Identification with Regional Data

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Outline

Outline

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 endogenous shock(s).
  2. X_i / Z_i captures endogenous exposure to heterogenous, quasi-random shocks.

Bartik / Shift-Share

- National or industry shocks or trends affect some regions more than others because they are more exposed to that shock or trend.

- Bartik instrument interacts national / industry shock with local area exposure.

- Called "Bartik" instrument or shock due to Bartik (1991). Popularized by Blanchard and Katz (1992).

Examples

- Local employment by industry (Bartik, 1991)
- Local wage shocks by worker skill (Diamond, 2016)
- Decline of manufacturing (Charles, Hurst, Notowidigdo, 2018)
- Penetration of Chinese imports (Autor, Dorn, Hanson, 2013)
- Penetration of robots (Acemoglu and Restrepo, 2019)
- Military spending shocks (Nakamura and Steinsson, 2014)
- Bank health shocks (Mondragon, 2020)

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:

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

Autor, Dorn, Hanson (AER, 2013) "China Shock"

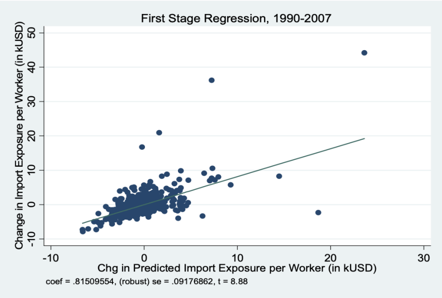
- What is the effect of import competition on aggregate labor demand?
- Difficult to make causal claim in the aggregate:
  - If find negative correlation between industry imports and industry employment, this could just be a labor supply effect.
  - Even if labor demand, aggregate regression may simply measure a reallocation to a different industry.
- Measure import penetration at local area level i:

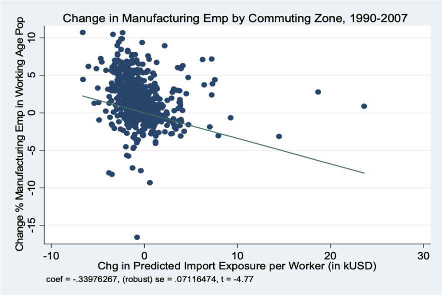
$$IPW_{uit} = \sum_j \frac{L_{ijt}}{L_{it}} \frac{\Delta M_{ucjt}}{L_{jt}}$$

- Instrument using rise in imports elsewhere in the world:

$$\Delta IPW_{oit} = \sum_j \frac{L_{ij,t-1}}{L_{i,t-1}} \frac{\Delta M_{ocjt}}{L_{j,t-1}}$$

Autor, Dorn, Hanson (AER, 2013) "China Shock"





Bartik: Concerns

Require:

$$E(\varepsilon_l B_l) = E(\varepsilon_l \sum_k z_{l,k} g_k) = 0$$

1. Pre-shock shares endogenous to lagged shock or the same shock if serially correlated, $E(\varepsilon_l z_{l,k}) \neq 0$.
    - Random assignment conditional on controls can be difficult to justify: regions that differ in z probably differ on other (unobserved) dimensions too!
2. National industry shocks correlated with local shocks, , $E(\varepsilon_l g_k) \neq 0$.
    - In classic Bartik example, worry that g_k is correlated with (unobserved) labor supply shocks.

How to handle identification arguments?

Outline

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:

- $Z_{lt} = (z_{l1t}, ..., z_{lkt})$ is a $1 \times K$ vector of industry shares.
- $Z_t = (Z'_{1t}, ..., Z'_{Lt})'$ is a $L \times K$ matrix of industry shares.
- $G_t = (g_{1t}, ..., g_{kt})'$ 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.
- $X_t = (x_{1t}, ..., x_{Lt})'$ is a $L \times 1$ vector of endogenous variables.
- $Y_t = (y_{1t}, ..., y_{Lt})'$ 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 K instruments corresponding to the industry shares in Z weighted with industry GG'.

- More notation extends to case with controls.

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):

$$E\left[\frac{1}{L}\sum_{l=1}^{L} \varepsilon_{lt} z_{zlk0}\right] = 0, \qquad \forall k, t$$

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 $k = 1, ..., k$. 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.

