Business Dynamics of a Clean Energy Policy

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Abstract

In July 2012, the Australian government introduced the CleanTech Investment Programme to encourage firms to switch to cleaner technology while allowing them to maintain their competitiveness. In this study I investigate whether the performance of firms that received CleanTech grants was any better than their non-CleanTech counterparts. I find that firms with CleanTech grants managed to create more jobs and grow faster than a similar firm but with no CleanTech grants. However, the positive effect is mostly concentrated among larger firms and those firms that were performing poorly prior to receiving the grants.

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Key points

- **Firms that received CleanTech grants show a higher rate of employment and turnover growth during the projects compared to similar firms without the grants.**

- **Exporting firms with CleanTech grants also show a higher rate of growth in exports value compared to similar firms with no grants. However, there is no evidence that CleanTech helped firms to commence exporting.**

- **The positive effects on firm performance are mostly concentrated among those firms that were contracting in size before they received CleanTech grants.**

- **The performance differential is more nuanced among large and medium-sized firms.**

- **The analysis is firm-level. The facility that used CleanTech may have grown or contracted independent of the growth rate of the firm as a whole.**

1.   Introduction

Currently, many governments around the world have emission reduction targets as part of a concerted effort to contain the rate of global warming. In tandem, there is an ongoing debate on whether forcing firms to switch to cleaner technology will cost the economy in terms of production capacity and employment in the long run by imposing unnecessarily high costs and restrictions on the operation of firms. In the case of Australia, for instance, Chapple et al.(2013) predicted a seven to 10 per cent drop in the value of Australian companies publicly listed in the ASX as a result of taxing carbon emissions.[1]

In July 2012, the Australian Government initiated a Clean Technology Investment Programme (CleanTech) to allow firms to switch to cleaner and more energy efficient technologies and capital equipment while maintaining their competitiveness. As part of this programme, firms would receive up to half the cost of their proposed projects as a grant. The investment grants were only awarded to manufacturing facilities and had to be spent on the particular facility indicated in the initial submission. Since 2015, no new applications are being accepted for the programme.[2]

Bakhtiari (2016) already studies the impact of the CleanTech grants on the adoption of cleaner technology and on emission reduction among manufacturing facilities. The findings in that work are mixed and smaller facilities that received CleanTech grants are found to have reduced emissions beyond the average facility through switching to cleaner technology.

In this paper, I focus on aspects of business operation other than energy and emission to see whether receiving CleanTech grants had any broader implications in terms of business strategy and operations. More specifically, I intend to investigate whether receiving these grants had any impact on the dynamics of participating firms in terms of growth in employment, turnover, exports, and capital investments and compare them to firms that were also subject to the carbon pricing scheme but did not benefit from the CleanTech Investment programme. The default hypothesis is that the availability of CleanTech grants should have made the transition to cleaner technology smoother with the least amount of disruption to the overall operation of the firm. On the other hand, the programme was meant to assist firms that were less competitive than the average and would be in trouble if left unassisted. In case this selection is strong enough, there might be some underperformance inherent in the responses of the firms that received the grants.

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[1] See also Productivity Commission (2011) for a review of carbon trading schemes in other countries.

[2] Years in this document refer to financial years that start from July 1st to June 30th of the next calendar year. For instance, year 2015 refers to the financial year 2014−2015.

2. Data

This research uses a matched dataset of CleanTech projects provided by the the Department of Industry, Innovation and Science linked to the firm performance information from Business Longitudinal Analysis Data Environment (BLADE) provided by the Australian Bureau of Statistics (ABS). In what follows, I will describe each source of data and its contribution to the matched dataset.

2.1 CleanTech

CleanTech was introduced in 2012 by the Australian government as part of the Clean Energy Act (2011) to help Australian firms to maintain their competitiveness while switching to a cleaner and more energy efficient capital equipment or technology. This measure was deemed necessary with the introduction of the Carbon Pricing Scheme in the same year that would burden firms financially, especially those with large emission outputs. The programme was targeted at manufacturing facilities with an emphasis on food industry and foundries.[3]

Firms were offered up to half the proposed cost of such projects. The programme last accepted new applications in 2014. Overall the programme offered about half a billion dollars to 547 projects. More than half the projects had finished by 2013, and as of 2015, 156 projects are still progressing (Bakhtiari, 2016).

