Annex A: Technical Annex

This Annex sets out the details of a series of econometric analyses exploring the impacts of the Made Smarter Adoption (MSA) programme on beneficiary businesses.

A.1 Data

The sample for the analysis was based on records of 2,412 firms that at least reached initial engagement in the programme between 2018 and July 2024 – based on monitoring data compiled by DBT across the five regions delivering the programme. The dataset included details of:

- 1,681 firms that progressed to a digital road-mapping workshop (Service Level 3 and above). This is the first stage at which a business received material 'support' from the programme and these businesses are considered participants in the programme.
- 731 firms that engaged initially but did not progress to the substantive support package (Service Levels 1 and 2). These businesses are not considered participants in the programme.

The dataset including a variety of details of participating firms including their registration date, Company Reference Number (CRN), and the highest MSA Service Level reached. The dataset was then linked by the Office for National Statistics to the Business Structure Database (BSD) and the Annual Business Survey (ABS) using the company CRN:

- The BSD is an annual snapshot of the Interdepartmental Business Register (IDBR), providing data for all businesses in the UK registered for VAT and PAYE. Of the initial number of firms, 99% were matched to the BSD (2,402 companies in total).
- The ABS is an annual census of large firms and a sample survey of SMEs, collecting around 62,000 observations per year, and providing additional information on key outcomes of interest, such as capital investment, GVA, and productivity (GVA per worker). However, as SMEs are sampled at irregular intervals, coverage of the MSA population is not complete in each year. It was possible to match 1,151 firms making at least initial engagement with MSA to the ABS (45% of the sample).

Table A.1 below, provides an overview of the datasets used in this analysis. The data were accessed through the ONS Integrated Data Service (IDS)[1].

[1] The ONS Integrated Data Services is the new name of the previously known Secure Research Service.

Table A.1: Datasets used in econometric analysis

Dataset name	Years covered	Description	Variables	Total number of observations	Number of firms matched
MSA Monitoring data	N/A	The aggregated list of all firms that had registered with the programme, as of July 2024. This covered firms that had registered since the MSA pilot in 2019.	CRN, Registration date, Region, Service Level (SL) reached.	2,412	N/A
Business Structure Database (BSD)	2012 - 2023	An annual snapshot of the Interdepartmental Business Register (IDBR) with coverage of all firms registered for VAT or PAYE. This dataset provides yearly measures of employment, turnover and turnover per worker and covers the UK business population comprehensively.	Turnover, Employment, Productivity (expressed as turnover/employees), Sector, CRN	40,228,708	2,402
Annual Business Survey	2012 - 2022	An annual survey of the business population undertaken by ONS, used to generate estimates of output and other national accounting measures in non-financial services sectors.	Capital Investment, GVA, GVA per worker, Exports, Consumption of intermediate goods and services.	484,034	1,151

Given that the ABS is a sample, the MSA beneficiary firms that were matched to the ABS may not be entirely representative of the population of MSA beneficiaries. For example, the analysis undertaken indicates that this sample of businesses matched with the ABS differs to that captured by the BSD, with higher average pre-treatment turnover (£21.4 million compared to £8.8 million) and higher average levels of employment (132 employees compared to 51). Therefore, the sample captured by the ABS may be exposed to a degree of bias towards firms of larger size.

A.2 Counterfactual selection

To obtain robust estimates of the impacts of the programme, it is necessary to compare the performance of participating firms (which for the purposes of this analysis was defined as firms that progress to Service Level 3) to an equivalent group of non-participating firms (to establish what may have occurred in the absence of participation).

A.3 Selection bias

The main risk of bias in comparing MSA participants to other firms arises from the self-selecting nature of firms participating in the programme. MSA participating firms 'choose' to seek out and register with the programme. As such, participating businesses are likely to differ in systematic ways to other firms in ways which are linked to their growth and productivity prospects. For example, firms seeking MSA support may have greater awareness of IDTs and have greater levels of interest in pursuing productivity raising investments. In this case, comparing participants to the general population of SME manufacturers would likely overstate the impacts of the programme, as participants would likely outperform non-participants regardless of the support provided. Three approaches for selecting comparison groups and addressing selection bias were adopted, these are explained in the following table.

Table A.2: MSA Counterfactual groups

Comparison group	Description
Model 1: Matched comparisons with SME manufacturers	The first approach replicated the principles of analysis undertaken as part of the evaluation of the North West pilot programme and focused on identifying a sample of SME manufacturers that shared similar observable characteristics to participating firms on the basis of (a) their industrial sector, (b) their size, and (c) their performance trajectory prior to the introduction of MSA in terms of employment, turnover and productivity growth (covering the period 2012 to 2017). The comparison sample was identified using Propensity Score Matching methods. The key risk with this approach is that it does not account for unobservable differences between participants and other businesses (i.e. those factors that may have motivated their engagement with the programme). As illustrated by the findings of an evaluation of the Growth Vouchers scheme published in 2024[2], these types of approach have been shown to significantly overstate the size and persistence of the impacts of business support programme as firms seeking advisory support typically outperform those that do not.
Model 2: Comparisons with those reaching up to Service Level 2	To address potential concerns around the biases that may arise from comparisons to the general business population, a second set of comparisons were made with those firms that registered with the programme but did not progress to substantive support (i.e. they reached Service Level 1 or 2). As this group had expressed an interest in the programme, it can be assumed that they share some unobservable characteristics (e.g. motivations and managerial focus, awareness of IDTs) in common with MSA participants. As such, this approach is likely to yield more robust results than comparisons with the general SME population. However, there may be residual concerns that those disengaging with the programme may also differ in other ways to those progressing to Service Level 3. For example many firms did not progress into the scheme because they considered the programme inappropriate for their business (either

[2]Nunez-Chaim, Overman & Riom (2024). Does subsidising business advice improve firm performance? Evidence from a large RCT. Accessed on 16/06/2025 at: https://cep.lse.ac.uk/_NEW/publications/abstract.asp?index=10660

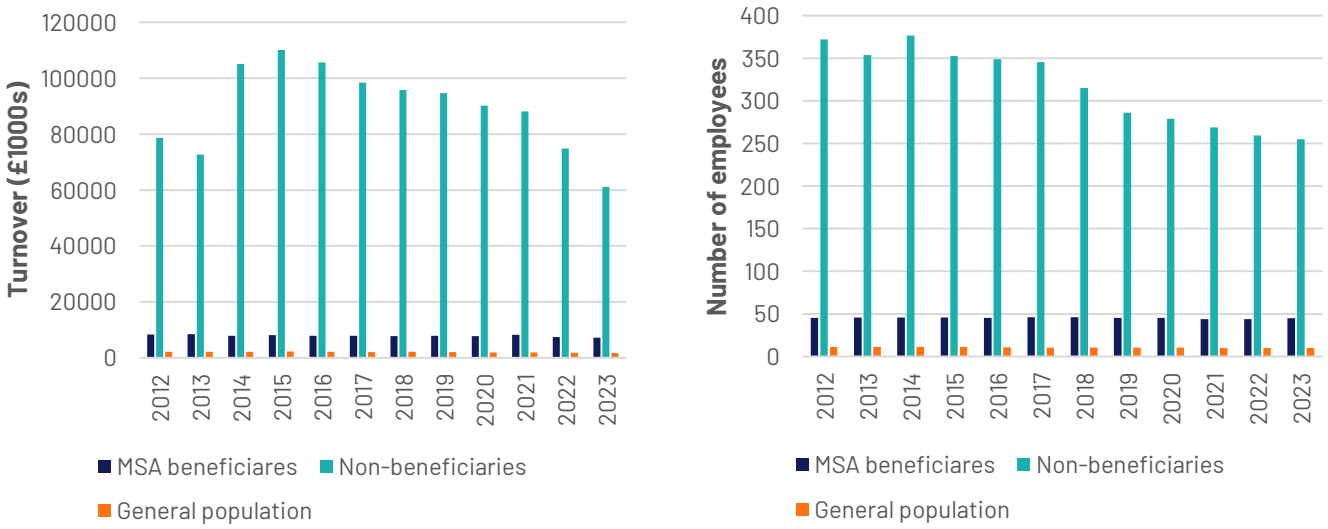
Comparison group	Description
	because they had already a good level of digitalisation or their levels of digital maturity were too low).
Model 3: Early vs late – staggered treatment design	To address these residual concerns around potential bias, a final set of analyses sought to infer the impact of the programme from comparisons between firms that joined the programme in earlier years to those that joined in later years (with the assumption that those participating in the programme first will experience the impacts of the programme at an earlier stage). As this approach only makes comparisons between firms that eventually were supported by the programme, it is likely to be the most effective in addressing possible concerns around biases driven by unobservable differences between groups. The main threat to bias in these approaches arises from the possibility that there are systematic differences between firms registering with the programme in different periods.

A.4 Comparison between MSA beneficiaries and comparison groups

A preliminary comparison of MSA beneficiaries, non-beneficiaries and firms in the general population of businesses was conducted across the BSD and ABS datasets which are set out in the following charts. This comparison found that there were statistically significant differences between the groups in terms of their sector distribution (unsurprising given the focus on manufacturing), size, and growth trajectories. For all variables assessed, the difference between MSA beneficiaries and firms in the general population was statistically significant at the 1% significance level.