Outline

BHJ Identification

- Bartik = TSLS estimator:

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

- Moment condition for identification:

$$E\left[\frac{1}{L}\sum_{l=1}^{L} b_{lt}\varepsilon_{lt}\right] = E\left[\frac{1}{L}\sum_{l=1}^{L}\left(\sum_{t=1}^{T}\sum_{k=1}^{K} g_{kt} z_{lk0}\right)\varepsilon_{lt}\right] = 0$$

  - GPSS: quasi-random shares $E(\frac{1}{L}\sum_l z_{lk0}\varepsilon_{lt} | g_{kt}) = 0$
  - BHJ approach: quasi-random shocks

BHJ Moment Condition

- Moment condition in terms of shocks:

$$E\left[\frac{1}{L}B'\varepsilon\right] = E\left[\frac{1}{L}\sum_{l=1}^{L}\left(\sum_{t=1}^{T}\sum_{k=1}^{K} g_{kt} z_{lkt}\right)\varepsilon_{lt}\right]$$

$$= E\left[\sum_{k=1}^{K}\sum_{t=1}^{T}\underbrace{\left(\frac{1}{L}\sum_{l=1}^{L} z_{lkt}\right)}_{z_{kt}} g_{kt} \underbrace{\left(\frac{\frac{1}{L}\sum_{l=1}^{L} z_{lkt}\varepsilon_{lt}}{\frac{1}{L}\sum_{l=1}^{L} z_{lkt}}\right)}_{\bar{\varepsilon}_{kt}}\right]$$

$$= E\left[\sum_{k=1}^{K}\sum_{t=1}^{T} z_{kt} g_{kt} \bar{\varepsilon}_{kt}\right] = E\left[(\check{Z}G)'\bar{\varepsilon}\right]$$

  where $\check{Z} = diag(z_{10}, ..., z_{KT})$.
- Interpretation:
  - z_{kt} is average exposure to industry k.
  - $\bar{\varepsilon}_{kt}$ is exposure-weighted average of shocks to wage growth.

BHJ Proposition 1

- Claim: Bartik IV is equivalent to a shock-level just-identifed IV regression of KT observations with g_{kt} being the instrument for $\bar{x}_{kt}$ and z_{kt} being sample weight:

$$\bar{y}_{kt} = \alpha + \beta \bar{x}_{kt} + \bar{\varepsilon}_{kt}$$

where $\bar{v}_{kt} = \frac{\frac{1}{L}\sum_{l=1}^{L} z_{lkt} v_{lt}}{\frac{1}{L}\sum_{l=1}^{L} z_{lkt}}$.

- Proof:

$$\begin{aligned}
\hat{\beta}_{Bartik} &= (B'X)^{-1}(B'Y) \\
&= \left(\sum_{k=1}^{K}\sum_{t=1}^{T} z_{kt} g_{kt} \bar{x}_{kt}\right)^{-1} \left(\sum_{k=1}^{K}\sum_{t=1}^{T} z_{kt} g_{kt} \bar{y}_{kt}\right) \\
&= (\check{Z} G' \bar{X})^{-1}(\check{Z} G' \bar{Y})
\end{aligned}$$

Which case?

1. Exogenous shares: $E\left[\frac{1}{L}\sum_{l=1}^{L} z_{zlk0}\varepsilon_{lt}\right] = 0$

   - Ex ante exposure in location l uncorrelated with unobserved shocks to outcome.

2. Exogenous shocks (shifters): $E\left[\frac{1}{KT}\sum_{k=1}^{K}\sum_{t=1}^{T} z_{kt}g_{kt}\bar{\varepsilon}_{kt}\right] = 0$

   - Shocks to industry k uncorrelated with unobserved industry shocks when weighted by industry size.

- What are asymptotics?

- Which is more plausible? When?

