"Bartik Shift-Share Instruments" Discussion of Goldsmith-Pinkham, Sorkin, and Swift, AER 2020

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Bartik or Shift-Share Instruments

Very common instrument that uses lagged stocks of a variable at a regional level combined with aggregate flows to predict current values of an endogenous variable comprised of different categories (ex: industries, immigrant groups)

The stocks are broken out into categories and transformed into shares (share of region l total employment in industry k, share of total immigrants from country c going to location l)

These are then multiplied by aggregate flows (total growth in industry k, total outflow from country c) and summed to create a prediction for the endogenous variable

An Important Instrument

Name comes from 1991 book by Bartik: “Who Benefits from State and Local Economic Development Policies?” (free to read on JSTOR)

Used by Blanchard and Katz (Brookings 1992), Bound and Holzer (JoLE 2000), Card (JoLE 2001), Moretti (AER 2004), Card (AER 2009), Aizer (AER 2010), Duranton and Turner (AER 2011), Beaudry, Green, and Sand (Econometrica 2012), Autor, Dorn, Hanson (AER 2013), Diamond (AER 2016), and many others

We saw it in Baum-Snow, Brandt, Henderson, Turner, Zhang (ReStat 2017) to predict population growth (lagged provincial migrant shares with current outflows)

Not Clear How It Works...Until Now

What is the identification assumption?

What can we do to provide support for the identification assumption?

What is the role of the national shocks and local shares?

Where does most of the identification come from; is it all group shares of just a few (ex: just a few important industries)?

Recent Work on Bartik Instruments

1. Jaeger, Ruist, Stuhler, NBER WP, 2018
2. Adao, Kolesar, Morales, QJE 2019
3. Goldsmith-Pinkham, Sorkin, Swift, AER 2020
4. Borusyak, Hull, Jaravel, ReStud 2021
5. Broxterman, Larson, J. Regional Science 2021

We will mostly discuss Goldsmith-Pinkham et. al., but:

Borusyak et. al. shows validity of shift-share IV with different exogeneity requirements (last slides)

Jaeger et. al. focuses specifically on predicting immigration flows and shows issues when immigration has both short-run and long-run economic effects

Goldsmith-Pinkham, Sorkin, and Swift, "Bartik Instruments: What, When, Why, and How", AER 2020

Basic Setup: Growth Between Two Periods

We want to estimate effect of employment growth in location l, x_l, on wage growth in l, y_l:

$$y_l = \rho + \beta_0 x_l + \epsilon_l \tag{1}$$

Overall employment growth can be decomposed into industry-level growth in l (K industries):

$$x_l = \sum_{k=1}^{K} z_{lk} g_{lk} \tag{2}$$

Industry level growth has national and local components:

$$g_{lk} = g_k + \tilde{g}_{lk} \tag{3}$$

Bartik instrument:

$$B_l = \sum_{k=1}^{K} z_{lk} g_k \tag{4}$$

Full Panel Setup

Full panel setup can predict multiple periods of growth, using period specific national growth rates and industry shares from a single period $t = 0$

$$y_{lt} = D_{lt}\rho + x_{lt}\beta_0 + \epsilon_{lt} \tag{5}$$

D_{lt} are location-time fixed effects

$$x_{lt} = Z_{lt}G_{lt} = \sum_{k=1}^{K} z_{lkt}g_{lkt} \tag{6}$$

$$g_{lkt} = g_{kt} + \tilde{g}_{lkt} \tag{7}$$

$$B_{lt} = Z_{l0}G_{t} = \sum_{k=1}^{K} z_{lk0}g_{kt} \tag{8}$$

Bartik Instrument Equivalent to GMM IV

Each industry's initial shares can be thought of as a separate instrument; multiplying by aggregate growth and summing is one way of combining multiple instruments into a single instrument

Generalized Method of Moments (GMM) is a technique to estimate coefficients by solving a set of conditions (moments)

With instruments $z_i \in Z$ and error term ϵ_i, each moment is $E(z_i \epsilon_i) = 0$ (exclusion restriction)

If number of instruments equals number of coefficients, this is exactly IV estimation; if more instruments then we choose weighting matrix to minimize squared error. This is GMM IV.

