Multinational Firms and International Business Cycle Transmission

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December 12, 2014

Question

Do multinational firms contribute to international comovement?

- International business cycle comovement: significant and not fully-understood
  - Potentially large role of multinationals
    - Produce about 0.25 of world output
    - Can transfer technology across countries
    - Vertical production linkages
  - Hard to quantify
- This paper: New data and model to shed light on this question

I- New data and facts on comovement within multinationals

Data:

- Firm level data from ORBIS, cross- and within-border ownership
- Parents and foreign affiliates observed in the same dataset
- 8 Million firms, 34 countries, 2004-2012

Findings:

1. Firm-level: strong correlation between parents and affiliates growth
   - Elasticity of affiliate to parent growth $\simeq 20\%$

2. Source-destination level: decompose growth rates into source and destination effects
   - Source effects explain 10% of variation in the data (to 20% for destination effects)

II- Quantitative model to evaluate aggregate implications

1. Embed observed comovements into quantitative MP framework
   - Multinationals transmit technology shocks across countries
   - Shocks originated in the source country are important for affiliates' productivity $\simeq 20-40\%$

2. Measure contribution of multinationals to aggregate comovements
   - Transmission of shocks:
     - Aggregate: about 10%
     - Largest source countries: 1-2%
     - Other source countries: almost nil
   - Bilateral business cycle correlation due to multinationals:
     - Only 0.01 if shocks are uncorrelated
     - Slope wrt multinational shares $\simeq 1/4$ that in the data
   - Counterfactual std. in growth rates:
     - Without multinationals: 10% larger
     - Complete integration: 35% lower

Related Literature

- Multinationals in the international business cycle [Burstein et al. (2008); Contessi (2010); Zlate (2012); Kose and Yi (2001); Arkolakis and Ramanarayanan (2009); Johnson (2013)]
  - Contribution: Multicountry-framework, calibrated to microdata on parent-affiliate comovement

- Empirics on multinationals and comovement [Budd et al., 2005; Desai and Foley, 2006; Desai et al., 2009; Buch and Lipponer (2005); Kleinert et al. (2012)]
  - Contribution: firm-level data from multiple countries, focus on output comovement

- Multinationals and technology transfers [McGrattan and Prescott (2009, 2010); Burstein and Monge-Naranjo (2009); Keller and Yeaple (2013); Ramondo and Rodríguez-Clare (2013); Ramondo (2014); Alviarez (2013); Fons Rosen et al. (2013) etc.]
  - Contribution: Estimate transmission at bussiness cycle frequency

Data

- ORBIS (Bureau van Dijk)
- Data from business registries and annual reports
- Both publicly listed and private firms
- Manufacturing and non-manufacturing
- 2004-2012
- Cross-firm ownership data
  - Multinationals >50% ownership

Data summary

- Sample: 34 countries with good coverage sample
  - Europe (Euro Area and perifery) + AUS, JPN, KOR, MEX, SGP
  - Average country: 180K firms
- Foreign multinationals account for a large share of revenue figure
  - 1/4 in our median country, >1/2 in some countries
- Large share of revenues concentrated in a few multinationals figure
  - In the median country, 5 largest foreign multinationals account account for 5% of revenues

Affiliate-parent correlations

$$\gamma_{in,t}(f) \quad = \quad \phi\,\gamma_{ii,t}(f) + \bar{a}_{inss',t} + \varepsilon_{in,t}(f)$$

- $\gamma_{in,t}(f)$: revenue growth rate of firm f
  - source i, destination n
- $\gamma_{ii,t}(f)$: growth rate of parent in i
- $\bar{a}_{inss',t}$: source$\times$sector$\times$destination$\times$sector$\times$year FE
- Sample: run on affiliates only

Affiliate-parent correlations

	All		Manufacturing		Services	
ϕ	0.278***	0.228***	0.402***	0.299***	0.233***	0.213***
	(0.00524)	(0.0117)	(0.0137)	(0.0394)	(0.00628)	(0.0131)
Obs.	181978	181978	19756	19756	105774	105774
N. mult.	18881	18881	2470	2470	12419	12419
R^2	0.047	0.724	0.102	0.789	0.032	0.674
FE	No	Yes	No	Yes	No	Yes

