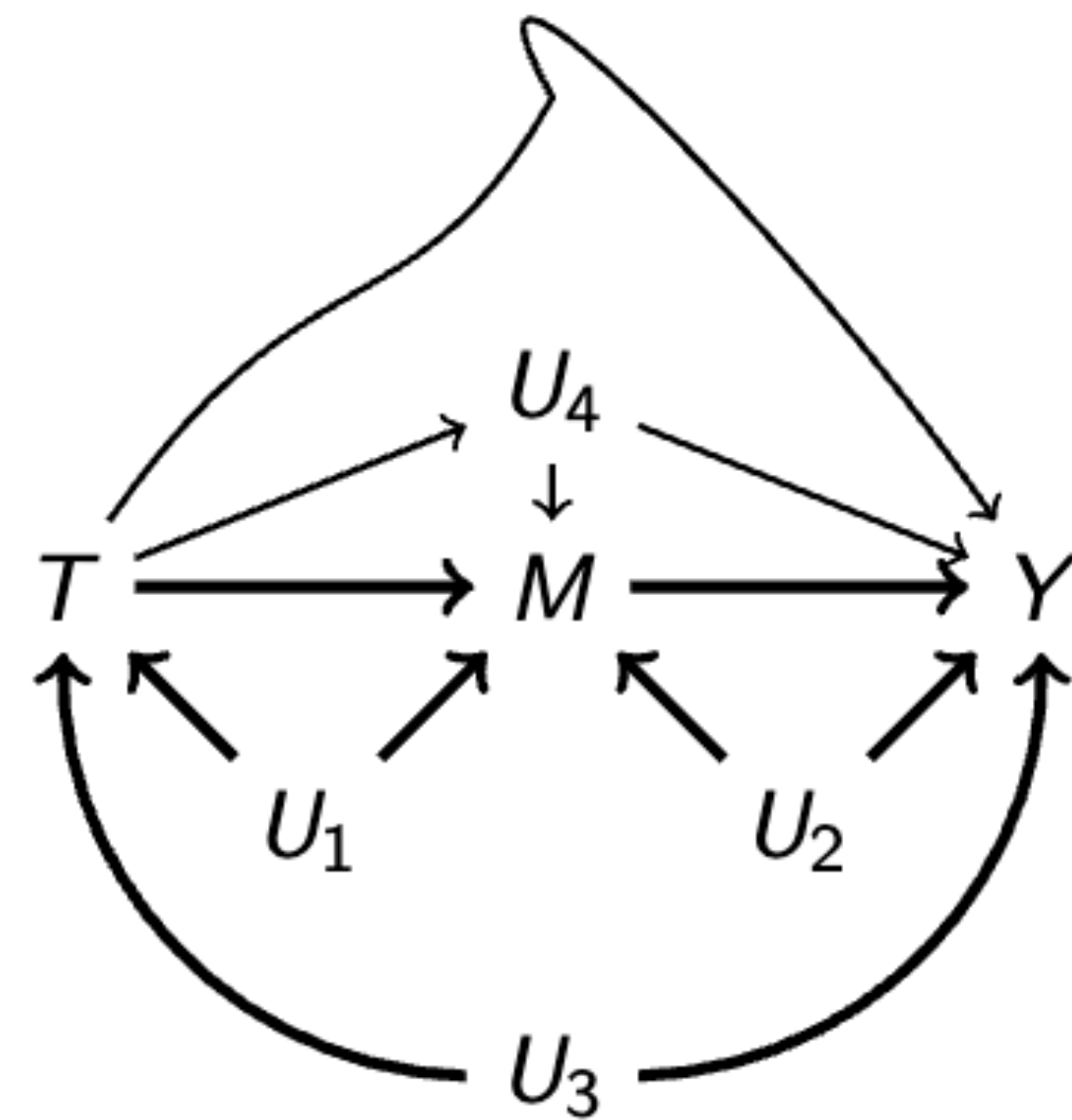


Alternative Identification Strategy for Mediation Analysis Relying on Heterogeneous Effects

Jiawei Fu (Ph.D. candidate at NYU)

- In an empirical study, causal effect has been identified.
- Now, we hope to study how this effect is mediated by M .