GSS show that a Bartik instrument is the same as using each industry's share as an instrument and then estimating with GMM IV, where the GMM weights matrix is equal to the cross product of industry growth rates

Identification: Shares are Exogenous

Shares are instruments: thus shares must be uncorrelated with error term, conditional on controls

This is standard conditional exogeneity assumption: $E(\epsilon Z|X) = 0$

This means shares are uncorrelated with unobservables affecting *growth* rates; note that levels are not a problem (ex: high wage level and high industry share)

What about national growth rates and exogeneity? These just change weighting matrix (efficiency); not important for identification

If shares are instruments, do we need all of them?

Importance of each instrument: Rotemberg weights

Many applications of Bartik instruments use shares from many categories (ex: hundreds of industries)

Are all of these equally important? No.

GSS use Rotemberg weights (Rotemberg 1983) to provide a measure (sums to one) of how important each share is

Method is beyond scope of our class, but they provide Stata and R code to easily compute these weights: https://github.com/paulgp/bartik-weight

Weights can be very useful to see which industries are important, and thus whether exogeneity assumptions are plausible for instruments with largest weight

Simple examples from GSS for intuition

Simplest case: two industries, one period growth

GSS use a simple example with just two industries and growth between two periods to build intuition

With just two industries and employment shares that add to one, we know industry mix from share of just one industry

Thus there is just a single instrument and a single coefficient, so GMM is identical to IV (generally, if there are K industries whose shares add to 1, there are $K-1$ instruments)

This makes easy to see some of their main points–we will concentrate on this simple case

Simplest case identical to IV with shares

Want to estimate: $y_l = \rho + \beta_0 x_l + \epsilon_l$

Two industries: $z_{l1} + z_{l2} = 1$; $x_l = g_{l1} * z_{l1} + g_{l2} * z_{l2}$

$$B_l = z_{l1} g_1 + z_{l2} g_2 \tag{9}$$

Substitute $z_{l2} = 1 - z_{l1}$ into first stage:

$$x_l = \gamma_0 + \gamma B_l + \eta_l = \gamma_0 + \gamma g_2 + \gamma(g_1 - g_2) z_{l1} + \eta_l \tag{10}$$

What if we just used z_{l1} directly as the instrument?

$$x_l = \delta_0 + \delta z_{l1} + \delta_l \tag{11}$$

Difference is simply multiplying z_{l1} by a constant $(g_1 - g_2)$, thus $\gamma = \delta/(g_1 - g_2)$ and the IV estimates of β_0 will be *identical*!

Two industries, two periods growth

Want to estimate: $y_{lt} = \tau_t + \beta_0 x_{lt} + \epsilon_{lt}$;

Use only initial shares: $z_{l2,0} = 1 - z_{l1,0}$

$$B_{lt} = g_{1t} z_{l1,0} + g_{2t} z_{l2,0} = g_{2t} + (g_{1t} - g_{2t}) z_{l1,0} \tag{12}$$

$$x_{lt} = (\tau_t + g_{2t}\gamma) + z_{l1,0}(g_{1t} - g_{2t})\gamma + \eta_{lt} \tag{13}$$

Rewrite with time FE: $g_{1t} - g_{2t} = 1(t=1)(g_{11} - g_{21}) + 1(t=2)(g_{12} - g_{22})$

$$x_{lt} = (\tau_t + g_{2t}\gamma) + z_{l1,0} 1(t=1)(g_{11} - g_{21})\gamma + z_{l1,0} 1(t=2)(g_{12} - g_{22})\gamma + \eta_{lt}$$

Now compare to first stage with shares interacted with time FE:

$$x_{lt} = \tau_t + z_{l1,0} 1(t=1)\delta_1 + z_{l1,0} 1(t=2)\delta_2 + \delta_{lt} \tag{14}$$

Identical if we constrain $\delta_1/(g_{11} - g_{21}) = \delta_2/(g_{12} - g_{22})$

Interpretation: 2 industries, 2 periods growth

GSS point out that with two periods, this is somewhat like differences-in-differences

The industry shares can be viewed as a measure of exposure to a policy

The growth rates measure the policy size

Then we are comparing locations with more exposure to locations with less exposure, across a period where the policy is stronger and a period where the policy is weaker

My question: shouldn't the unconstrained estimator always be just as good as Bartik? In this case, why use Bartik–is it simply because the instrument has a better connection to theory?

