Do Activity-Based Incentive Plans Work? Evidence from a Large-Scale Field Intervention

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Web Appendix

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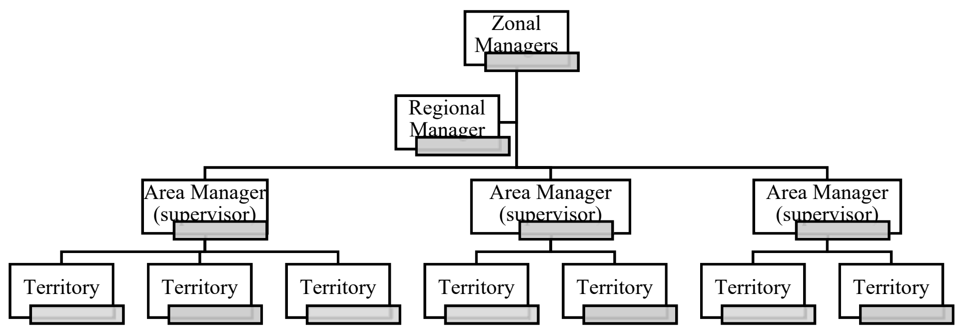
Web Appendix A: Sales Organization Chart

Figure A1: Sales Organization at the cooperating firm



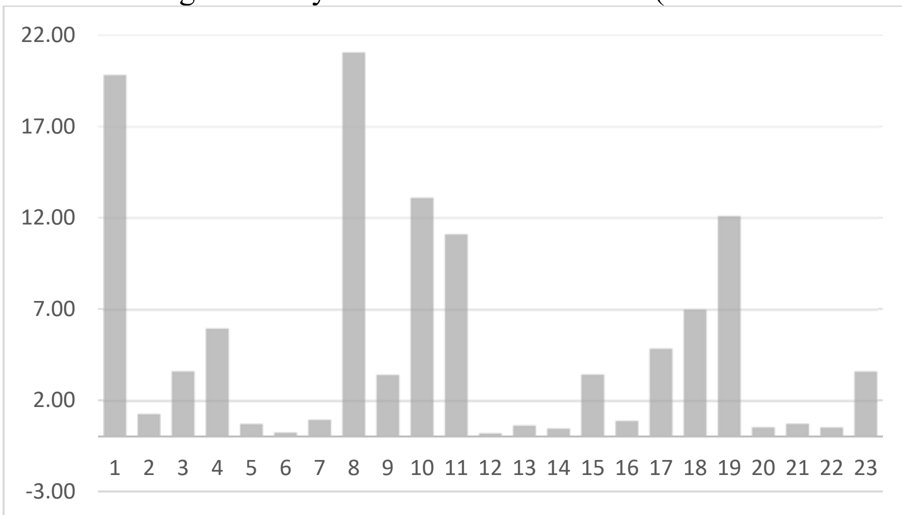
Notes: The market served by the firm is divided into 4 "zones" and each zone is headed by a zonal manager. Each zone is further subdivided into "regions" headed by regional managers. There are total 20 regions. Each region is further subdivided into "areas". Each area is headed by a frontline manager (called area manager and referred to as "supervisor" in the paper). Each area has a number of "territories." Each territory has one or more salespersons who report to the area supervisor. The firm has 71 areas headed by supervisors, and they manage a total 305 territories comprising of 412 salespeople.

Web Appendix B: Aggregate Analysis

As mentioned in the paper, our focal firm is one of the strategic business unit (SBU) of a large diversified pharma conglomerate, and we purchased a dataset included sales of the brands from the focal firm well as other business units (SBUs) of the parent firm. It is to be noted that the pricing and much of the planning for all the SBUs for this conglomerate are handled at the centralized office and are fairly standardized. We were able to verify that the incentive structure at all the SBUs was similar and that none of the SBUs (except for our focal firm) experimented with this incentive structure during or around our experimental intervention. Thus, sales information from other SBUs could form credible "quasi-control" within our setting.

The SBUs are of varying sizes and contain drugs that, in many cases, focus upon certain therapeutic categories. Our focal SBU is a diversified unit with a portfolio of multiple therapeutic categories. Figure B2 below depicts the relative sizes of different SBUs. SBU 1 is the focal (treated) firm.