- To identify causal mediation effect, the existence of U_2 imposes a huge difficulty to us.

Framework :

- For simplicity, we consider binary treatment T and single mediator M .

$$\begin{aligned} TE &= Y_i(1, M_i(1)) - Y_i(0, M_i(0)) \\ DE &= Y_i(1, M_i(1)) - Y_i(0, M_i(1)) \\ IE &= Y_i(0, M_i(1)) - Y_i(0, M_i(0)) \end{aligned}$$

- Then, we can decompose average treatment effect (ATE) into Average DE and Average IE.

$$ATE = ADE + AIE$$

Abstract:



In this study, we propose a new identification strategy to bypass the ignorability assumptions. The new strategy explores independent heterogeneous effects.



As we have shown, the new strategy for mediation can be easily incorporated into common causal identification assumptions. Therefore, our method does not add additional burdens to researchers who want to explore mechanisms.

Identification Strategy (Principle of HTE)

$$ATE = ADE + \mathbb{E}[Y_i(0, M_i(1)) - Y_i(0, M_i(0))] \quad (5)$$

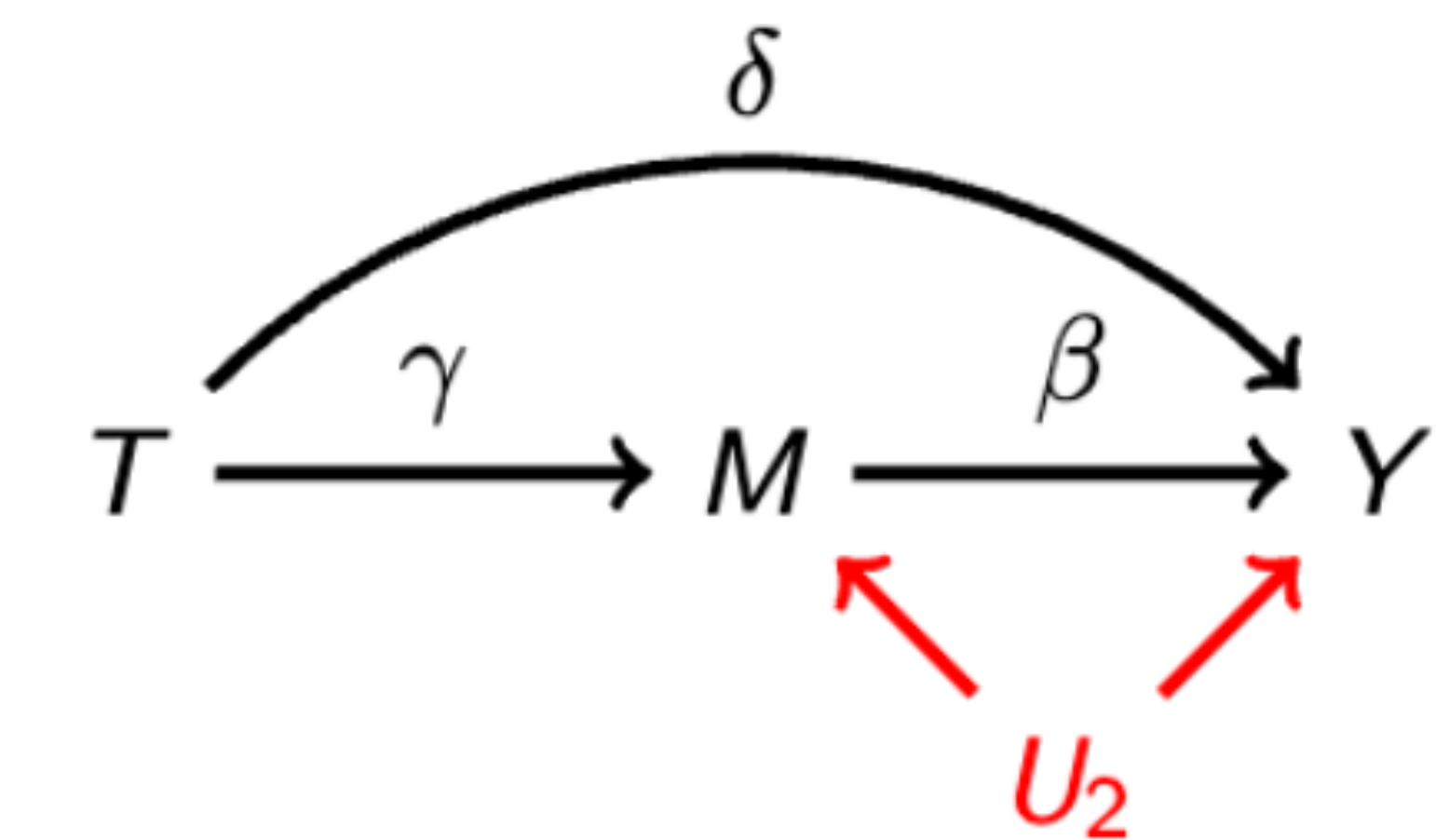
$$\underbrace{ATE}_{\tau} = \underbrace{ADE}_{\delta} + \underbrace{\frac{\mathbb{E}[Y_i(0, M_i(1)) - Y_i(0, M_i(0))]}{\mathbb{E}[M_i(1) - M_i(0)]}}_{\beta} \times \underbrace{\mathbb{E}[M_i(1) - M_i(0)]}_{\gamma} \quad (6)$$