Worth Additional Study

Many points in the paper I did not cover, well worth additional study

Very accessible (readable) for an econometrics paper; examples are also quite interesting

But, what to do if shares are not exogenous, even after conditioning on controls D_{lt}: $E[\epsilon_{lt} z_{lk0} | D_{lt}] \neq 0$?

Borusyak, Hull, and Jaravel, “Quasi-Experimental Shift-Share Research Designs”, ReStud 2022

Borusyak, Hull, and Jaravel 2022

Borusyak, Hull, and Jaravel (BHJ) show that shift-share instruments can be valid *even* when the shares are endogenous

The idea: many exogenous *shocks* (the shifts) will cause the bias from endogenous shares to cancel out

This paper is harder, but reading both papers together is a great way to understand shift-share designs

Authors of both papers clearly talked to each other frequently and they use the same notation (quite helpful) and China shock example

Identification from exogenous shocks

GSS show difference between Bartik (TSLS) instrument and true parameter value:

$$\hat{\beta} - \beta_0 = \frac{\sum_{t=1}^{T} \sum_{k=1}^{K} g_{kt} \sum_{l=1}^{L} z_{lk0} \epsilon_{lt}^{\perp}}{\sum_{t=1}^{T} \sum_{k=1}^{K} g_{kt} \sum_{l=1}^{L} z_{lk0} x_{lt}^{\perp}} \tag{5}$$

To get the numerator to converge to zero as $L \to \infty$, we can assume strict exogeneity of the shares: $E[\epsilon_{lt} z_{lk0} | D_{lt}] \neq 0$

However, BHJ show that as K gets large and the shocks g_{kt} are exogenous, then the numerator can still converge to zero

Thus exogeneity of shares is sufficient, but not necessary for consistency

Shift-share IV identification: shares or shocks?

GSS note that if there are only a few shares (small K) and the intuition can be illustrated by comparing regions with high and low shares, then the identification assumption must be exogenous shares

This is similar to DiD where we compare regions with different exposure and argue for no pre-trends

If instead, intuition comes from more and more shares (K getting larger) receiving shocks, then this is the shocks identification assumption

GSS note that this assumption can't be illustrated with a two-case example because the key is K increasing

Identification from shocks: BJH examples

The key is that shocks are essentially randomly assigned across the K industries or groups (share variable)

BJH motivating example is estimating inverse labor supply elasticity by regressing wage growth on employment growth (same as considered by GSS)

Instrument for employment growth using shocks from import tariffs applied across all industries; tariffs would raise demand for domestically produced goods and thus labor demand

The tariffs have to be applied to all industries, and strength of tariff cannot be correlated with unobservable labor supply shocks (ex: tariff only applied to manufacturing, and regions with high manufacturing have high unobservable migration)

Peri et al. (2016) look at effect of immigrants in technical fields on native outcomes, with assumption that flow of technical immigrants results from random changes to US visa policies (H1-B)

Autor, Dorn, and Hanson 2013–“China shock”

ADH use changes in imports from China (shocks) across different industries to look at effect on US employment in regions with different industry exposure (shares, measured using share of manufacturing employment in the industry ten years earlier)

The identification assumption here is that the industries in which China starts exporting are exogenous to conditions in US labor markets

ADH argue for exogenous shocks by using import changes *from other countries* as their measure of the shocks (ex: Chinese exports to Australia)

BJH note that shocks identification would not hold if (for ex.) China specialized in low-skill industries and regions in US specializing in these industries were already on different employment trends

BJH show how to use their framework to assess this kind of concern