SE clustered at the parent level

- Strong positive correlation between affiliates and parents
- Larger effects in manufacturing
- Robustness: FE, aggregation, alternative samples, growth in VA More

Bilateral comovements

$$\gamma_{in,t} = \quad s_{i,t} + d_{n,t} + a_{in,t}$$

- $\gamma_{in,t}$: growth rate of combined sales of firms from i operating in n
- $s_{i,t}$: source effect, common to all sales of firms from i worldwide
- $d_{n,t}$: destination effect, common to all sales in n

Bilateral comovements

	Source			Destination		
	Part. R^2	F-stat.	p-val.	Part. R^2	F-stat.	p-val.
year-by year (2005-2012)						
Mean	0.10	2.54	0.002	0.19	7.41	0.000
Median	0.09	2.28	0.000	0.19	7.57	0.000
Pooled + *in* FE						
	0.10	6.82	0.000	0.17	8.40	0.000

Model

- Multi-country structure
  - Homogeneous final good, produced with multiple intermediate goods
- Multinationals and domestic firms produce intermediate goods
  - Productivity of multinationals affiliates responds to shocks in source and destination
  - Aggregate productivity driven by productivity of all firms within the country
- Focus on output and productivity
  - Implications independent of international asset markets and demand shocks

Technologies and preferences

- Output of firm f:

$$Q_{in,t}(f) = \quad Z_{in,t}(f) L_{in,t}(f) = \quad Z_{i,t}^{\phi}(f) Z_{n,t}^{1-\phi}(f) L_{in,t}(f)$$

- Freely traded final good ($P_t^W = P_{n,t} = 1$)

$$Q_{n,t} \quad = \quad \left[\sum_i \sum_{f \in \Omega_i} A_{in,t}^{\frac{1}{\rho}} Q_{in,t}(f)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}$$

- Labor supply (GHH preferences)

$$L_{n,t} \quad = \quad W_{n,t}^{\psi-1}$$

Equilibrium

- Real wage

$$W_{n,t} = \frac{\rho - 1}{\rho} \left[\sum_i \sum_{f \in \Omega_i} A_{in,t} Z_{in,t}(f)^{\rho - 1} \right]^{\frac{1}{\rho - 1}}$$

- Aggregate revenues:

$$\sum_i P_{in,t} Q_{in,t} = \quad Q_{n,t} = \quad \frac{\rho}{\rho - 1} W_{n,t} L_{n,t}$$

- Aggregate output:

$$Q_{n,t} = \bar{\rho} \left[\sum_i \sum_{f \in \Omega_i} A_{in,t} Z_{in,t}(f)^{\rho - 1} \right]^{\frac{\psi}{\rho - 1}}$$

Aggregate growth rate

- Revenue growth:

$$\gamma_{n,t} = \psi \sum_i \sum_{f \in \Omega_i} \omega_{in,t}(f) \left[\frac{a_{in,t}}{\rho - 1} + \phi z_{i,t}(f) + (1-\phi) z_{n,t}(f) \right]$$

where $\omega_{in,t}(f)$ is firm f's revenue share.

- Special case: $z_{n,t}(f) = z_{n,t}$

$$\gamma_{n,t} = \psi \sum_i \omega_{in,t} \left[\frac{a_{in,t}}{\rho - 1} + \phi z_{i,t} \right] + \psi (1-\phi) z_{n,t}$$

where, $z_{i,t} = \sum_{f \in \Omega_i} \frac{\omega_{in,t}(f)}{\omega_{in,t}} z_{i,t}(f)$