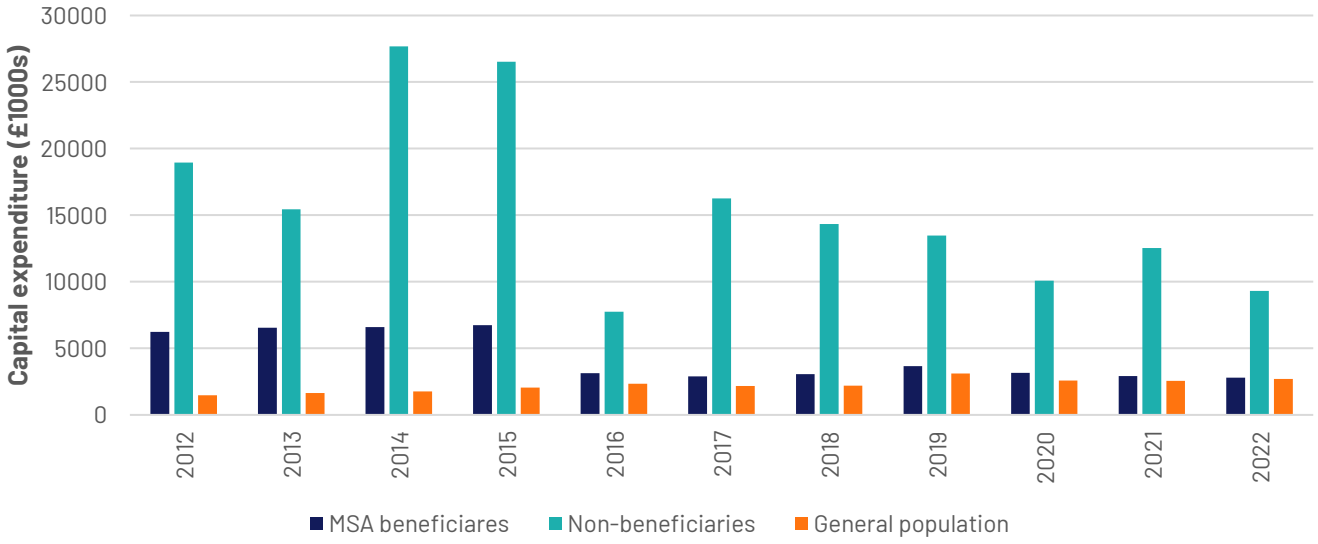
Based on the significant differences identified above between MSA beneficiary firms and firms in the general population, Propensity Score Matching was used to match MSA beneficiaries with similar manufacturing firms in the general population. This approach creates a comparison group that is more comparable to the treatment group, based on a set of observable characteristics, allowing for a more accurate estimate of the programme's impact. Whilst there were also significant differences between MSA beneficiaries and non-beneficiaries, Propensity Score Matching was not used when building our comparison group for Model 2. This was in order to preserve sample size, particular for the variables used in the ABS. However, to account for differences between the control and treatment group, dummy variables such as firms' size (medium and micro) and sector (only manufacturing sector) were included as control variables in the Staggered Difference-in-Difference model to control for these aspects and improve comparability.

Figure A.1 Left panel: average yearly turnover between MSA beneficiaries and firms in the general population of businesses. Right panel: average yearly employment between MSA beneficiaries and firms in the general population



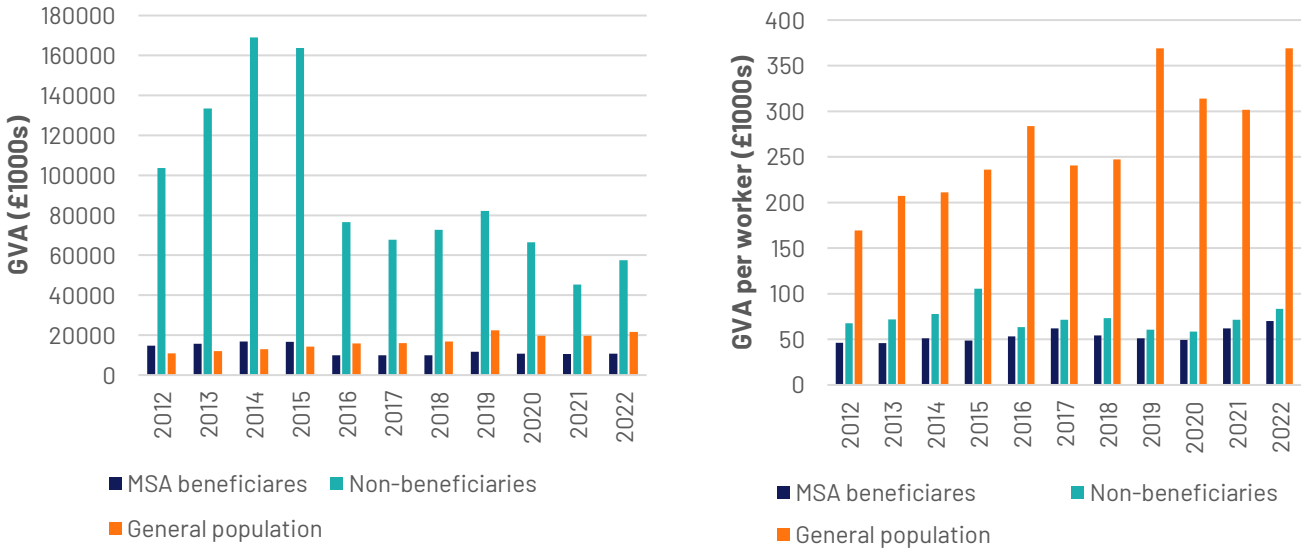
Source: Busines Structure Database, Ipsos' analysis, base 2,402 firms.

Figure A.2: Average yearly capital expenditure between MSA beneficiaries, non-beneficiaries and firms in the general population.



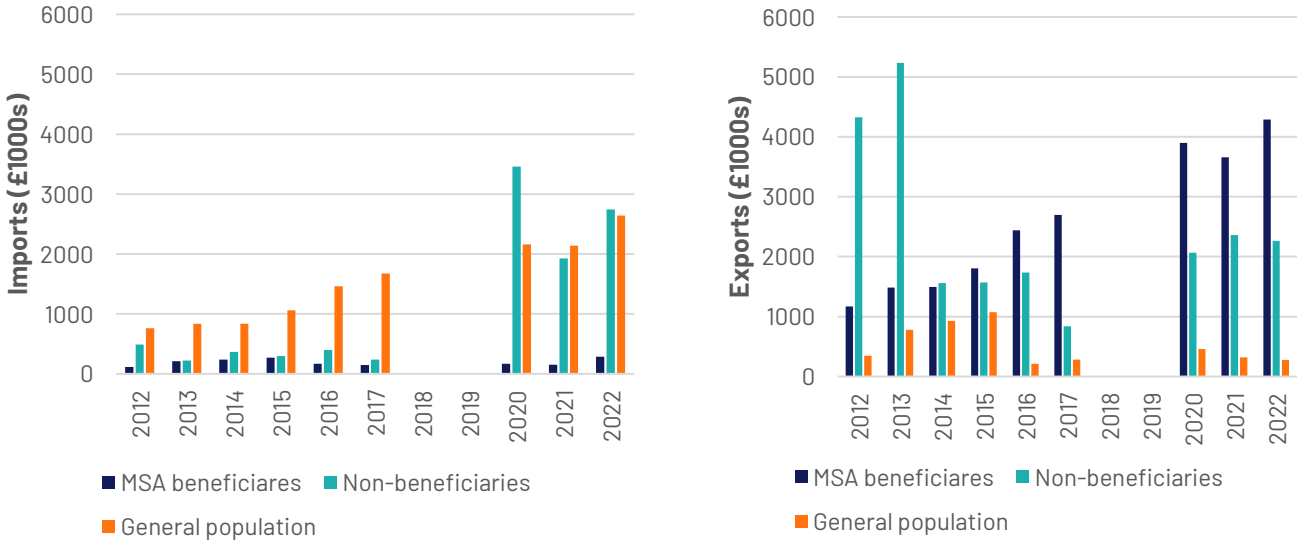
Source: Annual Business Survey, Ipsos' analysis, base 1,141 firms.

Figure A.3: Left panel: Average yearly GVA between MSA beneficiaries, non-beneficiaries and firms in the general population; Left panel: Average yearly GVA per worker between MSA beneficiaries, non-beneficiaries and firms in the general population.



Source: Annual Business Survey, Ipsos' analysis, base 1,141 firms.

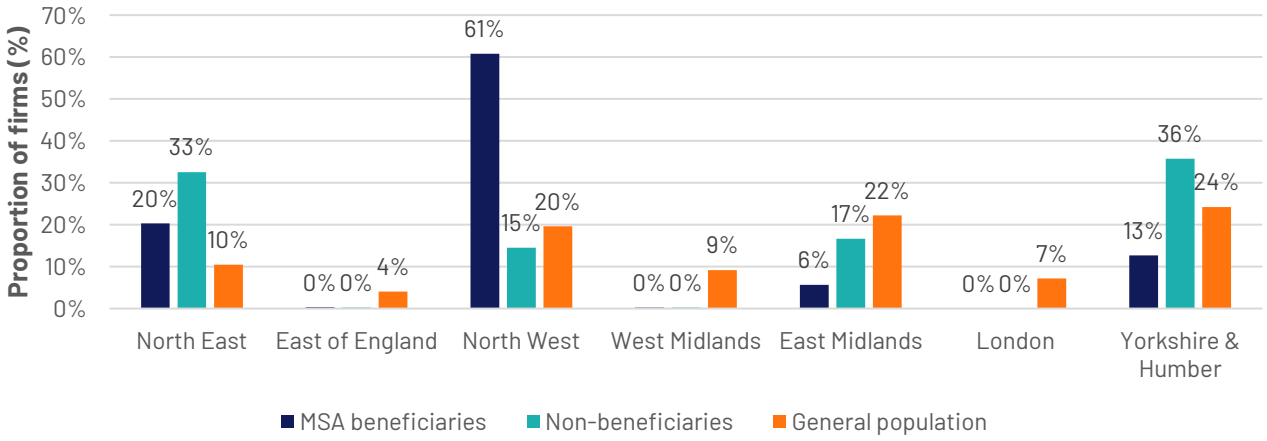
Figure A.4: Left panel: average yearly imports between MSA beneficiaries, non-beneficiaries, and firms in the general population of businesses. Right panel: average yearly exports between MSA beneficiaries, non-beneficiaries, and firms in the general population[3]



Source: Annual Business Survey, Ipsos' analysis, base 1,141 firms.

