the reference firm across time. In other words, the first component captures the cross-sectional distribution of output; whereas, the second component captures the shifts in the distribution of output over time. The intuition for the input part is similar.

With the ABS data described above, we compute TFP for each management unit in each year using equation (6). To compute the cost shares, we need estimates of values of output and inputs. As a measure of the value of output, we use total value of turnover. We deflate this by the corresponding sectoral Producer Price Index to get a proxy of output quantity. We use total wages and salaries and the total number of employees as measures of value and quantity of labour inputs. For the value of material inputs, we use the value of purchases and transfer in and other selected expenses. Finally, the cost share of capital is computed as the residual, and the quantity of capital inputs is estimated accordingly. Appendix 1 provides more detailed discussion of the variable constructions.

3.3. Defining the exporters

Because we want to compare the productive performance of exporters and non-exporters as described in Section 2, we need to define what we mean by exporters. We define exporters as MUs which have a positive value of exports in any of their establishments. The ABS data provide us with the share of exported produced goods for each establishment. If we multiply this proportion by the value of output, we obtain an estimate of the value of exports for each establishment. The distribution of value of exports over broad manufacturing industries during the study period is provided in Table 2.

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[14] For our purpose, we select 1994 as the base period.

Table 2: Distribution of value of exports across industries (%), 1995-2000

Industry	1995	1996	1997	1998	1999	2000
Food and tobacco	27.4	25.5	24.7	26.7	28.8	28.1
Beverages	1.5	2.0	2.4	2.2	2.3	2.3
Textiles	2.6	2.5	2.9	3.2	2.9	3.0
Apparel	0.5	0.3	0.4	0.3	0.2	0.3
Leather products	2.3	1.8	2.1	2.1	1.3	1.6
Footwear	0.1	0.1	0.1	0.1	0.1	0.1
Wood products	2.8	2.0	2.2	2.5	2.2	2.1
Furniture	0.3	0.1	0.3	0.3	0.2	0.3
Paper	0.8	0.7	0.7	0.9	0.7	0.6
Printing	1.7	1.6	2.1	2.0	1.6	1.7
Basic chemicals	3.8	3.1	3.1	2.6	2.4	2.5
Other chemical products	3.5	3.7	4.0	4.1	4.7	6.0
Petroleum refining, coal	0.8	0.2	0.4	0.3	0.4	0.4
Rubber products	0.1	0.1	0.1	0.1	0.2	0.1
Plastics	0.9	1.0	1.0	0.7	1.1	0.9
Ceramics	0.3	0.3	0.3	0.3	0.3	0.3
Glass	0.3	0.3	0.4	0.5	0.2	0.2
Non-metallic mineral	0.8	0.8	0.9	0.7	0.8	0.5
Iron and steel	10.0	9.0	8.0	7.5	8.4	6.4
Non-ferrous metal	14.7	17.5	13.3	15.0	14.3	14.0
Metal products	1.7	1.4	1.8	1.3	1.0	1.3
Motor vehicle and parts	72	6.9	9.2	9.2	8.2	11.3
Other transport equipment	3.8	4.6	4.3	5.1	4.7	3.5
Professional equipment	1.1	1.2	1.5	1.7	2.6	2.6
Electronic equipment	3.3	4.7	4.7	3.5	3.3	4.0
Electrical equipment	5.	5.1	5.3	3.6	3.8	3.1
Industrial machinery	2.5	3.0	3.5	2.9	2.8	2.6
Other	0.3	0.2	0.5	0.5	0.5	0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

Furthermore, we also classify the MUs according to the intensity of their export market exposure. As explained earlier when we discuss the regression equation (4), we define the low export intensity if the share of exported outputs is less than 25 per cent. The medium intensity is defined as between 25 and 75 per cent, while the high intensity is defined as an export share of greater than 75 per cent. Table 3 lists the total number of exporters and their distribution across different intensity in each of the survey year.