The Department of Industry, Innovation, and Science keeps an administrative database of CleanTech projects to monitor the use of funds and the progress of projects. This database forms the basis of identifying firms with CleanTech grants. The identification key used for the matching process is the Australian Business Number (ABN) of firms. To be precise, the grants are awarded to facilities, but the ABN pertains to the firm in control of the facility.

2.2 BLADE

The BLADE is a collection of firm-level databases held by the ABS and provides annual financial and operational information on firms identified by their ABN and enterprise group, which is the umbrella organisation (in case the firm is held by another organisation).[4] The available data currently covers years 2002 to 2013. I am particularly making use of the information on the Australian and New Zealand Standard Industry Classification (ANZSIC) and percentage of foreign ownership in addition to Full-Time equivalent Employees (FTE), turnover, exports, and capital expenditures. These latter variables will serve as performance indicators in the remainder.

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[3] The programme also offered grants for collaborative investment across firms. Only one or two of such funds were awarded; therefore, the statistical impact is negligible.

[4] See ABS cat.no.8171.0 for more details.

The data are matched to the CleanTech database by ABN, which is the common identifier on both databases. The matching rate is high, and out of 482 firms (ABNs) that receive CleanTech, 475 are matched to the BLADE.

Given that CleanTech grants were offered to manufacturing facilities only, I am restricting the BLADE to manufacturing firms. The matched subset of observations represents the group of firms treated with CleanTech grants, whereas the large subset of unmatched observations is used as the control group. The presence of the two subsets of firms play a crucial role in identifying the impact of CleanTech projects above and beyond the normal course taken by the industry.

Finally, to factor out price changes and their effects on the results, I convert monetary quantities to real values using appropriate deflators from ABS reports. Specifically, I am using manufacturing input price indexes (cat.no.6427.0.13) for Machinery and Equipment (ANZSIC 24) to deflate capital investments and manufacturing output price indexes (cat.no.6427.0.12) to deflate turnover and exports. The use of Machinery and Equipment price index for capital equipment follows from the fact that a large proportion of equipment provided to the manufacturing industry as a whole comes from this particular sector.

3.   Descriptive Statistics

Before presenting the main set of results, it is judicious to first compare CleanTech and non-CleanTech firms using a few simple statistics to see whether there is systematic differences between the two groups of firms (one serving as the control group, the other as treatment) and whether there is some selection at play.

Table 3.1 and Table 3.2 show some descriptive statistics for the key performance variables used in the analysis and separately for the two groups of non-CleanTech and CleanTech firms, respectively. FTE, turnover, value of exports, and capital investments are used as key performance indicators.

Table 3.1: Descriptive statistics for non-CleanTech firms in 2011. Monetary values are in 2015 dollars.

Variable	N	Mean	Std.Dev.	1st Quartile	Median	3rd Quartile
FTE	75,196	8.92	73.5	0	1.22	5.22
Turnover ($mil)	90,253	3.87	103.2	0	0.12	0.69
Exports ($mil)	90,253	0.72	68.0	0	0	0
Cap.Inv. ($mil)	115,522	0.12	6.61	0	0	0.002
Foreign Shareholding (per cent)	36,328	1.46	11.7	0	0	0

Source: Author's calculations based on the BLADE

Table 3.2: Descriptive statistics for CleanTech firms in 2011. Monetary values are in 2015 dollars.