Outline

Borusyak, Hull, WP 2021: Non-Random Exposure

$$y_i = \alpha + \beta x_i + \varepsilon_i$$
$$z_i = f_i(g, w)$$

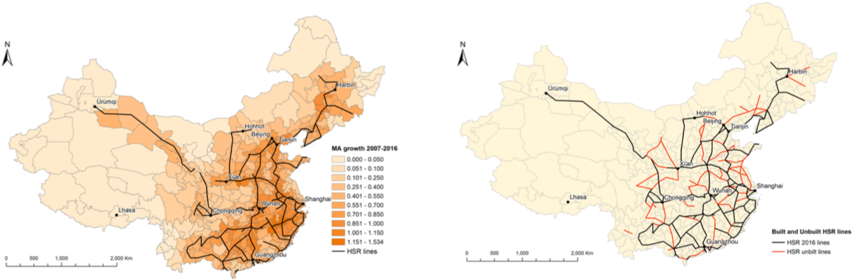
- Even if shocks are exogenous, $g \perp \varepsilon | w$, due to non-random exposure.
$$E\left[\frac{1}{N}\sum_i z_i \varepsilon_i\right] = E\left[\frac{1}{N}\sum_i \mu_i \varepsilon_i\right]$$
where $\mu_i = E[f_i(g, w)]$.
- Intuition: some areas systematically get higher / lower treatment due to non-random assignment (exposure).
- Solution: simulate draws of shocks, compute μ_i, and recenter instrument to $z_i - \mu_i$.
- A problem for Bartik (inner product) instruments?

BORUSYAK, HULL, WP 2021: NON-RANDOM EXPOSURE

Figure 1: Chinese High Speed Rail and Market Access Growth, 2007-2016

A. Completed Lines and MA Growth

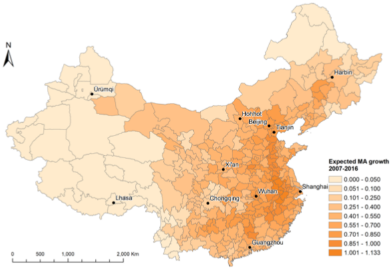
B. All Planned Lines



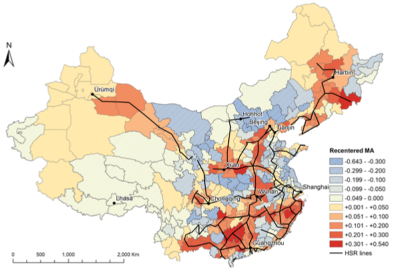
Notes: Panel A shows the completed China high-speed rail network by the end of 2016, with shading indicating MA growth (i.e. log-change in MA) relative to 2007. Panel B shows the network of all HSR lines, including those planned but not yet completed as of 2016 (in red).

Borusyak, Hull, WP 2021: Non-Random Exposure

A. Expected Market Access Growth



B. Recentered Market Access Growth



Outline

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

- Typically construct leave-one-out Bartik instrument:

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

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

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

- Often unimportant in practice. Why?

Standard Errors

- Adão, Kolesár, Morales (QJE, 2019): regions with similar exposure are not iid.
- Example DGP:

$$y_l = \alpha + \beta_0 x_l + \varepsilon_l, \qquad x_l = \sum_k z_{lk}(g_k^1 + g_k^2)$$

- Want to know impact of g^1 (e.g., China shock):

$$y_l = \alpha + \beta_0 \sum_k z_{lk} g_k^1 + (\sum_k z_{lk} g_k^2 + \varepsilon_l)$$

- Identified if $Cov(\sum_k z_{lk} g_k^1, \sum_k z_{lk} g_k^2 + \varepsilon_l) = 0$.
- But residuals correlated because of industry structure $\Rightarrow$ need to adjust standard errors. Severity depends on importance of g_k^2.
- BHJ solve this issue by clustering the industry-level regression.

Outline

Data

- Military procurement data by U.S. State and year.
  - DD-350 military procurement forms
  - Records purchases $>$ 10k before 1983 and $> 25k$ thereafter.
- GDP growth, employment growth, inflation by U.S. State and year.
  - How well are these measured?