[3] The ABS does not include data on the amount spent on imports and exports for the years 2018 and 2019, so the average amounts have been left blank for both of the graphs presented.

Figure A.5: Proportion of firms across regions between MSA beneficiaries, non-beneficiaries and firms in the general population.



Source: Business Structure Database, Ipsos data analysis. Base: 2,402 firms

A.5 Approach to matching with firms in the general population

As discussed above, propensity score matching was used to match firms in the general population to MSA beneficiaries. A separate procedure for matching was implemented for each of the datasets used (ABS and BSD) based on the fact that the sampling approach to the ABS. Firms in the BSD were matched against firm size, sector and region pre-treatment, these variables were used in the study of the pilot MSA programme to generate a comparison group that had shared characteristics to that of the treatment group. The additional variables of turnover and employment pre-treatment (2014, 2015, 2016 and 2017) were included in the analysis. Firms in the ABS were matched against their values in turnover, employment, capital expenditure, GVA, exports, imports, intermediate consumption and amount spent on machinery in 2017. This matching model could not use trends in values (as done with the BSD) as the sample size became too small due to the nature of the sampling for the ABS. This is because this would only include firms that had entries in the ABS for consecutive years, which leads to a significant reduction in the sample size. In addition, size, sector and region, were not able to be matched against due to the nature of how the ABS panel was constructed.

The results of the matching are provided in tables A.3 to A.5. This includes:

- **A 1st stage Logit Model results**: Table A.3 shows the results of the logit model undertaken as part of the PSM approach, where the coefficients demonstrate the impact of that variable on a firm's likelihood of participating in the MSA programme. This provides an indication of what factors are driving differences between MSA firms and firms in the general population of businesses.

- **Quality of matching**: Table A.4 below presents the quality of the matching performed. It shows the comparison of the average values for the variables used in the matching in the treatment and control group before and after matching. The columns titled p-value display the results of the t-tests, checking that there is no difference between the average values in the treatment and control groups (i.e. the null hypothesis). The results indicate that the difference between treatment and control groups after matching was insignificant for the majority of variables used, leading to a positive reduction in bias.

- **Overall bias reduction from matching**: Table A.5 shows the overall effect of PSM on the bias between the treatment and control groups. The matching reduced mean bias between firms in the treatment

and control groups from 38.1% to 1.2% for the BSD and a reduction of 6.3% to 0.9% for the ABS. This indicates that the PSM model was effective at generating a similar group[4] of manufacturing firms from the general population of businesses to those in the treatment group (firms that received any level of support through MSA).

[4] Similarity of the counterfactual group is ensured only with respect to the list of observable characteristics chosen turnover and employment before MSA, sector, size and region.

Table A.3: Propensity score matching – 1st Stage Logit Model (BSD)

Variable	BSD		ABS	
	Coefficient	p-value	Coefficient	p-value
Turnover 2014	0.000000	0.55	-	
Turnover 2015	0.000000	0.44	-	
Turnover 2016	0.000000	0.64	-	
Turnover 2017	0.000000	0.87	-0.000001*	0.05
Employment 2014	-0.000021	0.87	-	
Employment 2015	0.000003	0.98	-	
Employment 2016	-0.000041	0.69	-	
Employment 2017	0.000079	0.35	-0.000185*	0.03
Capital expenditure 2017	-	-	0.000003*	0.02
GVA 2017	-	-	0.000001	0.10
Exports 2017	-	-	-0.000006	0.37
Imports 2017	-	-	-0.000017	0.24
Intermediate consumption 2017	-	-	0.000001	0.25
Amount spent on machinery 2017	-	-	-0.000002	0.14
Sector (Manufacturing) 2016	1.120412***	0.00		-
Sector F (Construction) 2016	0.255501	0.12	-	-
Sector H (transportation and storage) 2016	0.482224***	0.00	-	-
Sector J (Information and communication) 2016	-0.601698***	0.00	-	-
Sector L (Real estate activities) 2016	-0.124596	0.41	-	-
Sector N (Administrative and support service activities) 2016	0.308648***	0.00	-	-
Sector S (Other service activities) 2016	-0.363843***	0.00	-	-
Region North-East 2016	3.979523	0.97	-	-
Region East of England 2016	2.807027	0.98	-	-
Region North-West 2016	4.219227	0.97	-	-
Region West Midlands 2016	2.636420	0.98	-	-
Region East Midlands 2016	3.396937	0.98	-	-
Region London 2016	2.460819	0.98	-	-
Region Yorkshire and Humber 2016	3.683705	0.97	-	-
Micro 2016	-0.614924***	0.00	-	-
Small 2016	0.206177*	0.04	-	-

Medium 2016	0.446307***	0.00	-	-

Source: The symbol (*) indicates statistical significance at the 10% level, (**) significance at the 5% level and (***) represents significance at the 1% level.

Table A.4: Propensity Score Matching – unmatched and matched samples (BSD)

	Unmatched			Matched			Bias reduction	Unmatched			Matched			Bias reduction
Variable	Treatment	Control	p-value	Treatment	Control	p-value		Treatment	Control	p-value	Treatment	Control	p-value	
Turnover 2014 (£1000s)	7,909	2,850	0.41	7,910	6,607	0.55	27%	-	-	-	-	-	-	
Turnover 2015 (£1000s)	8,483	2,908	0.37	8,484	7,358	0.62	20%	-	-	-	-	-	-	
Turnover 2016 (£1000s)	8,484	2,987	0.40	8,484	7,402	0.63	29%	-	-	-	-	-	-	
Turnover 2017 (£1000s)	8,827	2,896	0.32	8,827	7,681	0.64	43%	21,367	61,913	0.25	21,367	18,105	0.67	92.0%
Employment 2014 (number)	45.56	13.53	0.01*	45.56	46.26	0.95	98%	-			-			
Employment 2015 (number)	47.42	13.81	0.00**	47.42	48.97	0.90	71%	-			-			
Employment 2016 (number)	48.81	13.96	0.00**	48.81	48.81	1.00	84%	-			-			
Employment 2017 (number)	50.84	14.13	0.00***	50.84	52.67	0.89	75%	131.70	321.80	0.22	131.7	128.4	0.90	98.2%
Capital expenditure 2017 (£1000s)	-	-	-	-	-	-	-	3,500	2,673	0.71	3,500	2,716	0.82	5.2%
GVA 2017 (£1000s)	-	-	-	-	-	-	-	11,356	19,320	0.36	11,356	7,174	0.46	47.5%
Exports 2017 (£1000s)	-	-	-	-	-	-	-	347	3,326	0.35	347	127	0.14	92.6%

Imports 2017 (£1000s)	-	-	-	-	-	-	-	174	2,068	0.39	175	80	0.06*	95.0%
Intermediate consumption 2017 (£1000s)	-	-	-	-	-	-	-	9,432	20,972	0.35	9,432	8,558	0.78	92.4%
Amount spent on machinery 2017 (£1000s)	-	-	-	-	-	-	-	904	1,553	0.73	904	913	0.99	98.6%
Sector C (Manufacturing) 2016	0.63	0.06	0.00***	0.63	0.63	0.97	100%	-	-	-	-	-	-	-
Sector F (Construction) 2016	0.00	0.00	0.91	0.00	0.00	0.71	21%	-	-	-	-	-	-	-
Sector H (transportation and storage) 2016	0.18	0.16	0.01**	0.18	0.18	0.96	99%	-	-	-	-	-	-	-
Sector J (Information and communication) 2016	0.00	0.06	0.00***	0.00	0.00	0.66	99%	-	-	-	-	-	-	-
Sector L (Real estate activities) 2016	0.00	0.02	0.00***	0.00	0.00	1	100%	-	-	-	-	-	-	-
Sector N (Administrative and support service activities) 2016	0.07	0.17	0.00***	0.07	0.07	0.94	99%	-	-	-	-	-	-	-

Sector S (Other service activities) 2016	0.00	0.04	0.00***	0.00	0.00	0.80	98%	-	-	-	-	-	-	-
Region North-East 2016	0.00	0.10	0.00***	0.00	0.21	0.65	100%	-	-	-	-	-	-	-
Region East of England 2016	0.00	0.04	0.00***	0.06	0.00	0.56	97%	-	-	-	-	-	-	-
Region North-West 2016	0.60	0.19	0.00***	0.60	0.59	0.42	96%	-	-	-	-	-	-	-
Region West Midlands 2016	0.00	0.09	0.00***	0.00	0.00	1.00	99%	-	-	-	-	-	-	-
Region East Midlands 2016	0.05	0.22	0.00***	0.05	0.06	0.41	95%	-	-	-	-	-	-	-
Region London 2016	0.00	0.07	0.00***	0.00	0.00	0.56	98%	-	-	-	-	-	-	-
Region Yorkshire and Humber 2016	0.13	0.24	0.00***	0.13	0.13	0.95	99%	-	-	-	-	-	-	-
Micro 2016	0.25	0.87	0.00***	0.25	0.25	0.71	99%	-	-	-	-	-	-	-
Small 2016	0.51	0.09	0.00***	0.51	0.51	0.94	99%	-	-	-	-	-	-	-
Medium 2016	0.21	0.01	0.00***	0.21	0.22	0.63	96%	-	-	-	-	-	-	-

Source: The symbol (*) indicates statistical significance at the 10% level, (**) significance at the 5% level and (***) represents significance at the 1% level.

Table A.5: Effect of matching on bias reduction

	Sample	Ps R2	LR chi2	p>chi2	Mean Bias	Median Bias
BSD	Unmatched	0.31	6626	0.00	36.90	27.20
	Matched	0.00	7.9	0.99	0.9	0.50
ABS	Unmatched	0.01	37	0.00	6.30	7.00
	Matched	0.02	18	0.02	0.90	0.50

Source: BSD Propensity Score Matching, Ipsos' calculations.