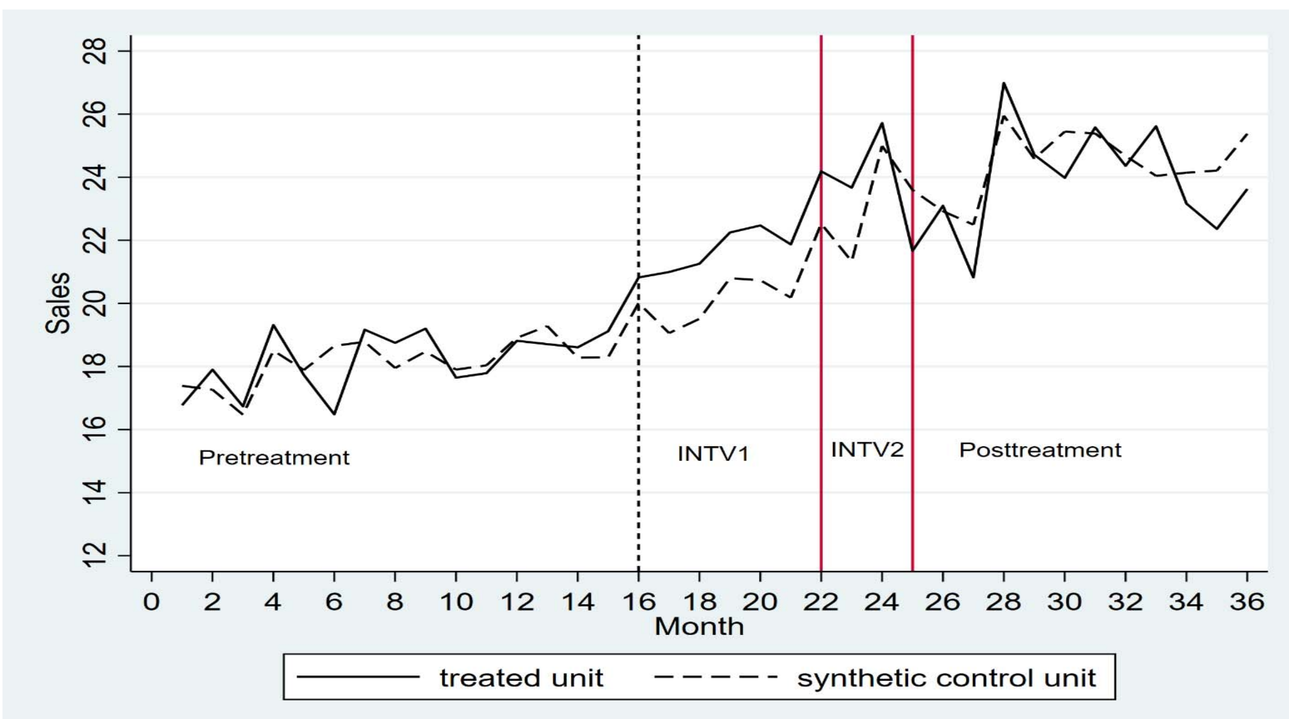
Figure B2: Average Monthly Sales of Different SBUs (SBU 1 is the focal firm)



Note: (1) The sales numbers are in local currency in tens of millions and have been multiplied with a constant to preserve the confidentiality of the focal firm.

Post-treatment Effects using Synthetic Control

Figure B3: Actual Sales of the Treated SBU and the Predicted Sales of the Synthetic SBU



Note: (1) The sales numbers are in local currency in tens of millions (2) INTV1 refers to "Salesperson+Supervisor ABIs" (SSABI) and INTV2 refers to "Supervisor-only ABIs" (SABI). (3) "Period" refers to an intervention month.

To check the robustness of our SCM estimates, we estimate the "treatment effects" for the post-treatment period (Months 25-36) when ABIs were removed using the synthetic control. We indeed find no evidence of any consistent effect after the treatment removal. For the 12 months of the post-treatment period, we find seven periods for which the effect is negative and five months for which the treatment is positive. Furthermore, of the 12 months, only four months show statistically significant results: three of these are negative, and one is positive. Overall, this gives us confidence that our estimates during the treatment period were unlikely to have been estimated by chance since outside of the treatment period, there is no evidence of such effects. Fig B3 above visually depicts the post-treatment effects, and Table B1 provides numerical measures of the post-treatment effects and associated *p*-values.