Table 3: Distribution of exporters by export intensity, 1995-2000

Year	Export intensity (%)			Total
	Low	Medium	High	
1995	73.9	17.7	8.3	2310
1996	76.4	16.5	7.1	2629
1997	75.5	17.0	7.5	5448
1998	74.8	17.1	8.1	3121
1999	74.8	17.6	7.6	2908
2000	73.1	17.8	9.1	3074

4. Results

4.1. Exporter differentials

The first set of results is summarised in Table 4. The second column of that table lists the current period average unconditional differences between exporters and non-exporters in terms of total turnovers, employment, average wage, values of capital input, and total factor productivity. For examples, exporters have, on average, 197 per cent higher turnover, 140 per cent more employees, 38 per cent higher average wage, 201 per cent more capital, and 11 per cent higher TFP over the non-exporters. The third column of the same table provides the estimates based on the regression model shown in equation (2).[15]

[15] We substitute other variable such as turnover for TFP as the dependent variable to get the conditional difference in, for example, sales turnover.

As shown in the table, if we condition for the previous period values of turnover, employment, wages per employee, capital input, and TFP, the sizes of the differences are smaller. Nevertheless, they are still significant statistically and in magnitude for the sizes of capital and labour as well as turnover. Overall, these results show that exporters are bigger and, based on the unconditional differences, more productive than non-exporters.

Table 4: Exporter and non-exporter average differentials (%)

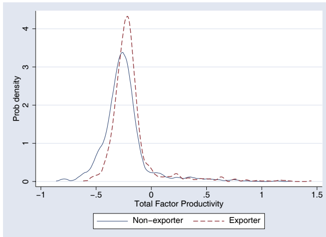
	Unconditional		Conditional	
	Diff.	Std. Error	Diff.	Std. Error
Turnover	196.9	1.91	4.94	0.63
Employment	139.6	1.51	4.05	0.61
Wages per employee	37.7	0.61	-0.86	0.69
Capital	201.6	2.11	7.95	1.36
TFP	11.3	0.19	-0.40	0.20
Pooled sample size		54344		19666

Notes: The average differentials are computed as the differences between average exporters and non-exporters values and expressed as percentages of average non-exporters values.

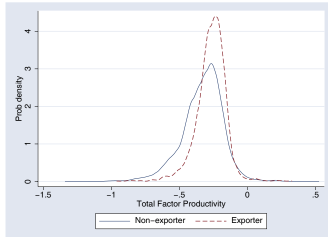
The estimated differences provided in Table 4 give us the estimates of differences in the means level. To visualise the extent of unconditional differences in terms of the distribution of TFP, Figure 1 shows kernel density plots of TFP for exporters and non-exporters separately in each year and for the whole period pooled together.[16] Furthermore, using Li's (1996) test, as summarised in Table 5, we find the differences in the TFP distributions are statistically significant except for 1995.

[16] Here, we make the year-by-year comparisons to make sure that there is no uncontrolled "time" effect. In all later analyses, we will only used pooled data with year dummy variables as control variables whenever appropriate.

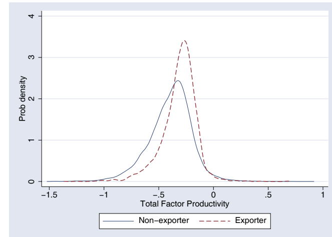
Figure 1: TFP distributions of exporters and non-exporters, 1995-2000