A.6 Econometric approach

Counterfactual selection will not fully eliminate all the potential sources of bias, in fact some issues are related to firms' time invariant characteristics (e.g. its location, size, sector, difference in business practices etc) or to specific time shocks that cannot be controlled for by a standard OLS regression model. To mitigate these issues, we firstly estimated the impact of the programme using a 'two-way fixed effects' models as follows:

$$y_{it} = \alpha + \beta T_{it} + \rho \cdot X_{it} \cdot t + \alpha^i + \alpha^t + u_{it}$$

This model explains the relationship between the outcomes of interest for firm i in period t (yit, such as turnover or employment) as a function of whether a firm participated or not in the MSA programme (the T_{it} indicator, that took the value of 1 for beneficiaries and a value of 0 for non-beneficiaries). The parameter β provides an estimate of the causal effect of the schemes' participation on the outcomes of interest. The model also controls for differential trends across the characteristics of the firms (e.g. location, size, sector, captured by $Xit•t$). This approach is robust to any time invariant but unobserved differences between firms (α^i) and unobserved but time specific shocks (α^t).

This 'two-way fixed effects' model has also been commonly used to estimate the causal effects of programmes in a wide variety of circumstances where 'treatment' is staggered over time. However, research in 2021 has indicated that these types of models can produce misleading findings under certain conditions (e.g. if the effects of programmes are variable across different firms).

The robustness of results was probed by applying recently developed estimators which control for potential biases related to the treatment being administered at different points in time and variable effects of the programme across different firms. This involves the application of the extension of difference in differences models to multi-period data proposed by Callaway and Sant'Anna (2021)[5]. This approach uses the standard (two period) difference-in-difference estimator comparing each cohort of MSA firms and every post-treatment period, with the group of untreated firms - including yet to be treated firms - forming the control group for these analyses). The estimated effect of the programme is established by taking a weighted average of these multiple treatment effects. The group-specific treatment effect estimator can be written as:

$$ATT(g,t) = E\left[\left(\frac{G_g}{E[G_g]} - \frac{\frac{p_g(X)C}{1-p_g(X)}}{E\left[\frac{p_g(X)C}{1-p_g(X)}\right]}\right)Y_t - Y_{g-1}\right]$$

Where the weights, p, are propensity scores, G is a binary variable that is equal to one for firms first treated in year g, and C is a binary variable equal to one for firms in the potential counterfactual group, which never participated in MSA. The equation above gives the treatment effect at time t for the group of firms receiving grants at time g, and it is computed by comparing changes in outcomes for group g between period g-1 to that of a control group of never treated firms (C).

[5] Brantly Callaway, Pedro Sant'Anna: "Difference-in-Differences with multiple time periods". Journal of Econometrics, 2021.

Our chosen DiD estimator for staggered treatment effects was implemented in STATA using the user-written command 'csdid'. Given the potential drawbacks of the two-way fixed effects models, these results are considered the most robust. Where possible control variables were added in addition to the treatment indicator, including region and sector. In addition, the validity of findings partly depends on a parallel trends' assumption – which assumes that MSA beneficiary firms would have followed a similar trajectory in the absence of the programme to the comparison group

In summary, the impact analysis conducted on MSA firms involved running the DiD estimator detailed above, with the three different control groups discussed above. These are briefly summarised below:

- **Model 1:** The specification used a staggered difference-in-difference approach using a matched sample of businesses from the general population as the comparison group. The treatment group in this specification is all firms that participated in MSA above service level 3. This specification, as detailed above, is likely to be affected by selection bias due likely differences in the motivation for participating in the MSA programme. This model replicated the methodology of the analysis undertaken in the evaluation of the North-West pilot MSA programme.
- **Model 2:** This model used the staggered difference-in-difference, using non-beneficiaries as the counterfactual group (i.e. firms that reached up to service level 2). This methodology is likely to allow the comparison between firms that had similar level of motivation to participate in MSA, however, there likely exist residual differences in characteristics between firms that took part up to service level 2 and those that progressed beyond that.
- **Model 3:** This approach uses staggered difference-in-difference, only looking at firms that received treatment (service level 3 or above), comparing firms enrolling earlier in MSA with businesses signing up at a later stage. The key assumption underpinning this model is that firms treated earlier and those treated later in programme delivery did not differ systematically (i.e. with respect to similar motivation to apply, similar digital readiness level, level of turnover etc) and therefore reduce the exposure to selection bias.

A.7 Regression results

The section below presents the results of the econometric analysis using the Business Structure Database and the Annual Business Survey. Table A.9 provides the results against each of the three models specified section 1.5 above. The column titled "Estimated % impact of participation in MSA" provides the coefficients from the regression, which represent the average estimated effect of participation on the natural logarithm of the variable in question (approximately equal to the percentage effect).

Results that are statistically significant are highlighted in pink, with stars denoting the standard significance levels. This is followed by a number of further statistical tests and indicators. This includes a series of robustness checks based on the degree to which the two groups were following similar trends (i.e. the parallel trends assumption) prior to their participation in the programme, providing a test of the validity:

- **Model 1:** As indicated in the figures set out in the following section, firms participating in MSA tended to show greater levels of employment and turnover growth relative to the comparison group in the years prior to their participation. Robustness checks indicated that differences in average turnover and employment were statistically significant over the entire pre-treatment period, were statistically significant from zero in 6 out of 11 pre-treatment periods, and a parallel trends test testing the

hypothesis that all pre-treatment differences were equal to zero could not be accepted. This highlights a likelihood that the results are likely to be associated with an upward bias. .

- **Models 2 and 3:** The parallel trends test was rejected across all three models, However, other robustness checks suggest that Models 2 and 3 offer more comparable pre-treatment trajectories than Model 1. This supports a preference for Models 2 and 3, as they achieve better alignment between participants in the MSA and the comparison group prior to treatment. Specifically, there were no statistically significant differences in average turnover and employment during the entire pre-treatment period, and year-by-year differences were substantially less frequent. While the parallel trends test, which assesses whether all pre-treatment differences are equal to zero, could not be accepted, additional analysis of estimated pre-treatment effects indicates that the two groups of firms followed broadly similar trajectories before programme participation. Taken together, these findings reinforce the preference for Models 2 and 3 over Model 1.

A.7.1 Turnover and turnover per worker

- Across the three econometric models analysed, only model 1 had a statistically significant coefficient (0.16), significant at the 1% level. This coefficient implies that participation in the programme led to a 16% increase in turnover. This result could not be replicated in Models 2 and 3, where the estimated effect on turnover was not significant at any significance level.

- The Model 1 analysis also found a statistically significant effect on turnover per worker (a measure of productivity), implying an increase of 3.8%. This was significant at the 5% level. There were no statistically significant effects found across the following two models specified. As outlined in Figure 1.3 and Figure 1.4, across all models, the effect in the fifth period has wide confidence intervals. This is likely the result of a small number of firms reaching this time period, given the staggered nature of delivery.

A.7.2 Employment

- The analysis found that a statistically significant effect was only observed in Model 1, indicating that firms that participated in MSA saw a 12% increase in employment, that was statistically significant at the 1% level. Across the other two models analysed, comparison with non-beneficiaries and pipeline design, there was no statistically significant effect on employment.

- As outlined in Figure 1.5, there was a statistically significant effect on employment within the fifth period after intervention in all three models assessed. For example, coefficients of 0.77 (77%), 0.29 (29%) and 0.32 (32%) for Model 1, Model 2 and Model 3 respectively. Across all three models this effect was statistically significant at the 5% level. However, these results should be taken with caution, as they are likely affected by the small sample size of firms that reached the fifth period after intervention. This is also evident by the large confidence intervals around the estimate. (represented by the large blue error bars in Figure 1.5).

A.7.3 Exports

- The ABS dataset was used to assess the impact of the MSA programme on the level of exports for participating firms. The analysis conducted in Model 1 was the only analysis undertaken that provided a statistically significant result of participating in MSA on the level of exports. This analysis found an overall negative coefficient of -0.81 on exports, which implies that participating in MSA led to an 81%

reduction in exports for participating firms. This result was statistically significant at the 10% level. This finding could not be replicated across the other two models.

- The results for exports are likely to be less robust than other results generated due to missing data, in fact the ABS did not include export data for the years 2018 and 2019. The effect of this is a reduced amount of data available after intervention.

A.7.4 GVA and GVA per worker

- The analysis found that a statistically significant effect on GVA and GVA per worker in Model 1 – with a positive coefficient of 0.15 (15%) and 0.17 (17%) for GVA and GVA per worker respectively within Model 1, significant at the 5% level. This could not be replicated, however, across Model 2 or 3 for both GVA and GVA per worker.

- The analysis found a positive significant effect in the third period after intervention for GVA and GVA per worker across all three models. This includes coefficients of 0.51 (51%), 0.34 (34%) and 0.42 (42%) across the Models 1, 2, and 3 respectively. However, the magnitude of this effect is rather large and would need to be validated by repeating the analysis in future years.

A.7.5 Intermediate consumption

- The effect of MSA on intermediate consumption was explored in the analysis to provide an explanation for the observed increase in the third period after intervention[6]. Intermediate consumption is the amount spent by firms on inputs used in the production process. The analysis highlighted a statistically significant effect on intermediate consumption in the third period after intervention of -0.33 (33% reduction),-0.54 (54% reduction), -0.41 (41% reduction) for Model 1, Model 2 and Model 3 respectively. These results suggest that increased GVA for firms taking part in the programme is the result of a reduction in the amount spent on raw materials and other inputs costs. However, as with the effects on GVA and GVA per worker, the magnitude of this effect is large and therefore would need to be validated further.