Variable	N	Mean	Std.Dev.	1st Quartile	Median	3rd Quartile
FTE	446	611.3	1,573.2	17.2	51.1	316.3
Turnover ($mil)	368	379.6	1,112.6	6.57	19.8	172.5
Exports ($mil)	368	43.2	191.6	0	0.33	9.56
Cap.Inv. ($mil)	456	14.8	60.9	0.07	0.57	4.01
Foreign Shareholding (per cent)	349	2.58	15.4	0	0	0

Source: Author's calculations based on the BLADE

One notable finding from the tables is that firms receiving CleanTech are very likely to have zero percent foreign ownership. The majority of the grants went to fully Australian-owned firms. There are exceptions; for instance, Coca-Cola Amatil and GlaxoSmithKline are two foreign owned companies that used CleanTech grants.[5]

The other notable take form the tables is that firms that received CleanTech grants are on average larger (as judged by FTE and turnover numbers) than firms that did not have any CleanTech projects. Their exports value and capital expenditures are also larger on average. This difference in size is manifested not only in the mean values but also in all the quartiles. However, CleanTech firms are also more dispersed in their sizes. It should be noted that CleanTech grants were offered to particular facilities within firms. It is quite possible that the facility that received the grant is small whereas the parent firm's large size is driving the statistics in Table 3.2.

Regarding the point made about the size of CleanTech firms, one might argue that the small number of CleanTech firms might be affecting the size statistics. To emphasise that the CleanTech programme mostly ended up with larger firms, I use a Gaussian kernel with a bandwidth of 0.15 for the log of employment and use it to estimate the total number of firms and then the total number of CleanTech firms at different employment (*FTE*) sizes. The percentage of CleanTech firms from the total estimated in this way is illustrated in Figure 3.1. It can be seen in the picture that the proportion of CleanTech firms is increasing with size and approaches 100 per cent among the largest firms. In other words, proportionally, the largest firms are the main recipients of the CleanTech grants

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[5] See https://www.business.gov.au/assistance/clean-technology-investment-program for the list of grant recipients.

Figure 3.1 The estimated percentage of CleanTech firms from the total.
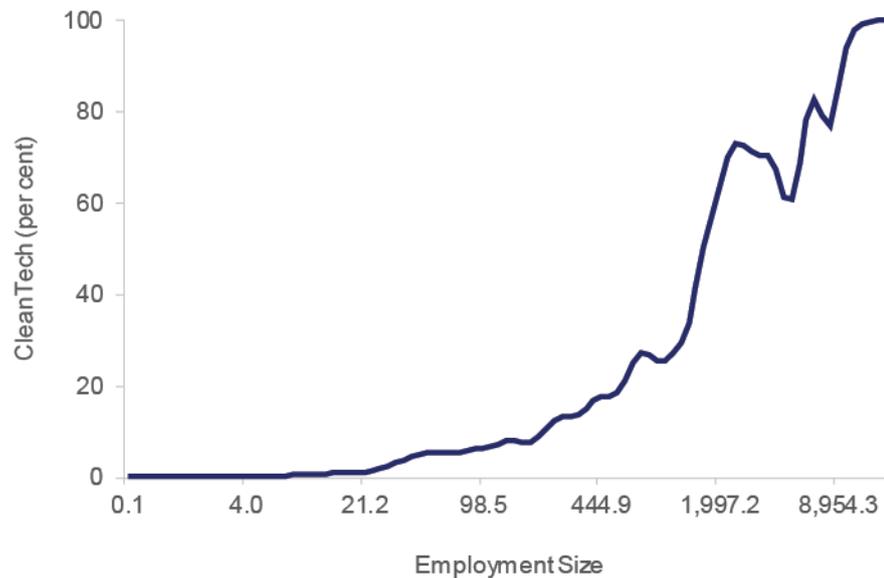
4. CleanTech versus Non-CleanTech

The rate of growth in various performance variables are compared between CleanTech and non-CleanTech firms and over time. In the spirit of Davis et al. (1996), the rate of growth is defined as:

$$\Delta X = \frac{X_2 - X_1}{\frac{1}{2}(X_2 + X_1)}$$

This particular definition guarantees that the rate of change is restricted within [-2,2] range, hence, no extreme value is generated and is affecting the results. Entries and exits will be assigned 2 and -2, respectively.

Initially, I do a simple comparison of how CleanTech and non-CleanTech firms grow over time by estimating kernel densities of the growth rates and plotting them over two periods for each type of firms. The evidence will be anecdotal as I am not accounting for differences in the firm characteristics, but it will provide an overall picture of dynamics prevailing within CleanTech firms versus that present across all other firms.