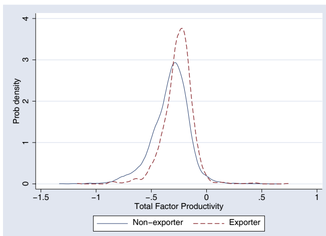
(a) 1995



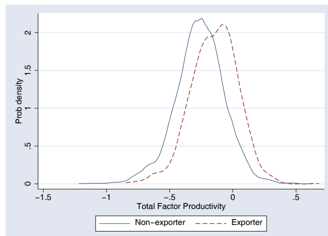
(b) 1996



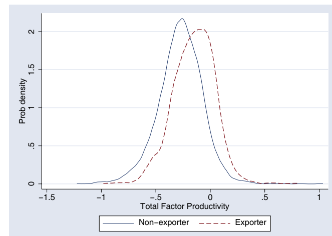
(c) 1997



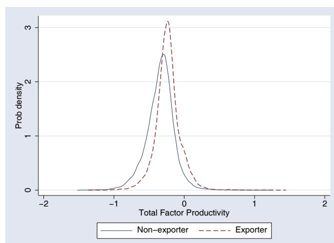
(d) 1998



(e) 1999



(f) 2000



(g) 1995-2000

Table 5: Li's hypothesis tests of differentials in TFP distribution

Null hypothesis (H_0)	t-test statistics	Decision (5% significance)
$f(TFP^e_{1995}) = g(TFP^s_{1995})$	-0.2	Fail to reject H_0
$f(TFP^e_{1996}) = g(TFP^s_{1996})$	3.1	Reject H_0
$f(TFP^e_{1997}) = g(TFP^s_{1997})$	40.6	Reject H_0
$f(TFP^e_{1998}) = g(TFP^s_{1998})$	7.7	Reject H_0
$f(TFP^e_{1999}) = g(TFP^s_{1999})$	12.5	Reject H_0
$f(TFP^e_{2000}) = g(TFP^s_{2000})$	15.4	Reject H_0
$f(TFP^e) = g(TFP^s)$	148.5	Reject H_0

Notes: $f(x^e)$ and $g(x^s)$ are kernel distribution functions exporters and non-exporters' specific characteristic x^e **,** respectively. The null-hypothesis is $H_0 : f(\bullet) = g(\bullet)$.

4.2. Self-selection effect

The regression results for testing the self-selection hypothesis are summarised in Table 6 below. From that table, we can see that even before they become exporters, the MUs which export in the future already have some advantages over their non-exporting counterparts in the previous period. For example, on average they have around six per cent higher TFP level than the non-exporting MU. The pre-export differentials are even more apparent when we look at the size of turnover or employment. Thus, it seems that the "better" and larger firms self-select into the export market. Furthermore, relative to the findings from other studies, the 6.2% unconditional pre-export differentials in terms of TFP is comparable in magnitude to the 5-6% differentials found for the case of, for examples, the United States (Bernard and Jensen, 1999), Germany (Bernard and Wagner, 2001) and Taiwan (Aw *et al.*, 2000).[17]

Table 6: P*re-export* differentials of exporters and non-exporters (%)

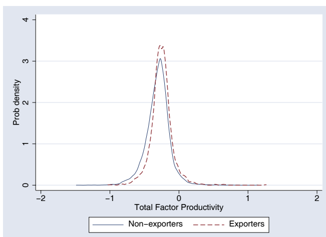
	Unconditional		Conditional	
	Diff.	Std. Error	Diff.	Std. Error
Turnover	129.1	5.18	3.01	1.59
Employment	90.9	4.09	2.07	1.57
Wages per employee	22.0	1.56	-1.18	1.56
Capital	126.8	5.49	3.36	3.44
TFP	6.2	0.48	-1.07	0.47
Pooled sample size	13576			5456

Notes: The average differentials are computed as the differences between average current (period *t*) exporters and non-exporters values at period $t-1$ and expressed as percentages of average non-exporters values.

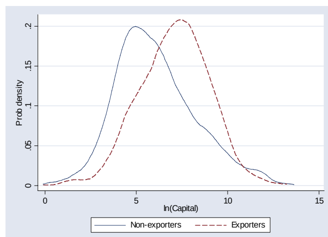
[17] For more comparisons, see Table 3 in Greenaway and Kneller (2005).

As before, Figure 2 shows the density plots for pre-export TFP differentials between future exporters and non-exporters in terms of size of output, capital inputs, average wage, TFP, and employment in distribution. Overall, the comparisons in mean and distribution suggest that self-selection is a possible explanation of the higher performance of the exporters.