- The above evidence aligns with the qualitative evidence gathered in the case studies. Firms interviewed indicated that MSA allowed them to improve the efficiency of their operations such as through improved resource and waste management. This aligns with the econometric findings of a reduction in the amount spent on intermediate consumption and subsequent productivity improvements. The delayed nature of these productivity improvements also aligns with the evidence on the nature of the interventions adopted under the programme. For example, firms that adopted technologies such as monitoring systems, digitalisation of systems, Enterprise Planning Resource (EPR), are likely to see a delay between adoption of systems and subsequent improvements in efficiency. This compares to adoption of technologies such as automation technologies, which are likely to see a shorter delay between adoption and efficiency improvements.

[6] Gross Added Value (GVA) is given by the difference of total output (or turnover) – intermediate consumption, GVA provides a monetary value for goods and services produced by a group of firms, a sector or a region. GVA can increase because output increases or because the value of intermediate consumption decreases.

- However, the significant magnitude of the effect on GVA and GVA per worker in the third period after intervention found in the econometric analysis is not supported in the case study evidence. For example, whilst participants discussed efficiency improvements, the magnitude of this was small or moderate, due to wider firm pressures including industry-wide downward trends in worker productivity, increased costs or international competition.

A.7.6 Expenditure on energy

- The analysis also explored the effect of MSA on energy expenditure. Whilst the analysis found no overall effect on energy costs across the three models, a statistically significant decrease in energy costs was observed for MSA beneficiaries in the third period after the programme's start, when compared to non-beneficiaries (model 2). This had a coefficient that was large in magnitude (-0.567), implying that the average expenditure on energy for firms in the treatment group was reduced by 56% (implying that effects on the consumption of intermediate goods was driven principally by greater energy efficiency). However, this result could not be replicated in either the comparison with matched firms in the general population (model 1) or when comparing early vs late participation (model 3).

A.7.8 Capital expenditure

- The analysis on the ABS assessed the effect of participation in the programme on the amount that participating firms are spending on capital expenditure. The analysis found that there were no significant effects on capital expenditure from taking part in MSA. This includes across all three of the models assessed. Temporarily, the analysis also found no significant effects within any time period across the analysis.

A.8 Next steps

The impact analysis of the Made Smarter Adoption programme showed some emerging evidence that the scheme appeared to improve production efficiency by decreasing firms' intermediate consumption and more specifically the cost of energy. However, other business performance metrics, like turnover and employment were not significantly impacted by scheme's participation. For the next phase, we propose the following analytical steps:

1. **Follow up analysis:** Replicating this analysis with both the Business Structure Database and the Annual Business Survey when data post 2022 (for the ABS especially) will become available through the ONS. Analysis over a longer time periods would be able to capture more gains associated to the investment in IDTs.
2. **Pre-treatment DRLs:** In addition, it would also be helpful to add pre-treatment Digital Readiness Level for all firms in the sample, as it could be relevant to see if results change for firms with higher/lower digitalisation levels.

Table A.9: Overall MSA regression results

Model	Comparison group	Coefficient	Standard Error	T-stat	P value	Confidence interval		Number of observations	Pre-trend coefficient	Number of significant pre-years	parallel trends test	Dataset
						Lower	Upper					
Estimated % impact on turnover												
1	Matched comparison with SME manufacturers	0.16**	0.02	7.84	0.00	0.12	0.20	36,497	0.03*** p-value = 0.00	6 of 11	Rejected	BSD
2	Comparisons with those reaching up to Service Level 2	0.01	0.03	0.49	0.62	-0.04	0.069	23,740	0.01 p-value = 0.25	2 of 11	Rejected	BSD
3	Early vs late – staggered treatment design	-0.03	0.03	-1.03	0.30	-0.09	0.029	16,863	0.00 p-value = 0.43	1 of 11	Rejected	BSD
Estimated % impact on turnover per worker												
1	Matched comparison with SME manufacturers	0.04*	0.02	2.08	0.04	0.00	0.07	36,497	0.013* p-value = 0.057	2 of 11	Rejected	BSD
2	Comparisons with those reaching up to Service Level 2	0.01	0.02	0.47	0.64	-0.04	0.06	23,740	0.01 p-value = 0.322	0 of 11	Rejected	BSD
3	Early vs late – staggered treatment design	-0.02	0.03	-0.69	0.49	-0.07	0.03	16,863	-0.01 p-value = 0.11	1 of 11	Rejected	BSD
Estimated % impact on employment												
1	Matched comparison with SME manufacturers	0.12**	0.01	10.02	0.00	0.10	0.15	36,497	0.02*** p-value = 0.00	6 of 11	Rejected	BSD

Model	Comparison group	Coefficient	Standard Error	T-stat	P value	Confidence interval		Number of observations	Pre-trend coefficient	Number of significant pre-years	parallel trends test	Dataset
						Lower	Upper					
2	Comparisons with those reaching up to Service Level 2	0.00	0.02	0.15	0.88	-0.03	0.03	23,740	0.00 p-value = 0.65	0 of 11	Rejected	BSD
3	Early vs late – staggered treatment design	-0.01	0.02	-0.76	0.45	-0.05	0.02	16,863	0.00 p-value = 0.36	0 of 11	Rejected	BSD
Estimated % impact on exports												
1	Matched comparison with SME manufacturers	-0.81*	0.45	-1.79	0.07	-1.70	0.08	1,489	0.14 p-value = 0.23	0 of 11	Rejected	ABS
2	Comparisons with those reaching up to Service Level 2	-0.61	0.45	-1.35	0.18	-1.49	0.27	1,758	0.03 p-value = 0.81	0 of 11	Accepted	ABS
3	Early vs late – staggered treatment design	-0.55	0.36	-1.56	0.12	-1.25	0.14	1,078	-0.14 p-value = 0.10	0 of 11	Accepted	ABS
Estimated % impact on GVA												
1	Matched comparison with SME manufacturers	0.15*	0.08	1.99	0.05	0.00	0.30	2,331	0.03 p-value = 0.50	2 of 11	Rejected	ABS
2	Comparisons with those reaching up to Service Level 2	0.05	0.06	0.79	0.429	-0.07	0.17	2,762	0.01 p-value = 0.85	0 of 11	Rejected	ABS
3	Early vs late – staggered treatment design	0.07	0.07	1.02	0.307	-0.07	0.21	1,865	-0.04 p-value = 0.19	1 of 11	Rejected	ABS

Model	Comparison group	Coefficient	Standard Error	T-stat	P value	Confidence interval		Number of observations	Pre-trend coefficient	Number of significant pre-years	parallel trends test	Dataset
						Lower	Upper					
Estimated % impact on GVA per worker												
1	Matched comparison with SME manufacturers	0.17*	0.08	2.15	0.032	0.02	0.32	2,331	0.03 p-value = 0.47	1 of 11	Rejected	ABS
2	Comparisons with those reaching up to Service Level 2	0.05	0.06	0.87	0.39	-0.07	0.17	2,762	-0.01 p-value = 0.82	0 of 11	Rejected	ABS
3	Early vs late – staggered treatment design	0.08	0.06	1.29	0.20	-0.04	0.20	1,867	-0.05 p-value = 0.20	1 of 11	Rejected	ABS
Estimated % impact on intermediate consumption												
1	Matched comparison with SME manufacturers	-0.06	0.06	-1.04	0.297	-0.20	0.06	2,291	-0.02 p-value = 0.70	1 of 11	Rejected	ABS
2	Comparisons with those reaching up to Service Level 2	-0.08	0.09	-.085	0.40	-0.25	0.10	2,721	0.02 p-value = 0.40	0 of 11	Rejected	ABS
3	Early vs late – staggered treatment design	-0.17*	0.09	-1.81	0.07	-0.35	0.01	1,823	0.00 p-value = 0.99	0 of 11	Rejected	ABS
Estimated % impact on turnover (ABS)												
1	Matched comparison with SME manufacturers	0.03	0.05	0.63	0.53	-0.07	0.14	2,416	0.01 p-value = 0.60	1 of 11	Rejected	ABS
2	Comparisons with those	-0.00	0.05	0.05	0.96	-0.1	0.09	2,808	-0.02 p-value = 0.46	1 of 11	Accepted	ABS

Model	Comparison group	Coefficient	Standard Error	T-stat	P value	Confidence interval		Number of observations	Pre-trend coefficient	Number of significant pre-years	parallel trends test	Dataset
						Lower	Upper					
	reaching up to Service Level 2											
3	Early vs late – staggered treatment design	0.01	0.04	0.32	0.75	-0.07	0.1	1,892	0.00 p-value = 0.95	0 of 11	Accepted	ABS
Estimated % impact on employment (ABS)												
1	Matched comparison with SME manufacturers	-0.02	0.04	-0.47	0.64	-0.08	0.05	2,416	0.00 p-value = 0.91	2 of 11	Rejected	ABS
2	Comparisons with those reaching up to Service Level 2	-0.03	0.03	-0.77	0.442	-0.09	-0.04	2,810	0.00 p-value = 0.89	1 of 11	Accepted	ABS
3	Early vs late – staggered treatment design	-0.00	0.03	-0.14	0.89	-0.06	0.06	1,894	-0.01 p-value = 0.35	2 of 11	Rejected	ABS
Estimated % impact on capital expenditure												
1	Matched comparison with SME manufacturers	-0.10	0.19	-0.55	0.58	-0.48	0.27	1,967	0.12 p-value = 0.27	2 of 11	Rejected	ABS
2	Comparisons with those reaching up to Service Level 2	-0.00	0.15	-0.01	0.99	-0.30	0.30	2,360	0.13 p-value = 0.17	1 of 11	Rejected	ABS
3	Early vs late – staggered treatment design	-0.1	0.22	-0.43	0.67	-0.54	0.34	1,809	-0.11 p-value = 0.30	0 of 11	Rejected	ABS

Model	Comparison group	Coefficient	Standard Error	T-stat	P value	Confidence interval		Number of observations	Pre-trend coefficient	Number of significant pre-years	parallel trends test	Dataset
						Lower	Upper					
Estimated % impact on energy expenditure												
1	Matched comparison with SME manufacturers	0.04	0.12	0.34	0.74	-0.20	0.28	1,297	0.05 p-value = 0.79	1 of 11	Rejected	ABS
2	Comparisons with those reaching up to Service Level 2	-0.10	0.09	-1.16	0.25	-0.27	0.07	2,764	-0.04 p-value = 0.54	1 of 11	Rejected	ABS
3	Early vs late – staggered treatment design	0.01	0.10	0.10	0.92	-0.18	0.21	1,861	0.1 p-value = 0.40	1 of 11	Rejected	ABS

Source: The symbol (*) indicates statistical significance at the 10% level, (**) significance at the 5% level and (***) represents significance at the 1% level.