Specifically, I will compare the growth rates from 2009 to 2011 to those of 2011 to 2013 (the latest available year in the BLADE). The first period, from 2009 to 2011, is indicative of pre-CleanTech and pre-carbon pricing behaviour of firms. The Clean Energy Bill of 2011 was enacted on 18 November 2011 and came into force on 1 July 2012, leaving ample time for firms to respond early and try to minimise their liabilities under the new emission law. Therefore, I consider the year 2011 the last year before firms are affected by the legislation.

By the same token, the period from 2011 to 2013 signifies the behaviours of firms affected by the Carbon Pricing Scheme. The use of 2011 as the starting year is helpful in capturing the full impact of the programme and the trading scheme. A comparison from the first to second period helps to underline how business dynamics were impacted by the introduction of the regulations. I will conduct this comparison by contrasting the change in the performance of non-CleanTech and CleanTech firms from the first to the second period.

Figure 4.1 shows the density estimates for CleanTech and non-CleanTech firms during the 2009 to 2011 period. The way the distributions are positioned relative to zero shows that a larger fraction of firms contracted in size during this period regardless of the type. Ignoring the entries and exits (at -2 and 2), both CleanTech and non-CleanTech firms behaved similarly before the carbon pricing and CleanTech programmes were introduced.

Figure 4.1: The distribution of FTE growth (2009−2011): CleanTech versus non-CleanTech firms
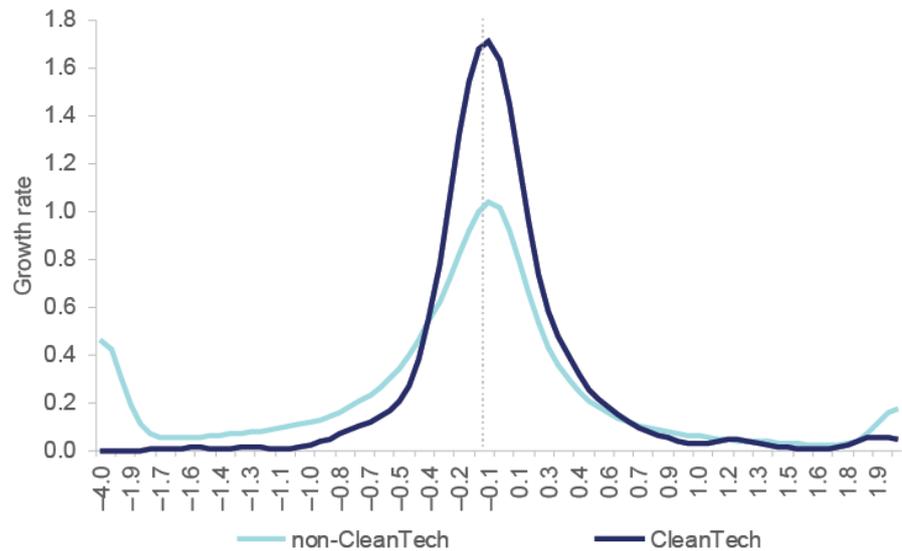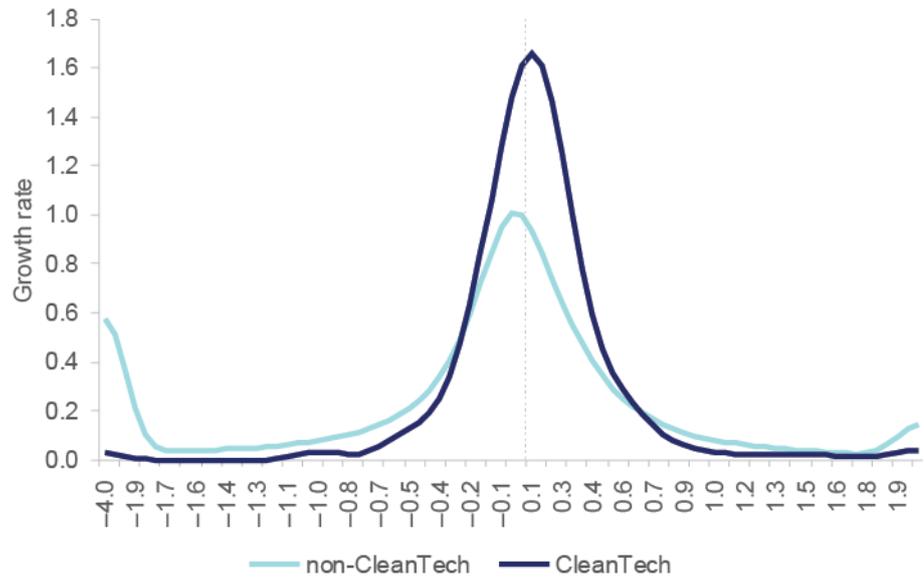