Affiliate-parent comovements

- Firm f revenue growth in destinations n and i:

$$\gamma_{in,t}(f) = \bar{a}_{in,t} + (\rho - 1)\,\phi\, z_{i,t}(f) + (\rho - 1)(1 - \phi)\, z_{n,t}(f)$$

$$\gamma_{ii,t}(f) = \bar{a}_{ii,t} + (\rho - 1)\, z_{i,t}(f)$$

- Substituting:

$$\gamma_{in,t}(f) = \tilde{a}_{in,t} + \phi\, \gamma_{ii,t}(f) + \varepsilon_{in,t}(f)$$

where $\bar{a}_{in,t} \equiv \tilde{a}_{in,t} - \phi\, \tilde{a}_{ii,t}$ and $\varepsilon_{in,t}(f) \equiv (\rho - 1)(1 - \phi)\, z_{n,t}(f)$

- Conclusion: $\phi \approx 0.2$

Calibrating ϕ with bilateral data

- Under $z_{n,t}(f) = z_{n,t}$ bilateral sales growth is:

$$\gamma_{in,t} \quad = \quad s_{i,t} + d_{n,t} + a_{in,t}$$

With

- $s_{i,t} = \phi(\rho - 1) z_{i,t}$
- $d_{n,t} = \frac{\psi + 1 - \rho}{\rho - 1} \sum_i \omega_{in,t} [a_{in,t} + \phi(\rho - 1) z_{i,t}] + \psi(1 - \phi) z_{n,t}$

- Low ϕ implies small source effects, and large destination effects
  - Choose ϕ to match relative variance of source and destination effects details
- Conclusion: $\phi \approx 0.4$ full table

Transmission of shocks across countries

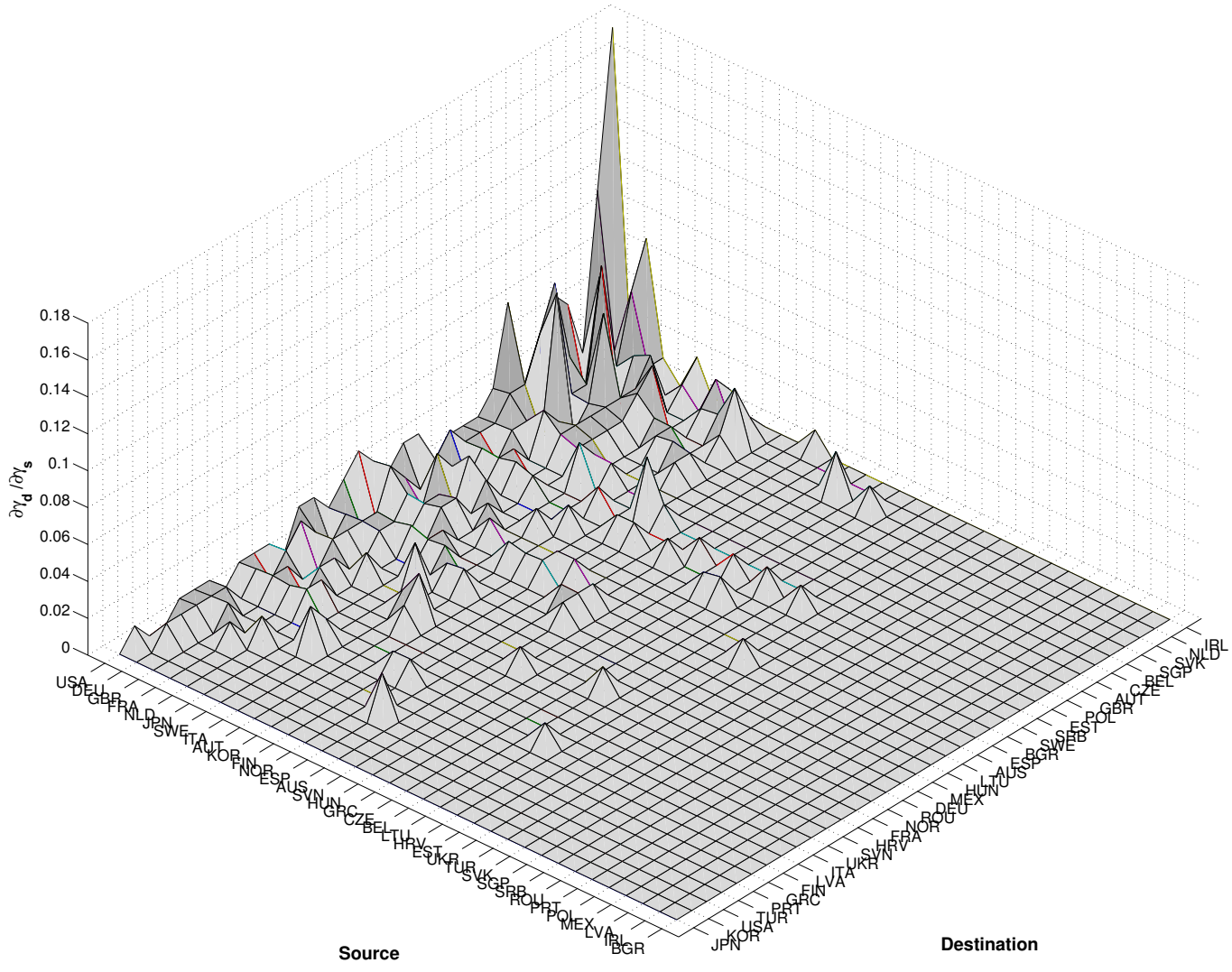
- Q: How does the UK respond to a shock that increases US output by 1%?
- Elasticity of growth in n to a shock in i