Specification

- Second stage:

$$\frac{Y_{it} - Y_{it-2}}{Y_{it-2}} = \alpha_i + \gamma_t + \beta \frac{G_{it} - G_{it-2}}{G_{it-2}} + \varepsilon_{it}$$

- First stage (I):

$$\frac{G_{it} - G_{it-2}}{G_{it-2}} = \delta_i + \theta_t + \sum_k \zeta_k 1(i = k) \frac{G_t - G_{t-2}}{G_{t-2}} + \eta_{it}$$

- First stage (II):

$$\frac{G_{it} - G_{it-2}}{G_{it-2}} = \delta_i + \theta_t + \zeta \left(s_i \frac{G_t - G_{t-2}}{G_{t-2}} \right) + \eta_{it}$$

Identification: Shares or Shocks?

Our identifying assumption is that the United States does not embark on military buildups-such as those associated with the Vietnam War and the Soviet invasion of Afghanistan-because states that receive a disproportionate amount of military spending are doing poorly relative to other states.

RESULTS

TABLE 2—THE EFFECTS OF MILITARY SPENDING

	Output		Output defl. state CPI		Employment		CPI	Population
	States	Regions	States	Regions	States	Regions	States	States
Prime military contracts	1.43	1.85	1.34	1.85	1.28	1.76	0.03	−0.12
	(0.36)	(0.58)	(0.36)	(0.71)	(0.29)	(0.62)	(0.18)	(0.17)
Prime contracts plus military compensation	1.62	1.62	1.36	1.44	1.39	1.51	0.19	0.07
	(0.40)	(0.84)	(0.39)	(0.96)	(0.32)	(0.91)	(0.16)	(0.21)
Observations	1,989	390	1,989	390	1,989	390	1,763	1,989

Notes: Each cell in the table reports results for a different regression with a shorthand for the main regressor of interest listed in the far left column. A shorthand for the dependent variable is stated at the top of each column. The dependent variable is a two-year change divided by the initial value in each case. Output and employment are per capita. The regressor is the two-year change divided by output. Military spending variables are per capita except in Population regression. Standard errors are in parentheses. All regressions include region and time fixed effects, and are estimated by two-stage least squares. The sample period is 1966–2006 for output, employment, and population, and 1969–2006 for the CPI. Output is state GDP, first deflated by the national CPI and then by our state CPI measures. Employment is from the BLS payroll survey. The CPI measure is described in the text. Standard errors are clustered by state or region.

Results

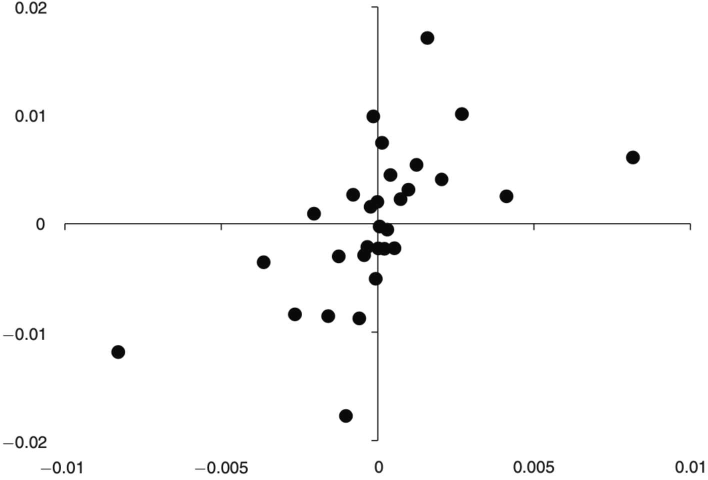


Figure 3. Quantiles of Change in Output versus Predicted Change in Military Spending

Notes: The figure shows averages of changes in output and predicted military spending (based on our first-stage regression), grouped by 30 quantiles of the predicted military spending variable. Both variables are demeaned by year and state fixed effects.