Table B1: Post-Treatment Effects and Associated *p*-values

Period	Effect	*p*-value
25	-1.930	$p<.05$
26	.172	.428
27	-1.674	$p<.05$
28	1.035	.190
29	.125	.523
30	-1.464	.190
31	.192	.476
32	-.315	.476
33	1.572	$p<.05$
34	-.979	.143
35	-1.850	$p<.05$
36	-1.750	.142

Web Appendix C: Details of Generalized Synthetic Control (GSC) Procedure

Our data consists of repeated cross-sections of sales observed over time with multiple treated territories and non-treated SBUs, each of which we refer to as a unit. We index a cross-sectional unit by $k = 1, \dots, K$. The total number of units is $K = K_{INTV} + K_{CO}$ where K_{INTV} and K_{CO} are the numbers of treated (equaling, 305) and control units (equaling, 22), respectively. All units are observed for periods $t = 1, \dots, T$. For territories in the treated SBU, we let $T_{0,K}$ denote the number of pretreatment periods. Focal SBU territories are all first exposed to the ABI treatment at time $T_{0K} + 1$ and subsequently observed for $T - T_{0K}$ periods. We represent Y_{kt} as the sales within a unit k at the time t. Following the GSC method (Xu 2017), we assume Y_{kt} is given by a latent factor model as follows

$$Y_{kt} = \delta_{kt} D_{kt} + \lambda'_k f_t + \varepsilon_{kt}. \qquad \text{(C1)}$$

The variable D_{kt} is the treatment indicator, which equals 1 for all treated units following ABI intervention. The parameter δ_k is the treatment effect on sales in the unit k that experiences the treatment. The vector $f_t = [f_{1t}, \ldots, f_{rt}]'$ is an r vector of unobserved common factors, while the vector $\lambda_k = [\lambda_{k1}, \ldots, \lambda_{kr}]'$ is an r vector of unknown factor loadings. The factor model approach covers a wide range of unobserved heterogeneities and can accommodate two-way fixed effects for units and time-periods.

We want to estimate the average treatment effect on the treated units (ATE) at $t, t > T_0$. The ATE at $t, t > T_0$ is given by the following:

$$ATE_{t,t>T_0} = \frac{1}{K_{INTV}} \sum_{k \in K} \delta_{kt} = \frac{1}{K_{INTV}} \sum_{k \in K} [Y_{kt}(D_{kt} = 1) - Y_{kt}(D_{kt} = 0)], \qquad \text{(C2)}$$

where K is the set of territories within the treated SBU.

Since $Y_{kt}(D_{kt} = 1)$ is observed for treated territories in the post-treatment periods following the implementation of ABIs, our core estimation lies in constructing the counterfactual for each territory during the ABI-periods. Let the control SBUs be subscripted from 1 to K_{CO}. We can re-write equation 2 for the control units only using matrix notation as:

$$Y_{CO} = F\Lambda'_{CO} + \varepsilon_{CO}, \qquad \text{(C3)}$$

where Y_{CO} and ε_{CO} are $(T \times Q_{CO})$ matrices and $F = [f_1, f_2, \ldots, f_T]'$is a $(T \times r)$ matrix of factor scores and $\Lambda_{CO} = \left[\lambda_1, \lambda_2, \ldots, \lambda_{K_{CO}}\right]'$ is a $(K_{CO} \times r)$ matrix of factor loadings. The above equation easily incorporates a set of covariates (which we do not have) and the unit and time fixed effects.

We estimate $\hat{\delta}_{kt} = Y_{kt}(D_{kt} = 1) - \hat{Y}_{kt}(D_{kt} = 0)$ via a three-step imputation process (Xu 2017) for $\hat{Y}_{kt}(D_{kt} = 0)$. First, using equation (3), we estimate a latent factor model with only the control observations to obtain $\{\hat{F}, \hat{\Lambda}_{CO}\}$. Second, we use $\{\hat{F}^0\}$ to estimate the factor loadings $\hat{\lambda}_k$ for each treated territory in the pretreatment period (where the superscript 0 denotes the pretreatment period). Lastly, we compute the treated counterfactual as follows $\hat{Y}_{kt}(D_{kt} = 0) = \hat{\lambda}'_k \hat{f}_t \ \forall k \in K, t > T_0$. The estimator for ATE_t is, therefore:

$$\widehat{ATE}_{t,t>T_0} = \frac{1}{K_{INTV}} \sum_{k \in K} \left[Y_{kt}(D_{kt} = 1) - \hat{Y}_{kt}(D_{kt} = 0)\right]. \qquad \text{(C4)}$$