$$\frac{\partial \gamma_n}{\partial z_i} = \psi \left[\omega_{in} \phi + (1 - \phi) \mathbb{I}_{i=n} \right]$$

- Relative to i:

$$\frac{\partial \gamma_n}{\partial z_i} \Big/ \frac{\partial \gamma_i}{\partial z_i} = \frac{\omega_{in} \phi}{\omega_{ii} \phi + (1 - \phi)} \quad n \neq i.$$

Response to shock that increases source country GDP by 1%



Response to shock that increases source country GDP by 1%

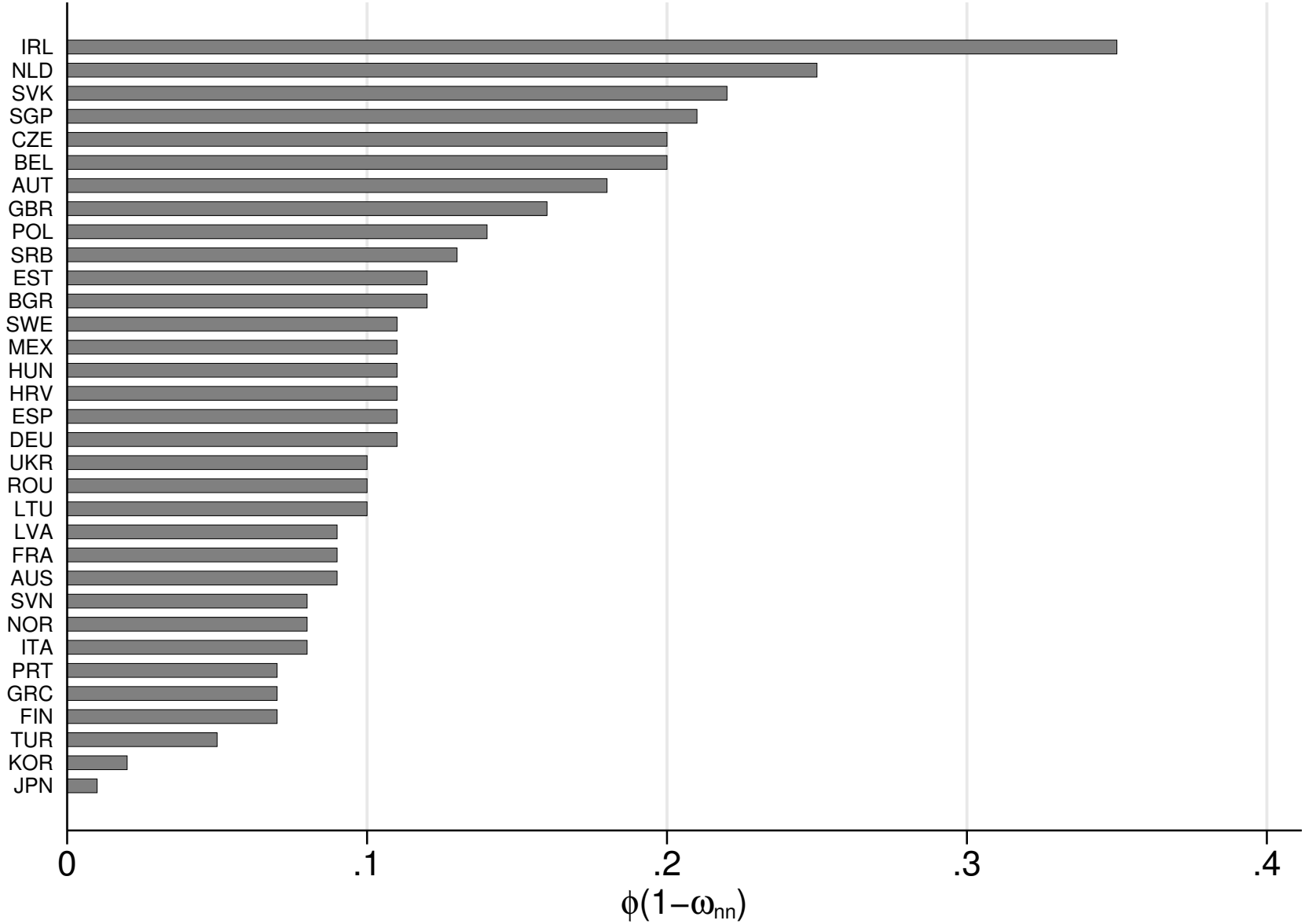
	Destination				
Source	All Countries	High-Income Europe	Emerging Europe	High-Income ROW	Emerging ROW
US	0.022	0.036	0.009	0.018	0.019
Germany	0.013	0.013	0.019	0.003	0.005
UK	0.013	0.019	0.006	0.017	0.004
France	0.009	0.013	0.009	0.002	0.003
World	0.121	0.140	0.073	0.126	0.078

