Topics in Macroeconomics

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Outline

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Cross-Sectional Regressions

$$Y_i = \alpha_i + \beta X_i + \varepsilon_i$$

- Interested in β.
- Can identify β if $E(\varepsilon_i | X_i) = 0$ or suitable instrument with $E(\varepsilon_i | Z_i) = 0$ and $E(X_i | Z_i) \neq 0$.
- What's the DGP? Two views:
  1. X_i / Z_i captures quasi-random heterogenous exposure to the same endogenous shock.
  2. X_i / Z_i captures heterogenous, quasi-random shocks.

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Bartik: Canonical Example

- Structural equation:

$$y_l = \rho + \beta x_l + \varepsilon_l$$

  - y_l: wage growth in area l.
  - x_l: employment growth in area l.

- Identities:

$$x_l = \sum_k z_{l,k} g_{l,k}, \qquad g_{l,k} = g_k + \tilde{g}_{l,k}$$

  - $z_{l,k}$: employment share in area l in industry k.
  - $g_{l,k}$: employment growth in area l in industry k.
  - g_k: national employment growth in industry k.
  - $\tilde{g}_{l,k}$: idiosyncratic component of employment growth rate.

- Bartik (1991) instrument to estimate inverse labor supply elasticity:

$$B_l = \sum_k z_{l,k} g_k$$

- What is exogenous? Shares? Shocks? Product?

Special Case: 2 Industries

- Bartik instrument is proportional to industry share:

$$B_l = z_{1l}g_1 + z_{2l}g_2 = g_2 + (g_1 - g_2)z_{1l}$$

- First stage:

$$x_l = \gamma_0 + \gamma B_l + \eta_l = \gamma_0 + \gamma g_2 + \gamma(g_1 - g_2)z_{1l} + \eta_l$$

- B_l is equivalent to using z_{1l} (or z_{2l}) as instrument.
- Intution:
  - z_{1l} measures exposure, $g_1 - g_2$ the magnitude of the treatment.
  - Many cross-sectional regressions take the view $g_2 = 0$: heterogeneous exposure to single aggregate shock.
  - What endogeneity problem does the Bartik instrument (or industry shares) solve? What does it not solve?

General Case (1)

Notation:

- $Z_{lt} = (z_{l1t}, \ldots, z_{lkt})$ is a $1 \times K$ vector of industry shares.
- $Z_t = (Z_{1t}', \ldots, Z_{Lt}')'$ is a $L \times K$ matrix of industry shares.
- $G_t = (g_{1t}, \ldots, g_{kt})'$ is a $K \times 1$ vector of industry growth rates.
- $B_t = Z_0 G_t$ is a $L \times 1$ vector of Bartik instruments.
- $X_t = (x_{1t}, \ldots, x_{Lt})'$ is a $L \times 1$ vector of endogenous variables.
- $Y_t = (y_{1t}, \ldots, y_{Lt})'$ is a $L \times 1$ vector of outcomes.
- Assume X_t, Y_t previously residualized with respect to any covariates.

General Case (2)

- B is a $LT \times 1$ vector of Bartik instruments.

$$B = ZG = \begin{pmatrix} Z_0 G_1 \\ Z_0 G_2 \\ \vdots \\ Z_0 G_T \end{pmatrix} = \underbrace{\begin{pmatrix} Z_0 & 0 & \dots & 0 \\ 0 & Z_0 & \dots & 0 \\ \vdots & 0 & \ddots & \vdots \\ 0 & \dots & 0 & Z_0 \end{pmatrix}}_{=Z} \underbrace{\begin{pmatrix} G_1 \\ G_2 \\ \vdots \\ G_T \end{pmatrix}}_{=G}$$

- Z is a $LT \times KT$ matrix of industry shares
- G is a $KT \times 1$ vector of industry growth rates.
- $X = (X_1', ..., X_T')'$ is a $LT \times 1$ vector of endogenous variables.
- $Y = (Y_1', ..., Y_T')'$ is a $LT \times 1$ vector of outcomes.
- The Bartik and GMM estimators are

$$\hat{\beta}_{Bartik} = \frac{B'Y}{B'X}, \qquad \hat{\beta}_{GMM} = \frac{X'ZWZ'Y}{X'ZWZ'X}$$

Equivalence of GMM and Bartik

- Proposition: When $W = GG'$ then $\hat{\beta}_{Bartik} = \hat{\beta}_{GMM}$

- Proof:

$$\begin{aligned}
\hat{\beta}_{GMM} &= (X'ZGG'Z'X)^{-1}(X'ZGG'Z'Y) \\
&= (X'BB'X)^{-1}(X'BB'Y) \\
&= (B'X)^{-1}(X'B)^{-1}(X'B)(B'Y) \\
&= \hat{\beta}_{Bartik}
\end{aligned}$$

- Bartik IV is numerically equivalent to IV regression with KT instruments corresponding to the industry shares in Z weighted with industry GG'.

Identifying assumptions

- TSLS estimator:

$$\hat{\beta} - \beta_0 = \frac{\sum_{t=1}^{T} \sum_{k=1}^{K} g_{kt} \sum_{l=1}^{L} z_{lk0} \varepsilon_{lt}}{\sum_{t=1}^{T} \sum_{k=1}^{K} g_{kt} \sum_{l=1}^{L} z_{lk0} x_{lt}}$$

- Identifying assumption (conditional on observables):

$$E[\varepsilon_{lt} z_{zlk0}] = 0, \qquad \forall k$$

  What are the asymptotics?

- KT moment conditions in GMM.
- In words: the differential effect of higher exposure of one industry (compared to another) only affects the change in the outcome (y_{lt}) through the endogenous variable of interest, and not through any potential confounding channel.

Rotemberg Weights

- In principle, must make exogeneity claim for every industry $k = 1, \ldots, k$. Very difficult to do in practice.
- GPSS: focus on select industries that are most influential in determining $\hat{\beta}_{Bartik}$.

$$\hat{\beta}_{Bartik} = \sum_k \hat{\alpha}_k \hat{\beta}_k$$

where

$$\hat{\beta}_k = (Z_k' X)^{-1}(Z_k' Y), \qquad \hat{\alpha}_k = \frac{G_k' Z_k' X}{\sum_k G_k' Z_k' X} = \frac{G_k' Z_k' X}{B' X}$$

- $\hat{\beta}_k$ is the just-identified IV estimate from using only the industry shares of industry k, Z_k.
- $\hat{\alpha}_k$ are the *Rotemberg Weights*, which sum to 1 (can be negative).
  - Contribution of industry k to Bartik first stage covariance. (Not the same as F-stat.)
  - Measure the sensitivity to bias in instrument k.

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General Specification Tests

1. Estimated coefficients sensitive to inclusion of covariates?
2. Pre-trends?
3. Placebo tests?
4. Overidentification tests.
5. Subsample analysis: drop influential observations.

Leave-one-out

1. Typically construct leave-one-out Bartik instrument:

$$B_l = \sum_k z_{l,k} g_{\tilde{l},k}$$

   - $g_{\tilde{l},k}$ is national employment growth in industry k excluding area l.

2. Removes finite sample correlation between idiosyncratic industry growth rate $\tilde{g}_{l,k}$ and Bartik instrument B_l.

3. Often unimportant in practice. Why?

Standard Errors

1. Adao et al

1. x

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