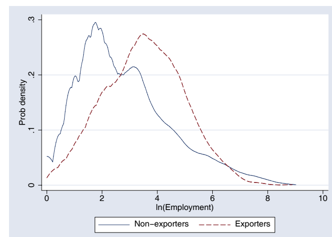
Figure 2: Pre-export distributions of TFP, 1995-2000



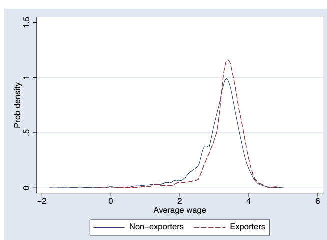
(a) TFP



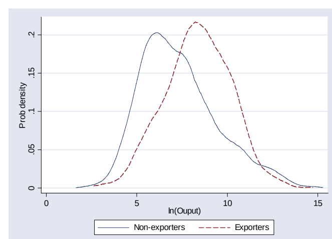
(b) capital



(c) labour



(d) wage



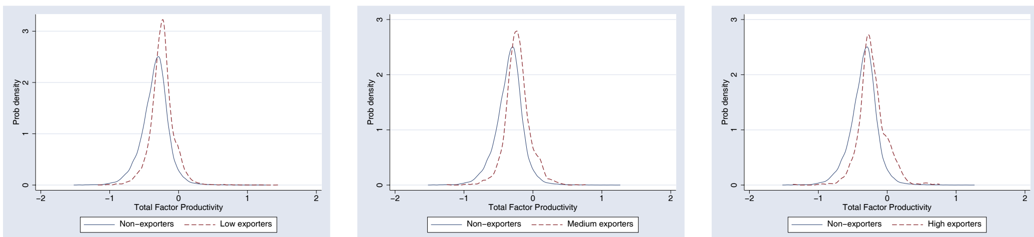
(e) turnover

4.3. Learning from exporting

The competing explanation for the higher performance of exporters aside from the self-selection hypothesis, which seems to be supported by our previous results, is the idea that exporters are better because they are better able to, for example, tap improved production technology or inputs to production from the international markets in which they participate. In addition, the level of market competition at the foreign markets is plausibly higher so that the exporting firms are required to work harder to be able to survive in such environment and thus overtime or as their exposure to the export market increases, they may develop further advantage over the non-exporting firms. Thus, to see if there is any evidence that supports the above hypothesis, we compare the productivity levels of low intensity, medium intensity, and high intensity exporters to non-exporters and to each other.

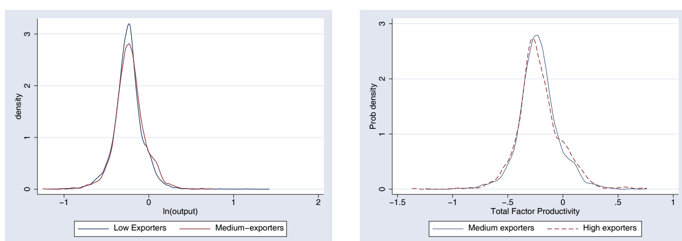
As can be seen from Figures 3 and 4 below, while exporters of any intensity level are more productive when we look at the whole distribution, there seems to be no evidence that the more intense the firm's exposure to the export market the more productive they are. Though they are all better than the non-exporters, when we compare them to each other, the medium exporters are no more productive than the low exporters and, in fact, if any, the medium exporters seem to be more productive than the high exporters.

Figure 3: TFP distributions exporters and non-exporters by export intensity



(a) low (b) medium (c) high

Figure 4: TFP distributions of exporters by export intensity



(a) low vs medium (b) medium vs high

In addition, Table 7 summarises the results of applying Li's (1996) test of exporter and non-exporter differentials in distribution as well as the distribution differentials of exporters across different export intensity levels. The results confirm that exporters, regardless of intensity level, are more productive than non-exporters. Furthermore, when we compare the distribution, there is no evidence that a higher level of export intensity is associated with a higher level of productivity.

Table 7: Li's hypothesis tests of differentials in distribution by export intensity

Null hypothesis (H_0)	t-test statistics	Decision (5% significance)
$f(TFP^e_{low}) = g(TFP^s)$	117.1	Reject H_0
$f(TFP^e_{med}) = g(TFP^s)$	31.4	Reject H_0
$f(TFP^e_{high}) = g(TFP^s)$	11.6	Reject H_0
$f(TFP^e_{low}) = g(TFP^e_{med})$	1.3	Failed to reject H_0
$f(TFP^e_{med}) = g(TFP^s_{high})$	2.5	Failed to reject H_0

Notes: $f(x^e_I)$ is the kernel distribution function for the exporters' specific characteristic x^e with $I = low, med, high$ indexes export intensity. Similarly, $g(x^s)$ or $g(x^e_I)$ is the kernel distribution function for the corresponding non-exporters' characteristic x^s or exporters with characteristic x^e and export intensity *I*. The null-hypothesis is $H_0 : f(\bullet) = g(\bullet)$.