Finally, we use a "leave-one-out-cross-validation" procedure (Xu 2017) to automatically choose the number of factors. The procedure iteratively repeats the second step from above using the pretreatment data for the treated units. On each iteration, it holds out one period's data for all the treated units. It then estimates the loadings, predicts the holdout sample outcomes, and computes the holdout prediction error for each treated unit for over each iteration. The procedure is repeated for a given set of possible values for r, and we pick an $r*$ that minimizes the mean square prediction error (MSPE)[1].

[1] The latent factors are usually not interpreted unless specific information about external events outside of treatment is available.

Web Appendix D: Gross Profit Impact (GPI) Calculations

Assumptions (Based on compensation information):

A1	ABIs as % of Marketing Costs (when used at both the levels)	4%
A2	Production Costs+Admin costs as % of revenue	25.00%
A3	Marketing costs (Variable+Non-Variable) as % of revenues	40.00%
A4	Variable pay as % of revenues	16.00%
A5	ABI Costs as % of revenues (when used at both the levels)	1.60%

Notes: We assume that all the marketing costs are payments made to supervisors and managers across the hierarchy. Variable pay is 40% of the total pay, so it is 16% of the revenues. ABI pay is 4% of the total pay (if used across both the salespeople and supervisors).

Additional firm-level information about salespeople and supervisors:

	Salespeople	**Supervisors**
Number	412	71
%Meeting ABI Targets INTV1 (SSABI)	0.84	0.75
% Meeting ABI Targets INTV2 (SABI)		0.78
ABI pay ratio	1	1.4

Notes: These numbers come from company records. 84% of the salespeople and 75% of the supervisors meet their target and receive some ABIs during SSABI[2]. Supervisor ABIs are about 40% higher than salespeople ABIs. This allows us to create the fraction of 1.6% of revenues that go to salespeople and to supervisors during SSABI as follows:
The fraction of ABI budget that goes to salespeople: (.84*412)/[.84*412+.75*71*1.4]=.823
The fraction of ABI budget that goes to supervisors: (.75*71*1.4)/[.84*412+.75*71*1.4]=.177
During INTV2 (SABI), only supervisors get paid ABIs, so ABI expenses are lower. However, more supervisors meet their targets (.75 vs. .78) under INTV2, so the fraction of the original ABI that goes towards paying supervisors is: (.78/.71)*.177=.184. These numbers allows us to calculate ABI costs in INTV2.

Average treatment effects are assumed as (Using Table 5 from the paper):

INTV1 (SSABI): 7.80% (Sales improvement attributable to ABIs)

INTV2 (SABI): 7.07% (Sales improvement attributable to ABIs)

Using these numbers, we provide the profitability analysis under three scenarios: (a) Baseline (No ABIs) (b) INTV1 (ABIs to salespersons and supervisors), and (3) INTV2 (ABIs to supervisors). We assume that baseline has sales of 10,000.

[2] We do not know which ABI tier these folks fall into. So, we assume that they all get an equal fraction of ABI budget of 1.6%,

Baseline Scenario

Sales	Prod/Admin Costs	Marketing (Non-variable)	Marketing (Variable)	ABI costs	Gross Margin
10000	2500	2400	1600	0	3500

Intervention 1 (Supervisor + Salesperson ABIs)

Sales	Prod/Admin Costs	Marketing (Non-variable)	Marketing (Variable)	ABI costs	Gross Margin	% IMPV over baseline
10780	2695	2400	1724.8	172.48	3787.72	**8.22%**

Intervention 2 (Supervisor ABIs)

Sales	Prod/Admin Costs	Marketing (Non-variable)	Marketing (Variable)	ABI costs	Gross Margin	% IMPV over baseline
10707	2676.75	2400	1713.12	31.57	3885.55	**11.02%**

Notes: Overall, the INTV2 is (11.02%-8.22%)/8.22%= 34% more effective than INTV1. Note that increased sales attributable to ABIs could also result in increased output-based incentives (in addition to input-based incentives) which have been accounted for under variable marketing costs.