Notes: Using a Gaussian kernel with the bandwidth of 0.1.

Source: Author's calculations based on the BLADE

Figure 4.2 shows the densities for the period 2011 to 2013. Rate of employment growth has improved for both types of firms, but more so for the firms that received CleanTech grants. The latter group practically shows a positive rate of growth, that is, they created jobs.

I do the same exercise using the rate of change in turnover, where the distributions are illustrated in Figure 4.3 and Figure 4.4. Figure 4.3 focuses on change in turnover during the 2009 to 2011 period. Again, ignoring entries and exits, one observes a rather similar distribution for both types of firms during this time period; a distribution that is basically centred around zero.

Turning to Figure 4.4, which illustrates the distributions for the period 2011 to 2013, it becomes evident that the distribution of turnover growth shifted to the left and the average became negative for both types of firms. However, non-CleanTech firms are on average experiencing a larger drop in their turnovers than is the case with CleanTech firms.

Figure 4.3: The distribution of turnover growth (2009−2011): CleanTech versus non-CleanTech firms

Notes: Using a Gaussian kernel with the bandwidth of 0.1.

Source: Author's calculations based on the BLADE

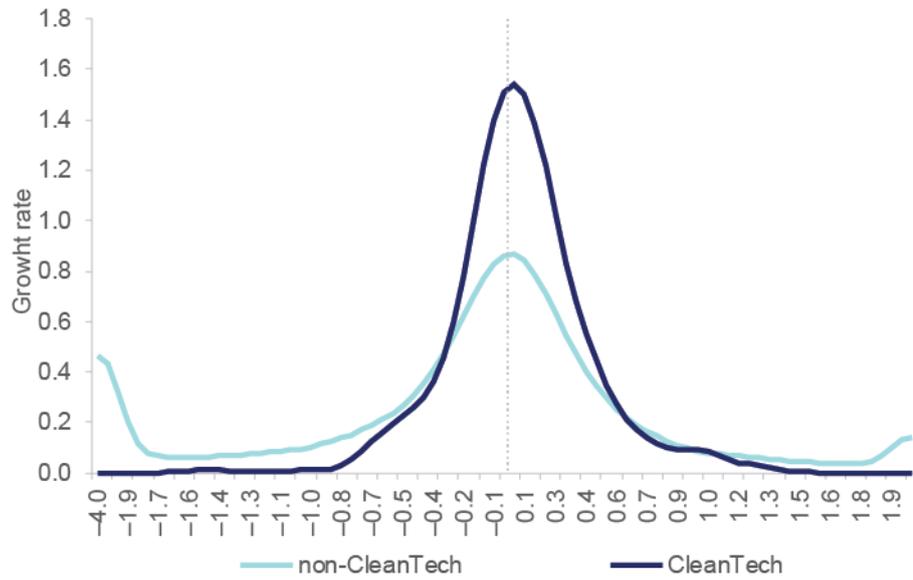Figure 4.4: The distribution of turnover growth (2011−2013): CleanTech versus non-CleanTech firms
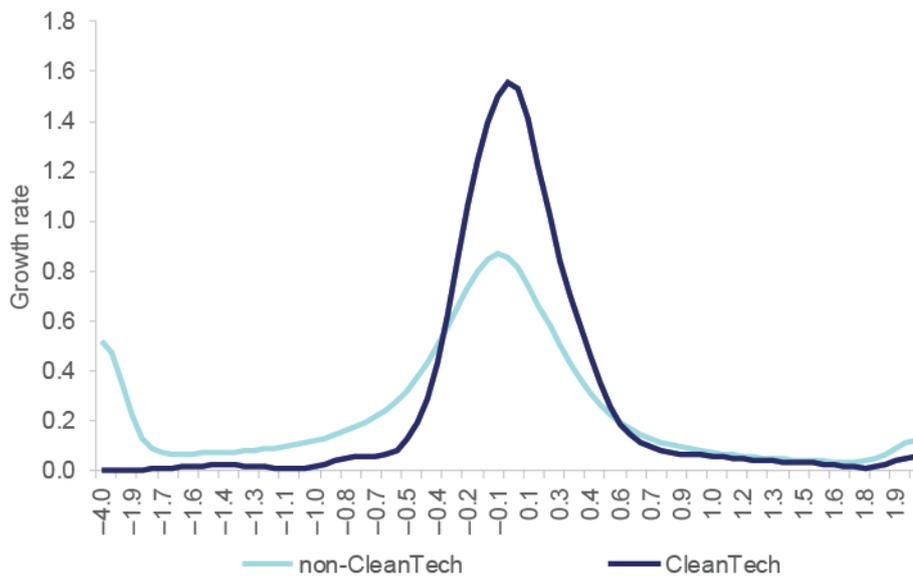
Notes: Using a Gaussian kernel with the bandwidth of 0.1.

