ACME Manufacturing:
The Effect of the Career 2030 Training Program on Promotion

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Executive Summary

ACME has launched the Career 2030 program aimed at fostering the career development of its workforce. A/B Testing confirms the program's effectiveness in employee promotion. Additionally, the distance employees must travel to the office significantly affects their participation in the program. Therefore, we recommend that ACME continue the program and explore remote options to encourage employee engagement.

Introduction

Objective

We aim to analyze the impact of the Career 2030 program on employee promotions through an A/B testing approach.

Data Source

ACME has provided a dataset consisting of 6,000 randomly selected employees, which represents 10% of the total workforce. Among them, 5% received training (treatment), while the remaining 5% served as no training group (control).

Limitations with Data

The data from ACME's randomized trial on the Career 2030 program may be influenced by post-randomization factors. Managerial interventions and individual choices can lead to deviations from the assigned groups, with some in the treatment group not participating and others outside it seeking involvement. This has transformed the dataset from a pure RCT into one with the characteristics of an observational study.

Methodologies

Randomization ensures that confounding variables, which affect both training (treatment) and promotion (outcome), are evenly distributed between the treatment and control groups, thereby eliminating the need for additional control measures. However, due to the above data limitation, we employed various balancing techniques such as Propensity Score Matching (PSM) and Inverse Probability Weighting (IPW). Additionally, considering the potential influence of unobserved variables, we explored Instrumental Variable (IV) analysis with 'dsthome' as a candidate IV.

Key Findings

1. Participating in the Career 2030 training program significantly boosts the chances of getting a promotion. This effect underscores the value of the training in advancing employees' careers.

2. An inclusive look at all employees reveals that training participation more than doubles the likelihood of promotion, with an odds ratio of 2.44, indicating that trained employees are 144% more likely to be promoted compared to their non-trained counterparts.
3. The analysis using the distance from home as an instrumental variable shows that longer distances from home make employees less likely to attend training.
4. The instrumental variable analysis also affirms the causal impact of the training program on promotion chances, with a 10% increase in the odds of promotion for participants, even when accounting for potential unobserved confounders. This finding strengthens the argument for the program's effectiveness by demonstrating a direct causal link between training participation and increased promotion likelihood.

Recommendations

1. ACME should continue the Career 2030 program and encourage employees to participate. The company can promote the program as a way to help them get promoted as proven by A/B Testing.
2. ACME needs to address distance barriers for employees, which could involve providing online training, offering a more flexible training schedule, partnering with local institutions to establish regional training centers, or providing transportation assistance to employees.

Appendix

A. Methodological Overview

This section provides a concise explanation of the statistical methods and analytical approaches used in the evaluation of ACME's Career 2030 program.

B. Matching and Propensity Score Analysis

- Unmatched Analysis:
    - Initial comparisons between the training (treatment) and no training (control) groups showed some imbalances in covariates, indicating potential confounding factors affecting the treatment outcome relationship.
- Matching Analysis:
    - To address imbalances and simulate a randomized control trial (RCT) environment, we utilized 1:1 matching with and without calipers, 1:2 matching with calipers, and 1:1 PSM.
    - While some matching strategies reduced imbalance, optimal balance across all covariates was achieved with 1:1 PSM using a caliper of 0.01, resulting in 1,372

matched pairs with all standardized mean differences (SMDs) below 0.1, indicating no violation of the positivity assumption.

C. Inverse Probability Weighting (IPW) Analysis

IPW was employed to generalize the findings from the matched sample to the broader population of ACME employees.

D. Instrumental Variable (IV) Analysis

To further address potential unobserved confounding such as managerial interventions or employee self-selection, we implemented an IV analysis using the distance from home (‘disthome’) as an instrumental variable. This approach aims to isolate the causal effect of training participation on promotion outcomes.

- "disthome" as an IV:
    - Relevance: The distance from an employee's home to the training facility or company likely influences their decision to participate, with closer proximity increasing attendance likelihood.
    - Exogeneity: The distance is considered exogenous, not related to personal characteristics like job performance or career ambitions, ensuring it doesn't directly affect promotion outcomes.
    - Exclusion: The impact of "disthome" on promotions is assumed to operate solely through its effect on training participation, without a direct relationship.
    - Diagnostic Test Confirmation: A diagnostic test showing a statistic of 1719.989 and a p-value less than 2e-16 confirms "disthome" as a robust IV.

E. Analytical Results

- McNemar Test on Propensity Score Matching:
    - Indicates that the propensity score matching effectively balanced the promotion rates between the treatment and control groups prior to analyzing the training effect, as shown by a non-significant p-value of 0.3735.
- Sensitivity Analysis:
    - Suggests moderate robustness of the propensity score matching results in potential unobserved confounding, with a relative risk of 1.544 and an E-value of 2.461, indicating confidence in the observed effects not being solely due to unmeasured variables.

F. Key Insights and Implications

- Propensity Score Matching Analysis (PSM):
    - Reveals a significant positive impact of the Career 2030 program on promotion rates, with training participants showing an odds ratio of 2.38, suggesting that the program effectively enhances promotion prospects.
- Inverse Probability Weighting (IPW) Analysis:
    - Supports and extends the findings from PSM to the entire employee population, indicating that training participants are more than twice as likely to be promoted, with an odds ratio of 2.44, underscoring the program's effectiveness across ACME.
- Instrumental Variable (IV) Analysis with "disthome":
    - Highlights a key insight that training boosts promotion odds by about 10.18%, even when accounting for logistical challenges like distance. This finding reinforces the positive impacts observed in both the propensity score matching and inverse probability weighting analyses.

G. Table: Summary of Odds Ratios and Statistical Significance

Analysis Method	Training Program Odds Ratio	Confidence Interval	P-Value
Unmatched	1.24	[1.11, 1.39]	<0.0001***
1:1 Matched	1.41	[1.25, 1.59]	<0.0001***
1:1 Matched with Caliper	1.82	[1.21, 2.76]	0.004**
1:2 Matched with Caliper	2.73	[1.51, 5.03]	0.0001***
Propensity Score Matched	2.38	[2.03, 2.80]	<0.0001***
IPW (Weighted)	2.44	[2.12, 2.82]	<0.0001***

H. Table: Impact of Training on Promotion Using "disthome" as an Instrumental Variable

Variable	Coefficient	Std. Error	P-Value	Interpretation
trainingYes	0.0970384	0.0256868	0.00016***	Log odds increase in being promoted for training participants. Suggests a positive impact of training

*** indicates p<0.001, ** indicates p<0.01, * indicates p<0.05.