Proposition (Identification).

Given random sample (τ_j, γ_j) and assume $Cov(\gamma, \delta) = 0$.

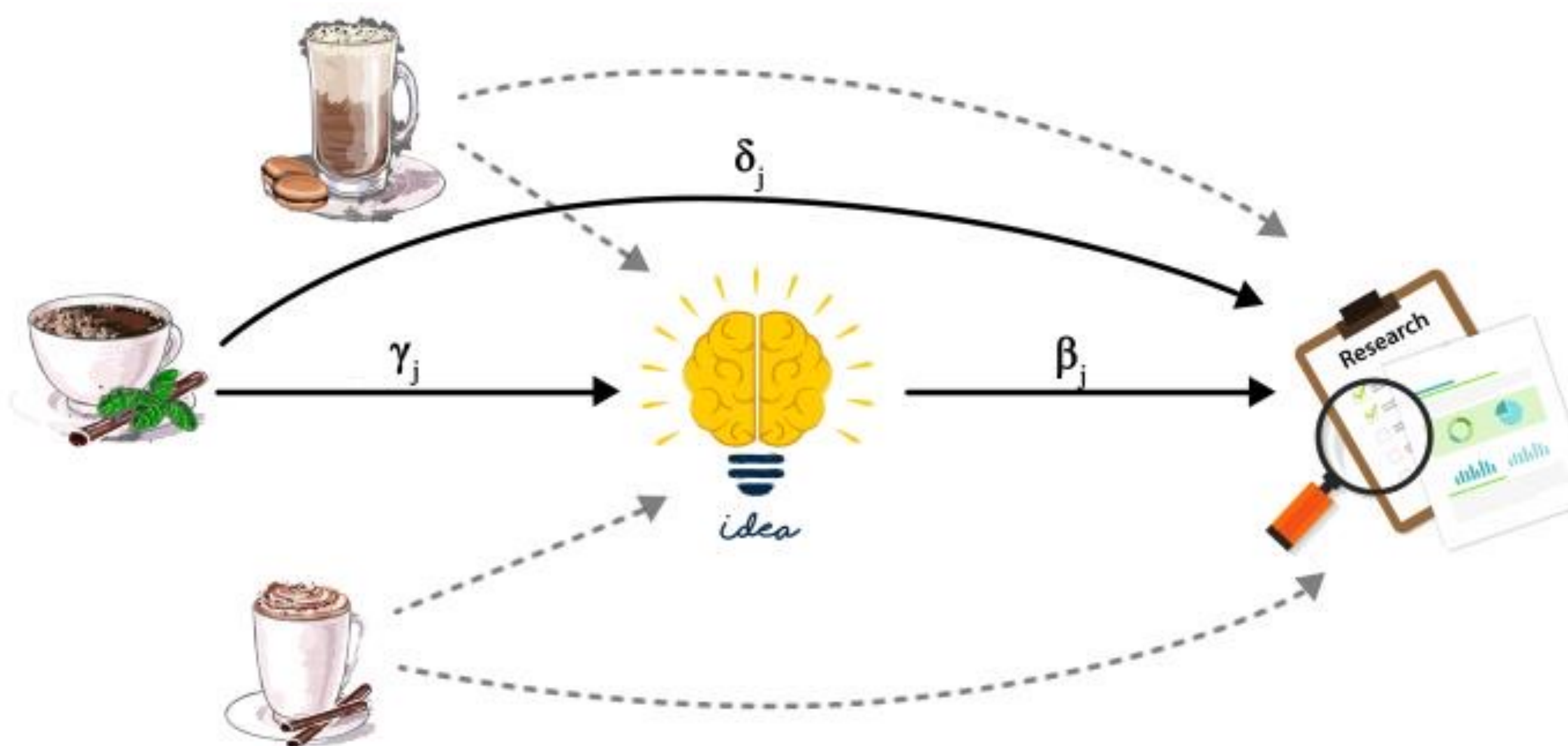
- If β is constant, β is identified and estimated by simple OLS.
- If β is random, then $\mathbb{E}\beta_j$ is identified under $Cov(\beta, \gamma) = 0$.