Source: Author's calculations based on the BLADE

Given the lumpiness of exports and capital investments (there are lots of zero values), I am not showing the density estimates for those variables and will discuss them in the next section where I conduct a matching exercise.

The overall picture suggests that firms with CleanTech grants were very similar to other firms before the introduction of Carbon Pricing Scheme and the

associated CleanTech Investment programme. The awarding of CleanTech seems to have had a positive effect on the growth rate of firms — in terms of sales and employment — compared to their non-CleanTech counterparts.

5. Matching Exercise

In this section, I add more rigor to the analysis by carrying out a matching exercise in which for every CleanTech firm I search for a similar non-CleanTech manufacturing firm as the potential counterfactual. I then conduct a comparison analysis.

Matching is done based on an array of idiosyncratic firm characteristics. The characteristics I use for matching are FTE, value of exports, change in FTE from 2009 to 2011, percentage of foreign ownership and ANZSIC. All characteristics except for the prior growth rate are those from the year 2011. For better results, I match each CleanTech firm to three nearest neighbours that are found from the pool of non-CleanTech manufacturing firms and use the average as the counter-factual. Given that the number of firms with CleanTech grants is about 500 and the number of manufacturing firms with no CleanTech grants is vast (about 100,000), there is no shortage of matches to be found.

Various business performance indicators are used and their rates of change are compared to those of the counterfactual set. I use Average Treatment Effect (ATE) to do the comparison. This quantity is the average difference between the response of the treated firms (firms with CleanTech) and the control group (matched firms without CleanTech). These ATEs along with their standard errors are reported in Table 5.1 to Table 5.3. For a more detailed picture, firms are also split by different characteristics to see whether the findings are restricted to certain types of firms.

In Table 5.1, I am looking at the average treatment effect of CleanTech on the rates of growth in FTE and turnover. As the numbers show, CleanTech had a significantly positive impact on both.