Also, to see if there is any learning-by-exporting effect at the average level instead of the whole distribution, Table 8 provides the estimated TFP differentials between exporters of different intensity levels on the one hand and non-exporters on the other based on the regression coefficient estimates specified in equation 4. Thus, unlike in the comparison of distributions, when we compare the average level of TFP, the extent of exposure seems to matter. In other words, there is an indication for learning-by-exporting effect in the sense that managements unit with high shares of exported output are more likely to have a higher average productivity level. However, this evidence may also be consistent with the self-selection hypothesis if higher export intensity involves higher entry costs such as the necessity of entering multiple export markets.

Table 8: TFP differentials of non-exporters and exporters

Export intensity	Total TFP differentials (%)	
	Unconditional	Conditional
Low (<25%)	6.9** (0.2)	-0.6** (0.2)
Medium (25-75%)	8.1** (0.4)	-0.2 (0.4)
High (>75%)	10.6** (0.7)	1.5** (0.6)

Notes: ** indicates significantly different from 0 at a 5% significant level. The conditional differentials are obtained from the same regression with one period lag values of TFP, average wage, turnover, labour and capital as additional explanatory variables. The differentials are the differences between average exporters and non-exporters values and expressed as percentages of average non-exporters values. (): standard error.

To reduce the possibility of mixing the possibly non-mutually exclusive self-selection and the learning-by-exporting effects, we proceed on looking at cohorts of exporters. That is, we want to see whether or not a longer exposure to the export market is associated with increased productivity differentials with respect to non-exporter. Table 9 provides the estimated productivity differentials between exporters and non-exporters at each subsequent year in the export market based on the coefficient estimates of the regression model specified in equation (5).[18] From that Table, we can infer, from both the conditional and the unconditional estimates, that the longer the exporters are in the export market the higher the TFP differentials with respect to non-exporters.

Table 9: TFP differentials after 1-6 years of exporting

Year in the export market	Total TFP differentials (%)	
	Unconditional	Conditional
1st	3.3**	-1.3
2nd	6.1**	-0.8
3rd	8.0**	-0.6
4th	9.8**	0.4
5th	12.2**	1.0**
6th	16.5**	2.1**

Notes: ** indicates significantly different from 0 at a 5% significant level. The conditional differentials are obtained from the same regression with one period lag values of TFP, average wage, turnover, labour and capital as additional explanatory variables. The differentials are the differences between average exporters and non-exporters values and expressed as percentages of average non-exporters values.

5. Conclusion

In this paper we utilised unpublished, manufacturing establishment level data to investigate the link between export activity and productivity for the case of Australian manufacturers. Our objective was to contribute to the growing literature that tries to explain the relationship between export and productivity which is often to be taken as granted in a specific causal relationship. In particular, we investigated whether the better firms self-select to become exporters or wether the exporters improve over time by being in the export market.

By comparing the performance of exporters and non-exporters, future exporters and non-exporters, and exporters of various export intensity we found that the evidence from Australian establishments indicates self-selection as an important factor for explaining

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[18] The actual coefficient estimates are provided in Appendix 3.

exporter and non-exporter differentials. We obtained this evidence from both when we only considered the average level of productivity and when we compared the whole productivity distributions of the two groups of firms. In addition, we also found the average pre-export productivity differentials for the case of Australia is comparable to that of US, German, or Taiwanese firms. However, unlike most of the earlier studies, we found some indication that learning-by-exporting might also be important for the case of Australia. However, this evidence was obtained from our comparisons of average level of productivity only as the result of our comparisons at the distribution level was less clear.

Altogether, as has been pointed out by earlier studies such as Lopez (2004), these findings suggest more analysis to investigate whether or not the better firms which self-select into the export market are better because they prepare themselves to be better. This is especially important for the case of Australia with the indication for the presence of learning-by-exporting effect shown above.