$$\begin{aligned} \tau_j &= \bar{\delta}_j + \beta\gamma_j + (\delta_j - \bar{\delta}_j) \\ \tau_j &= \text{intercept} + \beta\gamma_j + \text{error}_j \end{aligned}$$



Research Design 1: Multiple Treatments

- How does contact (door-to-door, email) affect turnout?
- How does drinking coffee (Americano, Latte, Flat White) affect political science research?



-
-
-

Proposition (Aggregate Level Estimator).

Suppose the following measurement equations hold.

$$\hat{\gamma}_j = \gamma_j + N(0, \sigma_\gamma^2) \quad (10)$$

$$\hat{\tau}_j = \tau_j + N(0, \sigma_\tau^2) \quad (11)$$

Then, $\lambda^{-1}\hat{\beta} \rightarrow \beta$ where $0 < \lambda < 1$.

- λ can be estimated by some methods; so that we can correct the bias and conduct inference.

Research Design 2: Heterogeneous Subgroups

- We use G_j to define each subgroups according to covariates $X = (X_1, X_2, \dots, X_k)$.
- Suppose treatment exhibits different effects δ and γ for different subgroups G_j . Let χ_{G_j} be the group indicator function.

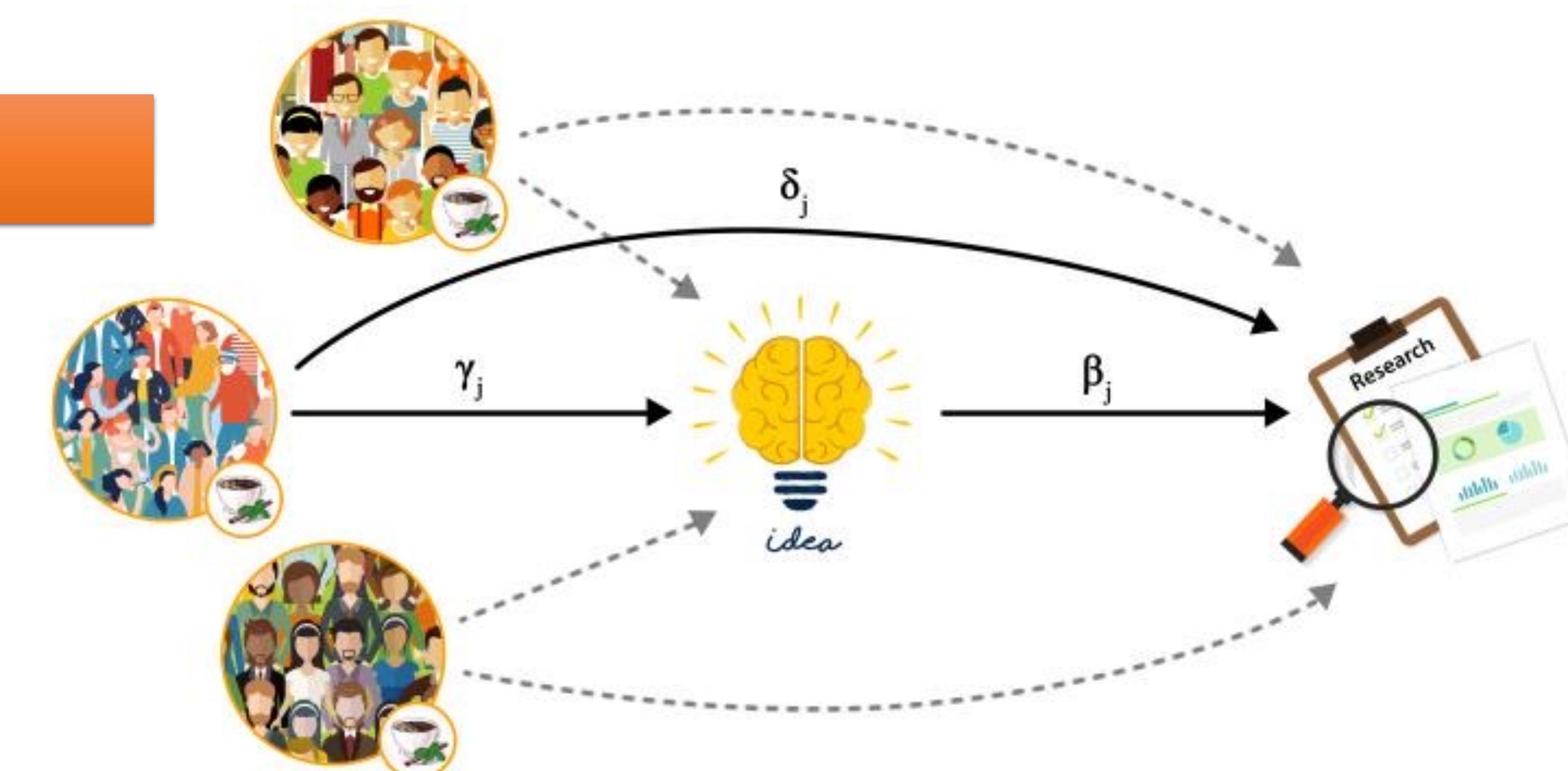
$$M_i = \sum \gamma_j T_i \chi_{G_j} + U_i \quad (12)$$

$$Y_i = \sum \delta_j T_i \chi_{G_j} + \beta M_i + V_i \quad (13)$$

- Note, we allow U and V are arbitrarily correlated so that M is 'endogenous'.

Proposition (Individual Level Estimator).

Suppose T is independent of U and V (by S). Then, β is identified.



- In observational studies, we cannot make sure T is independent of U and V .
- If our causal identification is IV, then we only need to add one more equation.

$$T_i = \theta Z_i + \varepsilon_i \quad (14)$$

Remarks:

- Please see the paper for other extensions, applications and combining DID/ RD.
- We can also use HTE (Fu and Slough 2023) to explore mechanisms activation rather than to estimate the causal mediation effect.