RESULTS

TABLE 3—ALTERNATIVE SPECIFICATIONS FOR EFFECTS OF MILITARY SPENDING

	1. Output level instr.		2. Employment level instr.		3. Output per working age		4. Output OLS	
	States	Regions	States	Regions	States	Regions	States	Regions
Prime military contracts	2.48	2.75	1.81	2.51	1.46	1.94	0.16	0.56
	(0.94)	(0.69)	(0.41)	(0.31)	(0.58)	(1.21)	(0.14)	(0.32)
Prime contracts plus military compensation	4.79	2.60	2.07	1.97	1.79	1.74	0.19	0.64
	(2.65)	(1.18)	(0.67)	(0.98)	(0.60)	(1.00)	(0.19)	(0.31)
Observations	1,989	390	1,989	390	1,785	350	1,989	390

	5. Output with oil controls		6. Output with real int. controls		7. Output LIML		8. BEA employment	
	States	Regions	States	Regions	States	Regions	States	Regions
Prime military contracts	1.32	1.89	1.40	1.80	1.95	2.07	1.52	1.64
	(0.36)	(0.54)	(0.35)	(0.59)	(0.62)	(0.66)	(0.37)	(0.98)
Prime contracts plus military compensation	1.43	1.72	1.61	1.59	2.21	1.90	1.62	1.28
	(0.39)	(0.66)	(0.40)	(0.84)	(0.67)	(1.02)	(0.42)	(1.16)
Observations	1,989	390	1,989	390	1,989	390	1,836	360

WHAT COULD GO WRONG?

- What problems do the instrument(s) solve?
- What problems remain?
- What would you like to see?

Outline

Mian and Sufi

Establish importance of household debt overhang during Great Recession in a series of papers:

1. 2009 QJE: Expansion of credit to new subprime borrowers from 2002-2006 led to defaults.
2. 2011 AER: Credit expansion through home equity borrowing by existing homeowners.
3. 2013 QJE (with Rao): Consumption and credit crunch 2006-2009.
4. 2014 Emca: Deleveraging and unemployment, 2006-2009.
5. 2014 WP: Consumption growth and house prices, 2002-2006.

Mian, Rao, and Sufi, QJE 2013

- What is the causal effect of changes in net worth on consumption?
- Housing net worth shock:

$$\frac{\Delta \log p^H_{i,06-09} H_{i,2006}}{NW_{i,2006}}$$

- Regression:

$$\Delta log C_{i,06-09} = \alpha_t + \beta \frac{\Delta \log p^H_{i,06-09} H_{i,2006}}{NW_{i,2006}} + \gamma X_{it} + \varepsilon_{it}$$

- Identification assumption?

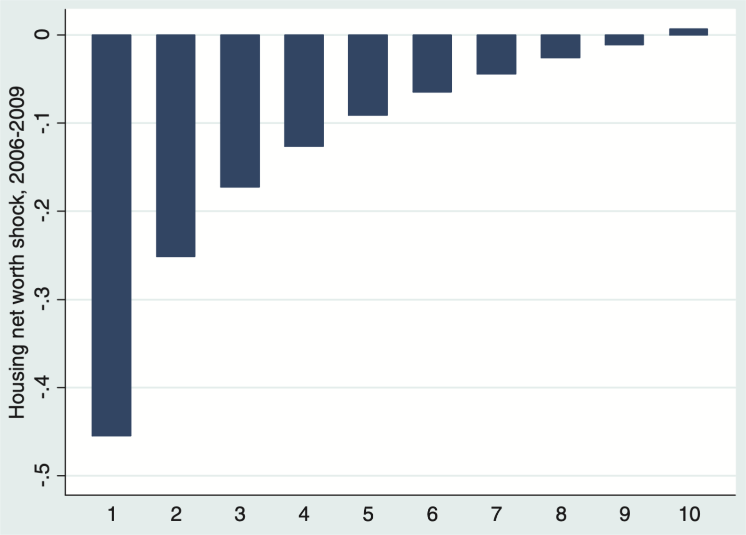
Data

- County-level total consumer purchases with a credit card or debit card for which MasterCard is the processor by NAICS code.
  - Combine with census retail sales data.
- ZIP code-level auto sales data.
- ZIP code-level net worth:

$$NW_{it} = S_{it} + B_{it} + H_{it} - D_{it}$$

  - IRS Statistics of Income (SOI) to proxy for S_{it}, B_{it}
  - Core Logic ZIP code-level house price index to get H_{it}.
  - Equifax Predictive Services to measure D_{it}

