# More IVs

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**Abstract**

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## 1. Shift-Share Instruments (Bartik IVs)

### Classic Endogeneity Problem

- Recall the standard endogeneity issue in market equilibrium models: prices and quantities (e.g., wages and employment) are determined simultaneously.
- To identify the slope of the supply curve, we need valid demand shifters (i.e., instruments that shift demand but are exogenous to supply).

### Estimation Equation

- The equation of interest is:

$$w_\ell = \beta N_\ell + \gamma X_\ell + \varepsilon_\ell \tag{1}$$

- Where:
  - $w_\ell$: wages in region $\ell$
  - $N_\ell$: employment in region $\ell$
  - $X_\ell$: controls (e.g., demographics, amenities)
  - $\varepsilon_\ell$: unobserved error term
- Endogeneity arises because $N_\ell$ is jointly determined with $w_\ell$, so we instrument $N_\ell$ with $z_\ell \rightarrow$ jointly deteried by demand and supply. We are creating now an exogenous shock in demand.

### The Bartik Instrument

- Bartik (1991) constructs a shift-share IV by predicting local demand shocks using national industry growth, weighted by local industrial composition.
- The instrument is:

$$z_\ell = \sum_k s_{\ell k} g_k \tag{2}$$

- Where:
  - $\ell$: index for local or regional labor markets
  - $k$: index for industries/sectors
  - $s_{\ell k}$: the share of industry $k$ in local market $\ell$, typically measured at a baseline year (e.g., initial period)
  - $g_k$: the national growth rate of industry $k$, optionally leave-one-out to avoid local endogeneity: $g_{k,-\ell}$
- **Key interpretation:** The Bartik IV is a weighted sum of national industry shocks ($g_k$), where the weights are the initial shares of each sector in the local economy ($s_{\ell k}$). This generates region-specific shocks even though the national shocks are common across regions.

### Validity Conditions

To be a valid IV, $z_\ell$ must satisfy two conditions:

1. **Relevance:** $z_\ell$ must be correlated with $N_\ell$
2. **Exogeneity:** $z_\ell$ must be uncorrelated with $\varepsilon_\ell$

**For Bartik IV, this means: IT HAS TO BE AN EXOGENOUS DEMAND SHOCK**

- **1. National shocks** $g_k$ must be exogenous to local shocks:

$$g_k \perp \varepsilon_\ell \quad \text{for all } \ell$$

- **2. Local past distribution of employment across sector** $s_{\ell k}$ exogenous to local contemporaneous shocks:

$$s_{\ell k} \perp \varepsilon_\ell$$

### Exclusion Restriction?

- Key question: Do either the shares $s_{\ell k}$ or the shocks $g_k$ affect outcomes directly, outside of their effect on $N_\ell$?
- If, for instance, local shares $s_{\ell k}$ were chosen in anticipation of future shocks, or $g_k$ reflects national trends influenced by local economic conditions, the exclusion restriction would be violated.

### 1.1. Applications of Shift-Share IVs

- Bartik IVs became more popular after:
  - **Autor et al. (2013):** Study of the *China shock*: they exploit heterogeneity in industrial composition across US regions and interact it with national growth in Chinese imports.
  - **Card** on immigrants

### 1.2. Identification: Goldsmith-Pinkham et al. (2020)

- Their key insight: identification depends not just on exogeneity of $g_k$, but also on exogeneity of $s_{\ell k}$
- Each $s_{\ell k}$ can be seen as generating a separate instrument for $\ell$. Each sector (defined by its share) experiences a different change in global demand (global migration) = different local evolution in demand (first stage: predicted change in migration, first stage setting wrt actual change in migration). The total Bartik IV estimate is a weighted average of these sector-level IV estimates (Roemberg weight).

$$\hat{\beta}^{\text{Bartik}} = \sum_k \hat{\alpha}_k \hat{\beta}_k, \quad \text{where} \quad \sum_k \hat{\alpha}_k = 1$$

- Robustness: estimate separate IV regressions using each $k$-level component.
- Each $k$-level IV contributes to the total estimate with a **Rotemberg weight** $\alpha_k$, defined as:

$$\alpha_k = \frac{g_k Z_k' N}{\sum_k g_k Z_k' N} \tag{3}$$

  where $Z_k$ is the vector of shares of sector $k$ across all regions. The larger the global shock, the more the industry is **heterogeneously** present across the regions (Zk varies a lot), and the more variation in Zk is correlated with variation in employment N (component of the first stage) the greater the weight
- **Diagnostics:**
  - Negative Rotemberg weights are problematic. Negative weigth sdpend on the sign of the product $g_k Z_k' N$. You have a negative weight if $g_k$ (global expansion in export for sector k) and $Z_k' N$ move in opposite directions: $g_k$ is saying: there was a positive shock for sector k (manufacturing), g > 0.
    $Z_k' N$ is saying (if < 0): there is a negative relationship between the local PREDICTED exposure to industry

k (manufacturing) and employment in the area (the endogenous areas). The more the exposure to industry k the lower employment
The sectors shock says: employment should go up. But: regions more exposed to that sector actually have lower employment.
We have an underlying assumption that global $g_k is positively or negatively (but one of the two) correlated with global N check fraction of negative weights is not too high$
- Identification narrative and F-statistics (weak instruments?) for the k dimensions with largest Rotemberg weights
- **Sectors with large weights** should have $\hat{\beta}_k$ close to $\hat{\beta}^{bartik}$; otherwise, result is sensitive to few sectors.

- Borusyak et al. (2021) offer an alternative: focus on exogeneity of the shocks $g_k$ instead of shares $s_{\ell k}$.

## 2. IV in Randomized Trials

- The instrument is a dummy for being assigned to treatment.
- The effect of assignment (the instrument) on outcomes is the **ITT**, an effect of interest in many cases (e.g., effect of being offered a free bank account).
- That is all we can get if the exclusion restriction does not hold. Note, A comparison between treated and control is not valid if the sample opening the bank account is not random.
- The IV estimate, `ivregress 2sls y (D = Z)`, is equal to the ratio between the ITT and the difference in compliance rates between treatment and control (recall previous lecture slides on IV and LATE):

$$\text{LATE} = \frac{\text{ITT}}{\Pr(D = 1 \mid Z = 1) - \Pr(D = 1 \mid Z = 0)}$$

- If compliance among the controls is perfect (no single control is treated), then the IV is the ATT. Rceall ex. 3 of interpretation of LATE! LATE is ATT if all people being offered the treatemtn take it up (I mean **recall the first set of notes on rubin modle, compliers are thsoe that are treated! (tthose that when treated react by taking up the treatmetn!** here the two correspond!)

### Example: IV in Randomized Trials

- Impact of having a bank account, using as instrument the assignment to being offered a free savings account.
- **Data:**
  - Average savings for those offered a free savings account: \$2,500
  - Average savings for those not offered a free savings account: \$1,500
  - Proportion of those offered who opened the account: 50%
  - Proportion of those not offered who opened the account: 20%
- **Calculations:**
  - ITT = \$2,500 - \$1,500 = \$1,000
  - LATE =

$$\frac{2,500 - 1,500}{0.5 - 0.2} = \frac{1,000}{0.3} = 3,333.33$$

- **Special case (perfect compliance in control group):**
  - If proportion of those **not offered** who opened an account is 0%, then:

$$\text{LATE} = \frac{2,500 - 1,500}{0.5} = \frac{1,000}{0.5} = 2,000$$

  - In this case: LATE = ATT