Figure 1.1: Estimated impact of participation in MSA on turnover

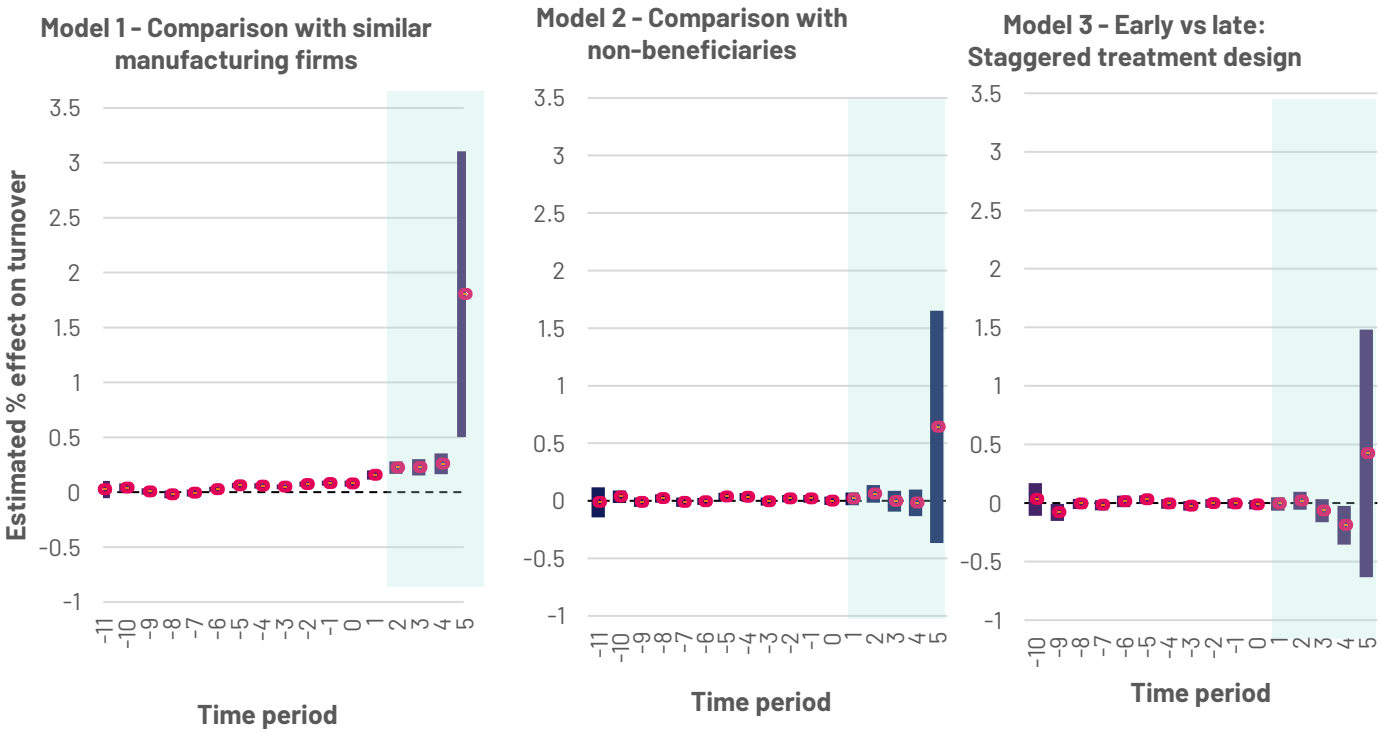


Figure 1.2: Estimated impact on participation in MSA on turnover per worker

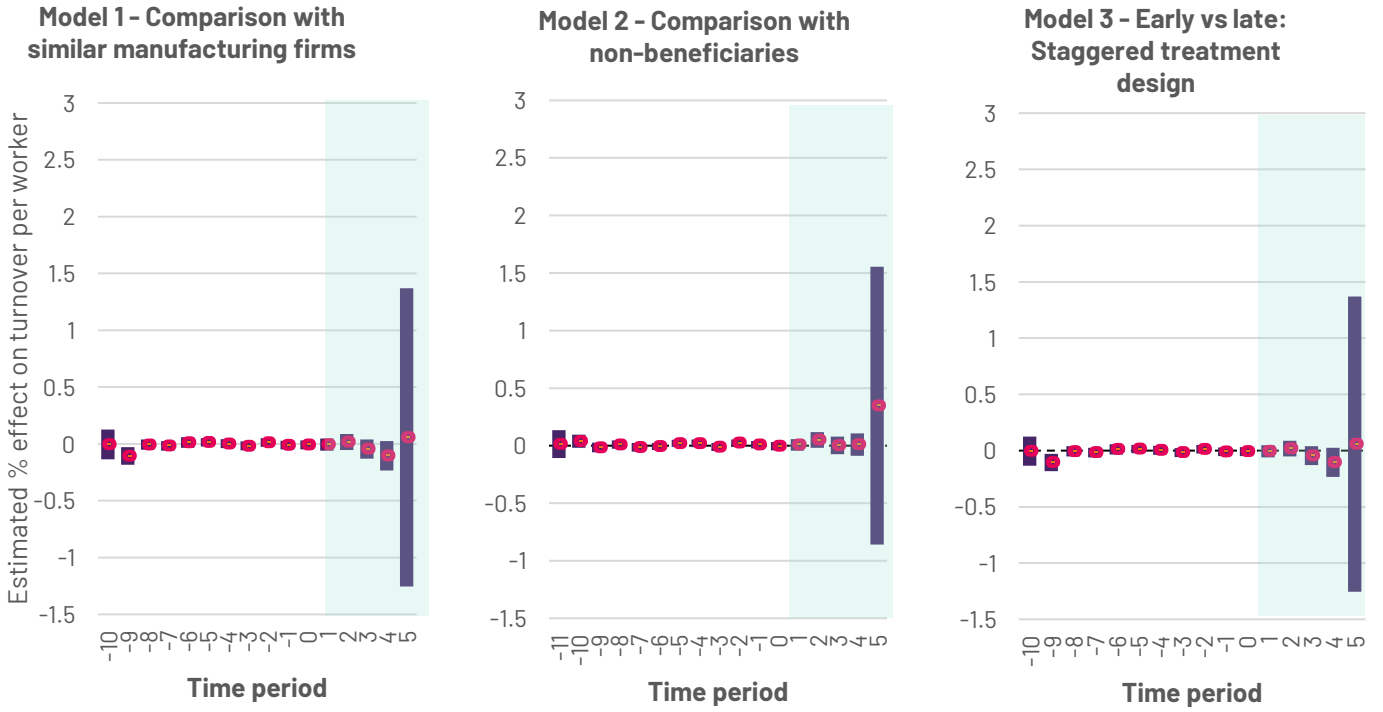


Figure 1.3: Estimated effect on participating in MSA on employment

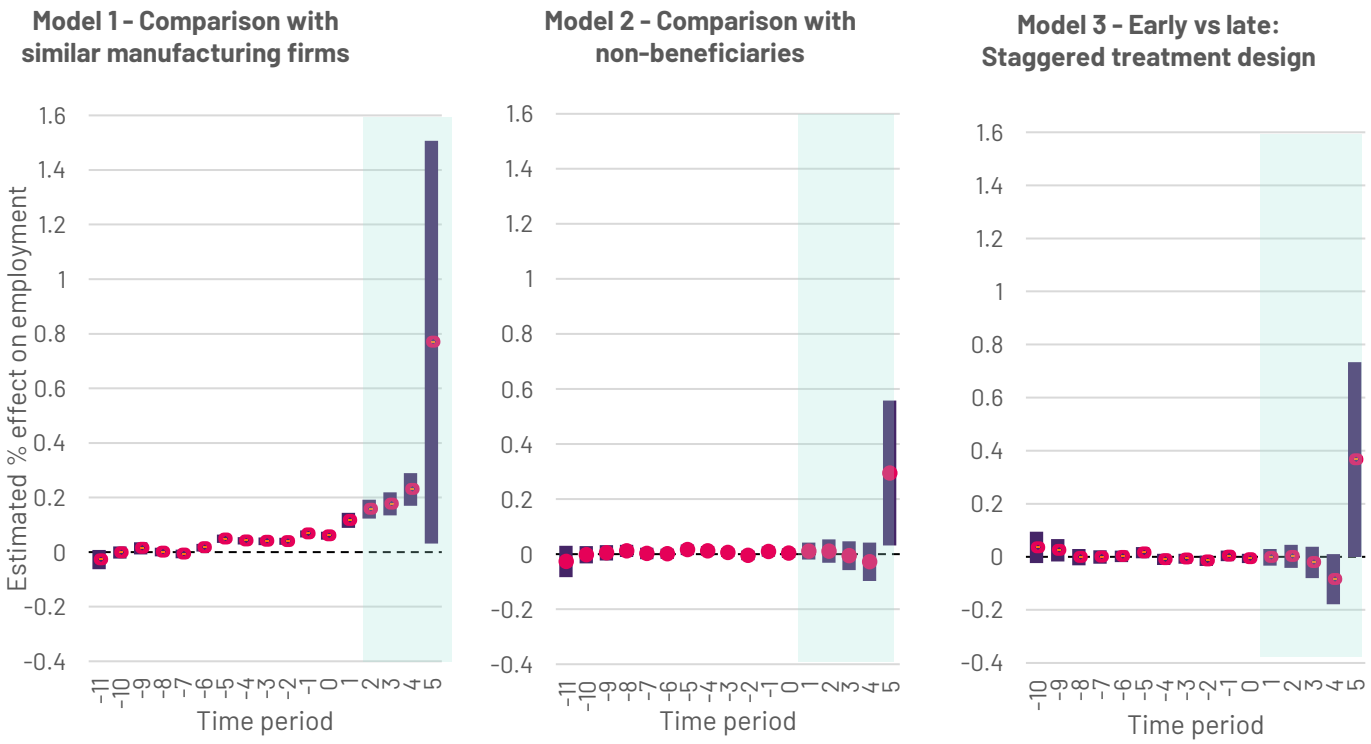


Figure 1.4: Estimated effect on exports