Large Variation in Net Worth



Correlated with Housing Supply Instrument

TABLE II

Housing Supply Elasticity as a Source of Variation

		Housing supply elasticity	Constant	N	R^2
(1)	Housing net worth shock, 2006–9	0.046**	−0.174**	540	0.190
		(0.011)	(0.037)		
(2)	Change in home value, \$000, 2006–9	27.795**	−95.740**	540	0.284
		(7.874)	(23.210)		
(3)	Change in wage growth (2002–6) – (1998–2002)	−0.002	−0.010	540	0.002
		(0.004)	(0.008)		
(4)	Employment share in construction, 2006	0.002	0.122**	540	0.003
		(0.003)	(0.008)		
(5)	Construction employment growth, 2002–6	0.005	0.940**	540	0.000
		(0.015)	(0.042)		
(6)	Population growth, 2002–6	0.012*	0.018	538	0.026
		(0.005)	(0.012)		
(7)	Income per household, 2006	−5.378**	69.392**	540	0.080
		(0.985)	(2.191)		
(8)	Net worth per household, 2006	−88.389**	674.620**	540	0.083
		(20.689)	(47.965)		

Net Worth Decline Predicts Spending Decline

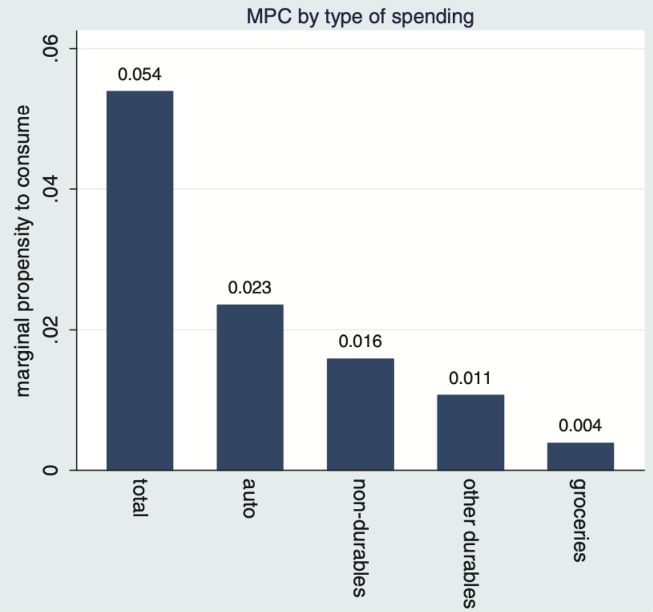
Net Worth Decline Predicts Spending Decline

TABLE III

Net Worth Shock and Consumption Growth, 2006–9

	(1)	(2)	(3)	(4) IV
Housing net worth shock, 2006–9	0.634**	0.613**	0.590**	0.774**
	(0.125)	(0.122)	(0.130)	(0.239)
Financial net worth shock, 2006–9		−0.595		
		(1.032)		
Construction employment share, 2006			−0.448**	−0.287
			(0.150)	(0.216)
Tradable employment share, 2006			0.051	0.011
			(0.067)	(0.092)
Other employment share, 2006			−0.025	−0.045
			(0.038)	(0.050)
Nontradable employment share, 2006			0.193	0.095
			(0.157)	(0.167)
Ln(income per household, 2006)			−0.002	0.024
			(0.033)	(0.047)
Ln(net worth per household, 2006)			−0.028	−0.035
			(0.018)	(0.023)
Constant	−0.034*	−0.092	0.167*	0.147
	(0.015)	(0.099)	(0.077)	(0.092)
N	944	944	944	540
R^2	0.298	0.301	0.355	0.319

MPC



MPC by type of spending
marginal propensity to consume
0
.02
.04
.06
0.054
0.023
0.016
0.011
0.004
total
auto
non-durables
other durables
groceries

What could go wrong?

- What problems do the instrument(s) solve?

- What problems remain?

- What would you like to see?

Heterogeneity in MPC

- Does MPC differ by household wealth, income, and / or leverage?