Table 5.1 Average treatment effect for employment and turnover rates of change. Numbers in parentheses are standard errors

Firm Group	ΔFTE	ΔTurnover	#Controls	#Treated
All firms	0.256*** (0.033)	0.262*** (0.065)	85,734	457
ΔFTE$_{2009-2011}>0$	−0.108*** (0.018)	0.120** (0.051)	68,195	320
ΔFTE$_{2009-2011}<0$	0.464*** (0.025)	0.285*** (0.075)	17,515	137
Exporting	0.147*** (0.030)	0.155*** (0.045)	26,392	325

Firm Group	ΔFTE	ΔTurnover	#Controls	#Treated
Non-exporting	0.272*** (0.078)	0.257*** (0.058)	59,342	132
Foreign ownership ≥10 per cent	0.108 (0.106)	0.100 (0.093)	60,348	117
Foreign Ownership <10 per cent	0.259*** (0.033)	0.264*** (0.066)	25,386	340
$FTE_{2011}<20$	0.185 (0.165)	0.247 (0.176)	47,141	122
$20≤FTE_{2011}<200$	0.173*** (0.029)	0.197*** (0.044)	3,556	188
$FTE_{2011}≥200$	0.090** (0.041)	0.038 (0.039)	35,037	147

Source: Author's calculations based on the BLADE

However, when splitting firms by prior growth in FTE, one sees an interesting pattern. The positive effect is actually concentrated among firms that were destroying jobs prior to the introduction of the programme. In contrast, the growth rate for firms that were expanding just fell.

Regarding other characteristics, the results show that both exporting and non-exporting firms equally benefited from the programme, but the effect is more pronounced among non-exporting firms.

It was found earlier that the majority of the firms that received CleanTech are fully Australian-owned, and the largest positive effect of CleanTech is also associated with firms with very little foreign ownership. The positive effect of CleanTech is also more evident among midsize and large firms. No statistically significant effect can be detected among small firms (those with fewer than 20 employees).

To get some insight into the type of jobs created, I will do a matching exercise where I use the ratio of FTE to the head count of employees in a firm. This ratio signifies whether most of the jobs in a firm are full-time or part-time. In the former case, the ratio would be close to one, whereas in the latter it becomes smaller than one depending on the number of part-timers. I am only reporting the significant matching outcomes in Table 5.2. The positive effects suggest that firms with access to CleanTech grants tend to create more full-time jobs, or switch part-timers to full-time positions, than a similar firm but without CleanTech. This trend, again, is more associated with firms that were contracting before CleanTech was introduced.

Table 5.2 Average treatment effect for the rate of change in the ratio of FTE to headcount. Numbers in parentheses are standard errors

Firm Group	All firms	$\Delta FTE_{2009-2011}<0$	Exporting	Non-exporting
Δ(FTE/HEAD)	0.042***	0.129***	0.069**	0.042***
	(0.016)	(0.027)	(0.029)	(0.016)

Source: Author's calculations based on the BLADE

In Table 5.3 I do a similar exercise to that of Table 5.1 but comparing the growth rate of exports and capital investments.

Table 5.3 Average treatment effects for exports and capital expenditure rates of change. Numbers in parentheses are standard errors.

Firm Group	ΔExports	ΔCap.Inv.	#Control Firms	#Treated Firms
All firms	0.227 (0.163)	0.357** (0.172)	85734	457
$\Delta FTE_{2009-2011}>0$	0.183 (0.196)	0.055 (0.194)	68195	320
$\Delta FTE_{2009-2011}<0$	−0.320 (0.286)	0.701** (0.286)	17515	137
Exporting	0.413*** (0.145)	0.179 (0.176)	26392	325
Non-exporting	−0.000*** (0.000)	0.600** (0.265)	59342	132
Foreign ownership ≥10 per cent	−0.740 (0.561)	1.771*** (0.252)	60348	117
Foreign Ownership <10 per cent	0.272* (0.157)	0.326* (0.175)	25386	340
$FTE_{2011}<20$	−0.034 (0.379)	0.524 (0.470)	47141	122
$20 \leq FTE_{2011}<200$	0.159 (0.200)	0.219 (0.215)	3556	188
$FTE_{2011} \geq 200$	−0.149 (0.103)	0.086 (0.106)	35037	147

Source: Author's calculations based on the BLADE

Results are less compelling here. Looking at the column on growth in exports, there are few effects that are statistically significant. The important finding here is that CleanTech firms had a higher rate of growth in exports value than non-CleanTech firms, whereas there is practically no increase in exporting (from zero) for non-exporting CleanTech firms. In other words, having access to CleanTech has not had any significant role in compelling non-exporting firms to commence exporting.