Figure 1.5: Estimated effect on participating firms on GVA

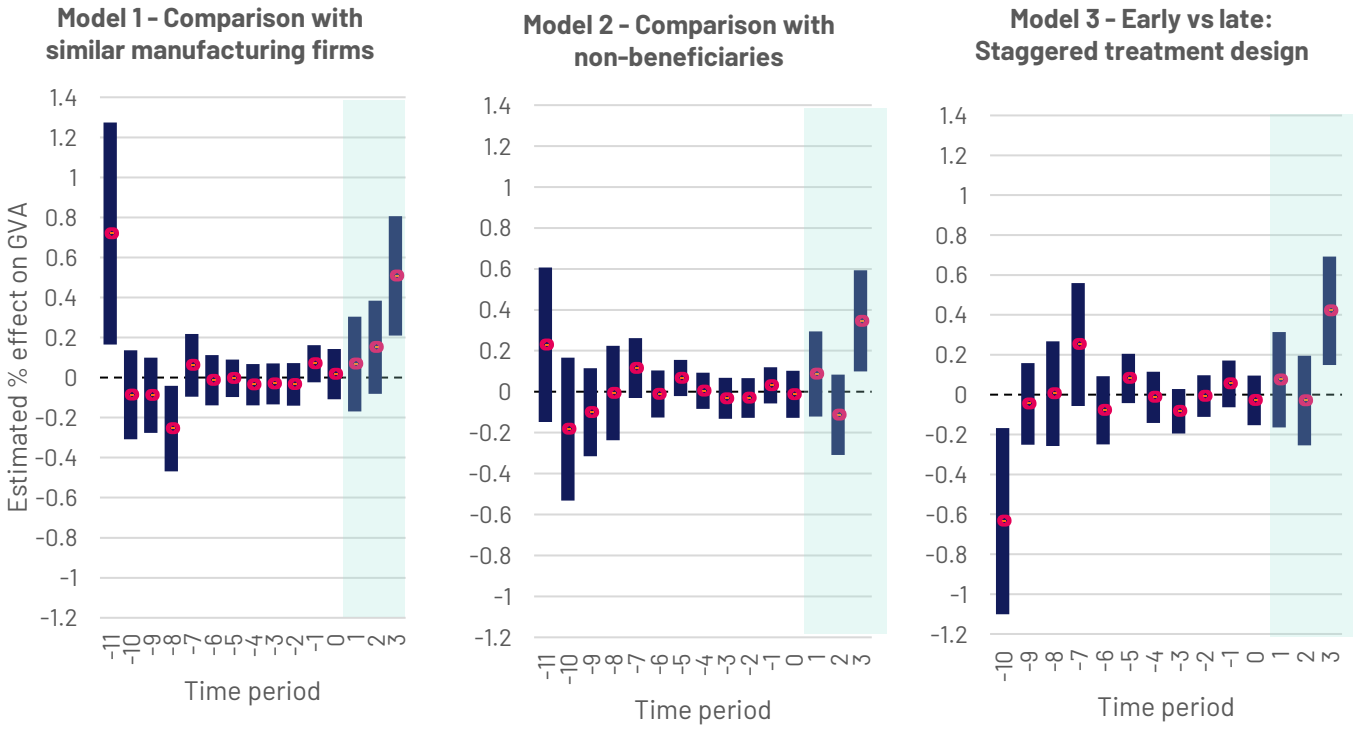


Figure 1.6: Estimated effect on participating firms on GVA per worker

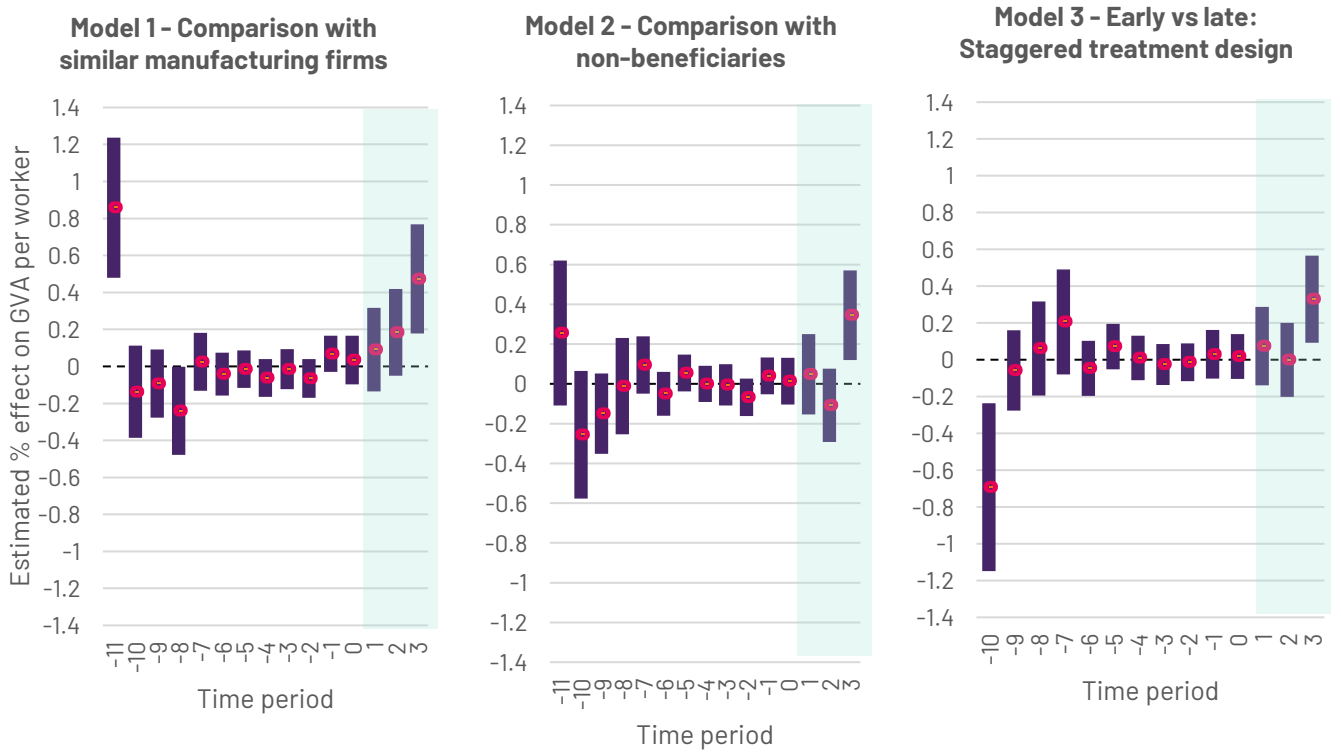


Figure 1.7: Estimated effect on energy costs

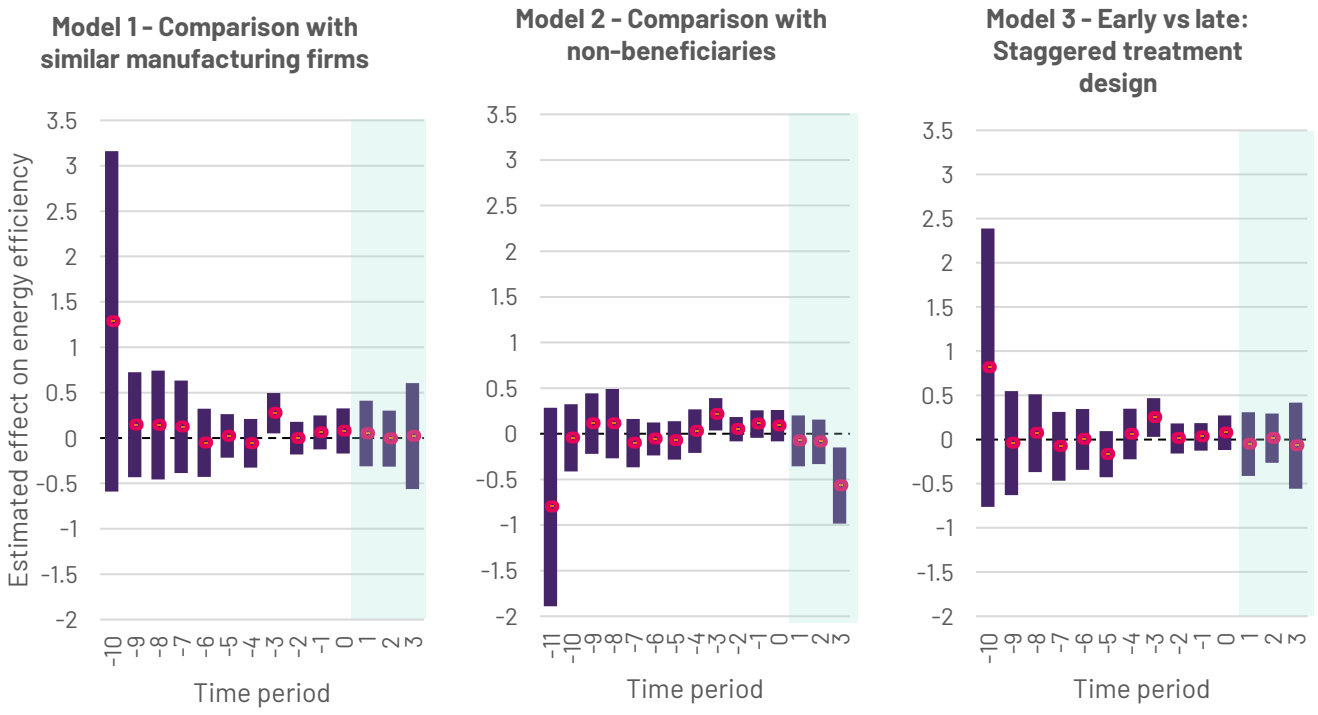


Figure 1.8: Estimated effect on participating firms on turnover (ABS)