Appendix 1: Data source and definition

The main data set used in the paper is constructed from unpublished, de-identified establishment level data obtained from a series of ABS Annual Manufacturing Survey from 1995/1996 to 1999/2000.

The definitions of the different production measures used are provided below:

- Value of output = Total sales and transfers out of goods produced and not produced + selected other income (govt. subsidies, service income, income from rent, leasing and hiring, and imputed commission)

- Quantity of output = Value of output / 3-digit Producer Price Index

- Value of labour = Total salaries and wages

- Quantity of labour = Total number of employees at June 30

- Value of raw materials = Total purchases and transfers-in of raw materials and goods for resale + selected expenses (motor vehicle running expenses, outward freight, rent, leasing and hiring expenses, subcontract/commission expenses, repair and maintenance expenses, and imputed commission paid)

- Quantity of raw materials = Value of raw materials / 3-digit Material Price Index

- Value of capital input = Value of output - Value of labour - Value of raw materials

- Quantity of capital input = Value of capital / simple average of Private machinery and equipment investment implicit deflator and Non-dwelling construction implicit deflator

Appendix 2: Li's (1996) test of the closeness of two distributions

Define $f(x^e)$ and $g(x^s)$ as the population densities of, say, TFP scores of exporters and non-exporters, respectively. Define $\{F^e\}$ and $\{F^s\}$ as n_1 and n_2 random samples of TFP from each group, respectively. Then, to test the null hypothesis $H_0 : f(x^e) = g(x^s)$, Li (1996) shows that under H_0, and assuming $h \to 0$, $n_1 h \to \infty$ and $n_2 h \to \infty$,

$$J = n_1 h^{1/2} \frac{\tilde{I}}{\hat{\sigma}} \sim N(0,1)$$

where

$$\tilde{I} = \frac{1}{h} \sum_{i=1}^{n_1} \sum_{j=1}^{n_2} \left[K\left(\frac{F_i^e - F_j^e}{h}\right) + K\left(\frac{F_i^s - F_j^s}{h}\right) - K\left(\frac{F_i^e - F_j^s}{h}\right) - K\left(\frac{F_i^s - F_j^e}{h}\right) \right],$$

$$\hat{\sigma}^2 = \frac{1}{\sqrt{\pi}} \left[\frac{1}{n_1^2} \sum_{i=1}^{n_1} \sum_{j=1}^{n_1} K\left(\frac{F_i^e - F_j^e}{h}\right) + \left(\frac{n_1}{n_2^2}\right)^2 \sum_{i=1}^{n_2} \sum_{j=1}^{n_2} K\left(\frac{F_i^s - F_j^s}{h}\right) \right.$$
$$\left. \frac{1}{n_2^2} \sum_{i=1}^{n_1} \sum_{j=1}^{n_2} K\left(\frac{F_i^e - F_j^s}{h}\right) + \frac{1}{n_2^2} \sum_{i=1}^{n_2} \sum_{j=1}^{n_1} K\left(\frac{F_i^s - F_j^e}{h}\right) \right]$$

and $K(\bullet)$ is a Gaussian kernel function.

Appendix 3: Coefficient estimates of regression equation (5)

Coefficient	Unconditional model		Conditional model	
	Estimate	Std. Error	Estimate	Std. Error
d_1	0.0326	0.0077	-0.0132	0.0073
d_2	0.0277	0.0089	0.0046	0.0095
d_3	0.0192	0.0082	0.0018	0.0079
d_4	0.0185	0.0101	0.0099	0.0068
d_5	0.0237	0.0119	0.0058	0.0080
d_6	0.0432	0.0155	0.0107	0.0104
$\ln TFP_{k,t-1}$			0.2663	0.0163
$\ln Wage_{k,t-1}$			0.0619	0.0055
$\ln Labour_{k,t-1}$			0.0177	0.0030
$\ln Capital_{k,t-1}$			0.0048	0.0021
$\ln Turnover_{k,t-1}$			0.0106	0.0036
Constant			-0.6153	0.0225
Sample size		9654		5920
Adjusted R-square		0.2420		0.5989

Notes: All regressions include 27 sectoral and 5 year dummy variables. (): standard error. Multiply the coefficients by 100 to obtain the differentials in % terms as reported in the text.

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