Capital investments rose among the CleanTech firms, as is expected especially in the field of clean technology. But again, the statistically significant effect is mostly concentrated among contracting and non-exporting firms.

Also considering the possibility that CleanTech projects could be carried out through a network of sub-contractors, I did an extra matching exercise using the reported cost of sub-contractors in BLADE. Despite showing some positive outcomes, none of the results in this case are statistically significant; hence, I am not reporting them.

6. CleanTech within Manufacturing Subdivisions

The previous results show that the CleanTech programme had a positive effect on the dynamism of manufacturing firms. However, given that about half of the CleanTech grants were offered to food manufacturers and foundries, one could wonder whether the results are being driven by those industries. To see whether, the impact of CleanTech is concentrated within certain manufacturing subdivisions or is present across all the manufacturing regardless of the type of activity, I repeat the matching exercise but this time separately within each manufacturing subdivision defined by its two-digit ANZSIC. The average treatment effects are reported in Table 6.1.

Table 6.1 Average treatment effects within manufacturing subdivisions. Numbers in parentheses are standard errors. A few subdivisions are suppressed due to small sample sizes and to protect confidentiality

Sub-division	ΔFTE	ΔTurnover	#Controls	#Treated
Food	0.227*** (0.068)	0.202*** (0.061)	7,894	173
Beverage & Tobacco	0.186*** (0.062)	0.173*** (0.048)	3,290	89
Wood Products	0.284*** (0.044)	0.253*** (0.028)	8,227	12
Printing	0.442*** (0.076)	0.469*** (0.136)	9,019	17
Basic Chemical Products	0.562 (0.364)	0.546* (0.305)	3,135	23
Polymer & Rubber	0.254***	0.297***	4,217	35

Sub-division	ΔFTE	ΔTurnover	#Controls	#Treated
	(0.040)	(0.052)		
Non-metallic Minerals	0.024	0.107	4,005	16
	(0.366)	(0.113)		
Primary Metals	0.172	0.362**	929	12
	(0.218)	(0.150)		
Fabricated Metal	0.163**	0.157***	19,551	20
	(0.073)	(0.061)		
Transport Equipment	0.217***	0.162*	4,048	10
	(0.077)	(0.088)		
Machinery & Equipment	0.283***	0.228***	11,678	27
	(0.052)	(0.082)		

Source: Author's calculations based on the BLADE

Looking at the numbers in the table makes it clear that practically every manufacturing subdivision benefited from CleanTech in terms of increased dynamism. Only in few cases the results are statistically insignificant. A few subdivisions in manufacturing had to be supressed to protect confidentiality due to non-existence of CleanTech firms or because of small size of the CleanTech sample.

7. Conclusion

Overall, CleanTech seems to have been in support of growth, job creation, and exporting but mostly among firms that were performing badly prior to the programme. The programme seems to have offered a lifeline to these firms that eventually enabled them to turn themselves around and start growing and creating jobs. There is very little evidence that the programme had a positive impact on firms that were already growing and could perform well. The bulk of the assistance went to firms that have no or very little foreign ownership and had the greatest impact among those firms. In that sense, the programme seems to have been properly targeted in support of the domestic economy.

There are two caveats. First, the study only looks at what happened as a result of CleanTech during 2011 to 2013. This is the period that firms were actually carrying out projects. For a longer term view of those effects one also needs to look at growth during 2013 to 2015. The data for this last period is currently unavailable in the BLADE, so a follow-up research in a few years could be helpful.

The second, and probably the more important, caveat is that owing to data limitations the analysis was carried out at firm (ABN) level whereas the grants were awarded to specific facilities. It is not clear from the results whether a facility that received CleanTech grants actually grew at the same time that the whole firm was growing. Subsequently, the findings need to be interpreted as the impact of CleanTech on the overall firm strategy including its ability to shift and redistribute activity across its multiple facilities and locations.

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