GSE 522

Varieties of Selection Bias: Insights from James Heckman

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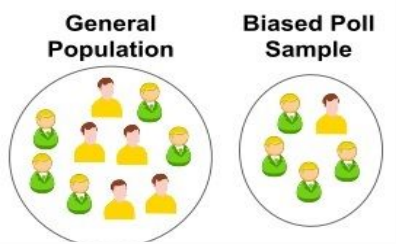
Introduction to Selection Bias

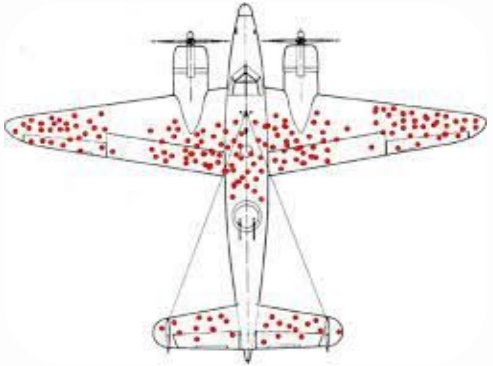
Understanding Selection Bias

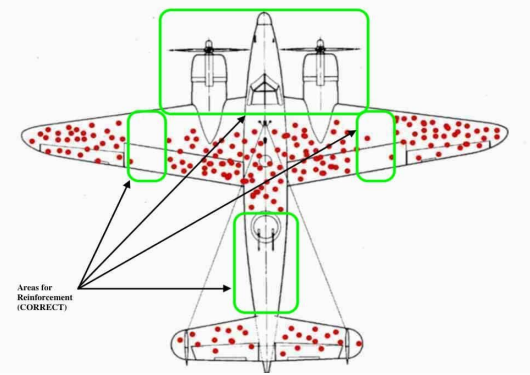
Selection bias occurs when the sample used in research does not accurately represent the population being studied, leading to skewed or biased results.



$$\hat{\beta} \neq \beta$$

In econometric analysis, this bias is particularly problematic, as it can significantly impact the estimation of parameters.





Importance of Dr. Heckman's Work

- In this paper, James Heckman's offering groundbreaking insights that have shaped subsequent research in the field.
- Dr. Heckman uses the **union wage differentials study** by H. Gregg Lewis as an example to explore the issue of selection bias.
- He created a comprehensive framework for addressing/mitigating bias, including innovative methods for identification and estimation with selection bias.
- He discussed uses involving both truncated and censored data.

Selection Bias in Unionization and Wages

Identification

- Workers **choose** to join unions based on factors that also affect their **wages:** skills, motivation, or access to union jobs.
- This **mixing** of **union choice** and **wage** causes selection bias.

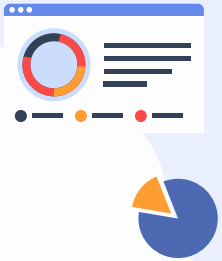
Implication

- It is difficult to isolate the true **effect of unionism on wages.**
- Failing to account for selection bias can lead to **misleading estimates** of the economic parameters of interest: union wage premium.

Innovation

- Dr. Heckman uses the union wage study as an example to explore the selection bias.
- He evaluates **nonparametric** and **functional form** approaches.
- He then argues for simpler methods: **IV** regression.

Splitting the Wages by Unionization Choice



1. **Union Wages (Y1)**: $Y1=X1*\beta1+U1$ where $E(U1)=0$

2. **Nonunion Wages (Y0):** $Y0=X0\beta0+U$ where $E(U0)=0$

3. **Choice Equation (D):** $I = Z_{gamma} + V$, where $E(V)=0$.
   I>0 implies choice of the union sector (D=1), otherwise D=0.

4. **Observed Wage (Y):** $Y=Y_1D+Y_0(1-D)=(X_1\beta_1)D+(X_0\beta_0)(1-D)+DU_1+(1-D)U_0$

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Parameters of Interest and Identification

The Parameters of Interest

Experimental Treatment Average ($\alpha_1 - \alpha_0$): The effect of moving a nonunion worker to the union sector.

Roy model assuming $\beta_1 = \beta_0$.

Impact on the Unionized E(Y1–Y0 | D=1,Z): = $(a_1-a_0) + E(U_1-U_0 | D =1, Z)$

This estimate represents the gain for a unionized person moving from the nonunionized to the unionized sector, accounting for individual attributes X and Z. This is also known as average treatment effect among the treated, ATT.

Assumptions for Identification and its Purpose

1. Independence

The error terms (U_0, U_1, V) must be independent of the covariates (X,Z).

2. Continuous Distributions

The error terms are assumed to have continuous distributions.

3. Zero Conditional Mean:

$$E[U_0 \mid X, Z] = 0$$
$$E[U_1 \mid X, Z] = 0$$
$$E[V \mid X, Z] = 0$$

Purpose 1:

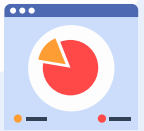
Ensures that the selection process can be separated from the outcome processes.

Purpose 2:

Allows using the observed data to infer the unobserved and identify parameters: error distributions and covariate effects.

Purpose 3:

Increases confidence due to normalization and centering.



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Results

Utilizing Distributional Information and Identifying Estimates: “Two-Step”

- Examines variation in the distribution of observed outcomes based on changes in covariates and selection states
- Deduces the underlying structure of the error terms through probabilities. (logit/probit)
- Then decomposes the observed outcomes into components attributable to the treatment effect (union wage premium) and those due to selection bias.
- By modeling the selection process and its likelihood on the observed outcomes, Heckman is able to correct for the bias
- Heckman's approach is able to estimate the Union-wage counterfactual without making parametric assumptions.

Model Advancements

- Heckman discusses other innovative methods being used and researched especially with censoring: **kernel methods**, **series estimators**, and **density estimations**
- Traditional models often rely on linear assumptions, **semiparametric** estimation accommodate more **complex relationships and distributional forms.**
- These semiparametric methods follow Heckman's framework and **identification theorem** to efficiently estimate parameters.
- He also explains that if $E(U_1-U_0 \mid D=1, z, x_c)=0$ than IV regression will result in the correct **Experimental Treatment Average.**

Heckman's Contribution and Results

- Introduced robust nonparametric and semiparametric identification and estimation techniques so we are not bound by restrictive parametric assumptions
- Developed a theoretical framework to create consistency in addressing selection bias.
- Advocated for further research to deal with complex models of human behavior and market dynamics.