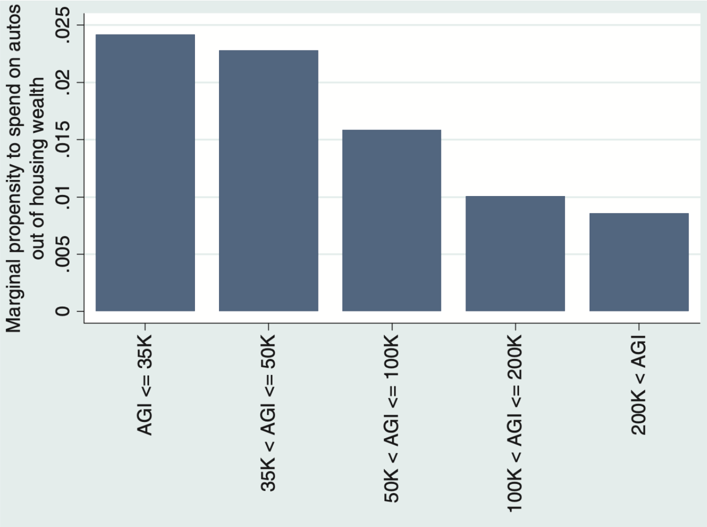
- Specification:

$$\begin{aligned} \Delta C_{i,06-09} = \alpha_t + \beta_1 \Delta p^H_{i,06-09} H_{i,2006} + \beta_2 Z_{i,t-1} \\ + \beta_3 \Delta p^H_{i,06-09} H_{i,2006} Z_{t-1} + \gamma X_{it} + \varepsilon_{it} \end{aligned}$$

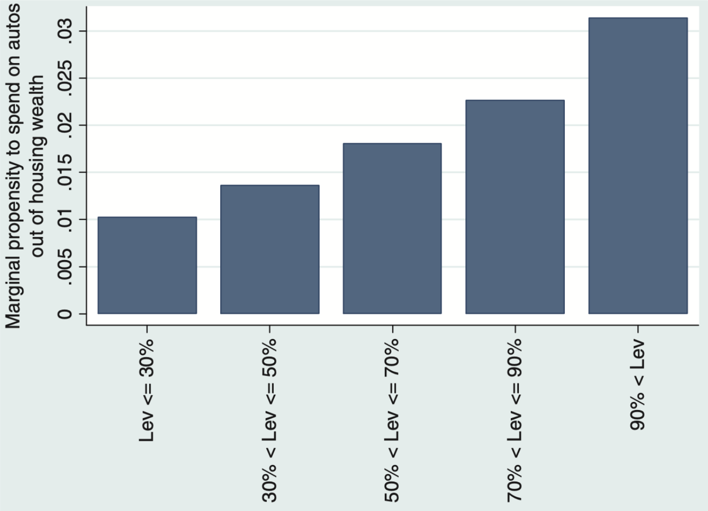
where $Z_{i,t-1} = NW_{i,2006}$, $Z_{i,t-1} = INC_{i,2006}$ or $Z_{i,t-1} = LTV_{2006}$

- Identification assumption?

Heterogeneity by Income



HETEROGENEITY BY LEVERAGE



Mechanism

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: Δ Home equity limit, \$000, 2006–9			*Dependent variable: Δ Credit card limit, \$000, 2006–9*		
Δ Home value, \$000, 2006–9	0.023**	−0.010*	0.040**	0.010**	0.009*	0.015**
	(0.002)	(0.004)	(0.006)	(0.001)	(0.004)	(0.003)
Housing leverage ratio, 2006		−1.234**			0.850*	
		(0.429)			(0.390)	
(Δ Home value)*(Housing leverage ratio, 2006)		0.058**			0.002	
		(0.007)			(0.007)	
Income per household, \$ millions, 2006			17.295			−3.516
			(11.630)			(2.224)
(Δ Home value)*(Income per household, 2006)			−0.187*			−0.070*
			(0.093)			(0.030)
Constant	0.216	0.972**	−0.603	−1.080**	−1.606**	−0.856**
	(0.114)	(0.273)	(0.610)	(0.094)	(0.224)	(0.134)
N	6,273	6,236	6,273	6,262	6,228	6,262
R^2	0.051	0.098	0.090	0.021	0.023	0.023

CONVINCING?