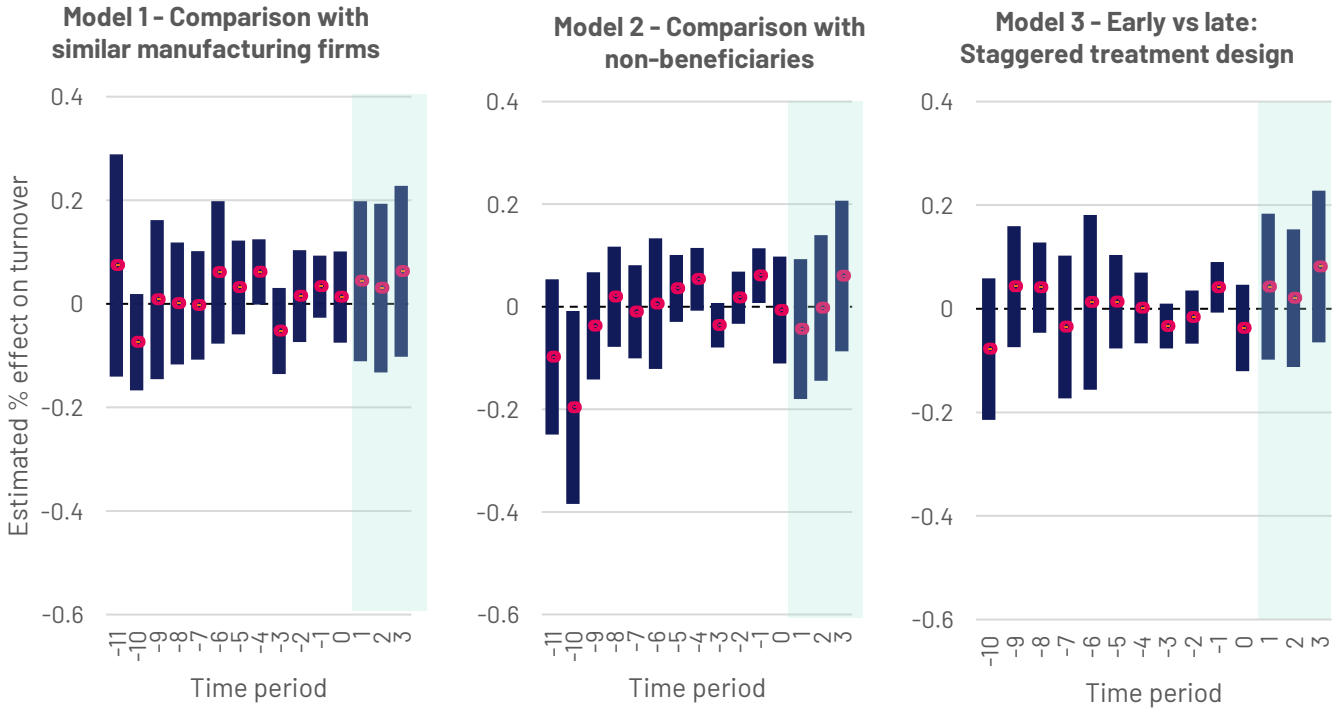


Figure 1.9: Estimated effect on participating firms on employment (ABS)

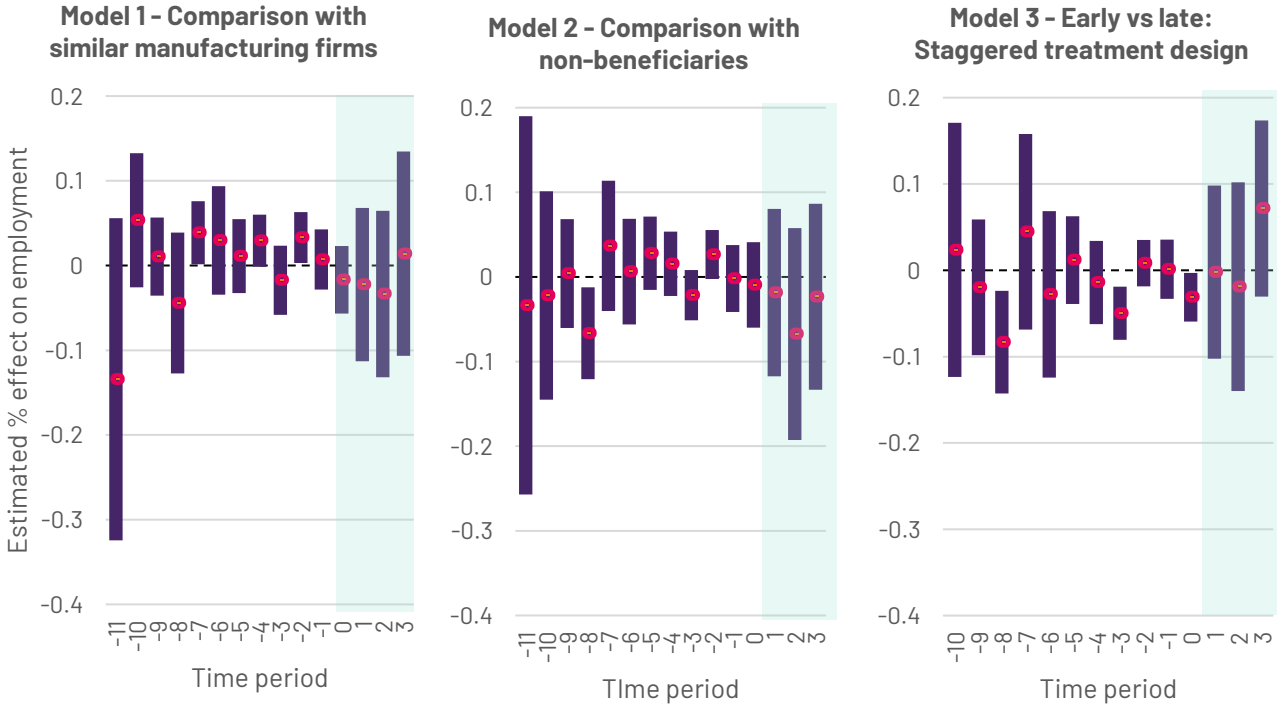
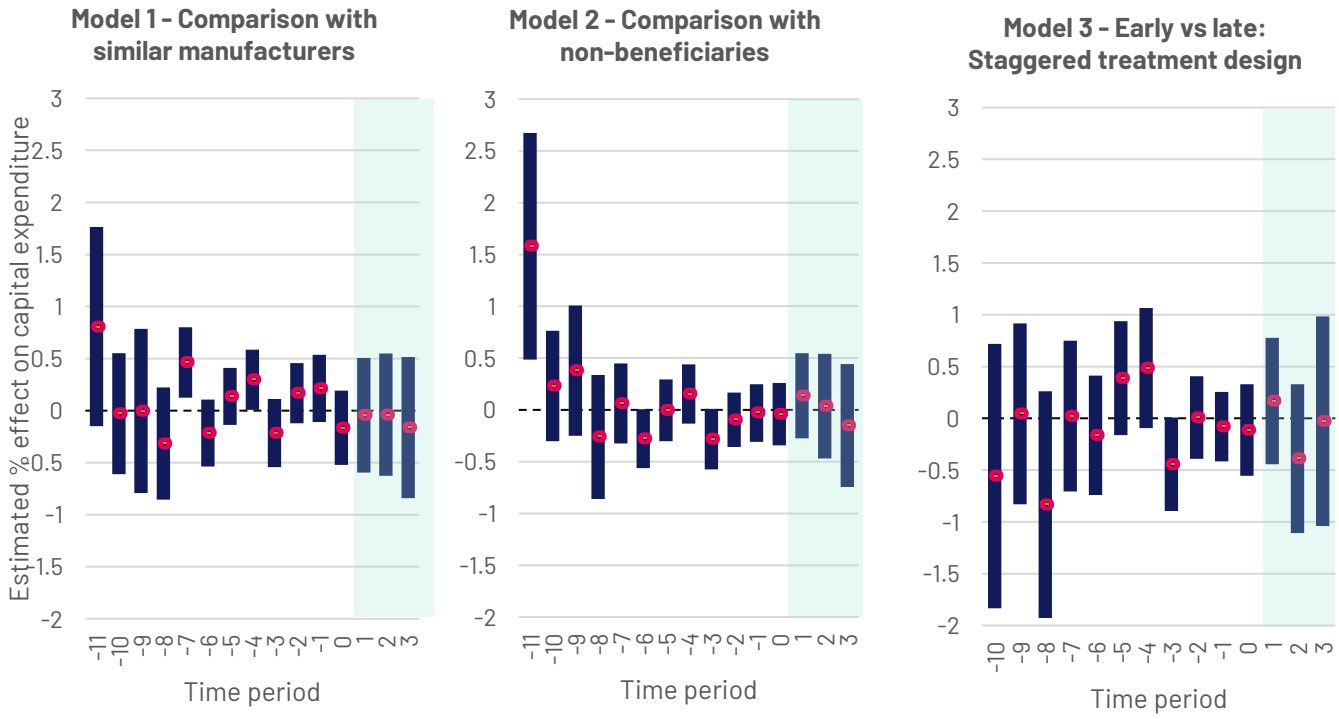


Figure 1.10: Estimated effect on participating firms on capital expenditure



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