Combined impact of all multinational activity

- Q: what would be the combined impact of a shock to all multinationals operating in the country?
- Change in productivity will be:

$$\phi(1 - \omega_{nn})$$

Combined impact of all multinational activity



Growth correlations

$\rho_{n,n'}$	Mean	St.Dev.	Min	Max	$d\rho_{n,n'}/d\omega$
Data	0.18	0.35	-0.68	0.87	2.27
Model	0.01	0.02	0.00	0.25	0.54

- max: US-Ireland (0.25), US-UK (0.12), US-Netherlands (0.12)
- 95% of country-pairs under 0.03

Counterfactual growth rates

Aggregate growth rate:

$$\gamma_{n,t} \quad = \psi \sum_i \omega_{in,t} \left[\frac{a_{in,t}}{\rho - 1} + \phi z_{i,t} \right] + \psi (1 - \phi) z_{n,t}$$

Two counterfactuals, changing multinational shares:

1. "No multinationals:" $\omega_{in,t}^{NM} = 1$ if $i = n$, $\omega_{in,t}^{NM} = 0$ if $i \neq n$
2. "Full Integration:" $\omega_{in,t}^{FI} = \bar{\omega}_{i,t}^{FI} = \frac{1}{N} \sum_n^N \omega_{in,t}$

- Focus on σ_{γ_n}

Counterfactual dispersion in growth rates

Cross-sectional standard deviation in $\gamma_{n,t}$

	Baseline	No Multinationals	Full Integration	C1/Model	C2/Model
2005-2012					
Mean	0.058	0.064	0.039	1.094	0.673
Median	0.060	0.066	0.039	1.087	0.654

Taking stock

1. Documented strong comovements between parent's and their foreign affiliates $\simeq 20-40\%$

2. Limited contribution of multinationals for observed comovements
   - Small bilateral MP shares
   - Important for some country pairs (i.e. involving the US)

3. Can become an important channel as MP shares grow (i.e. counterfactual full integration)

Firm level

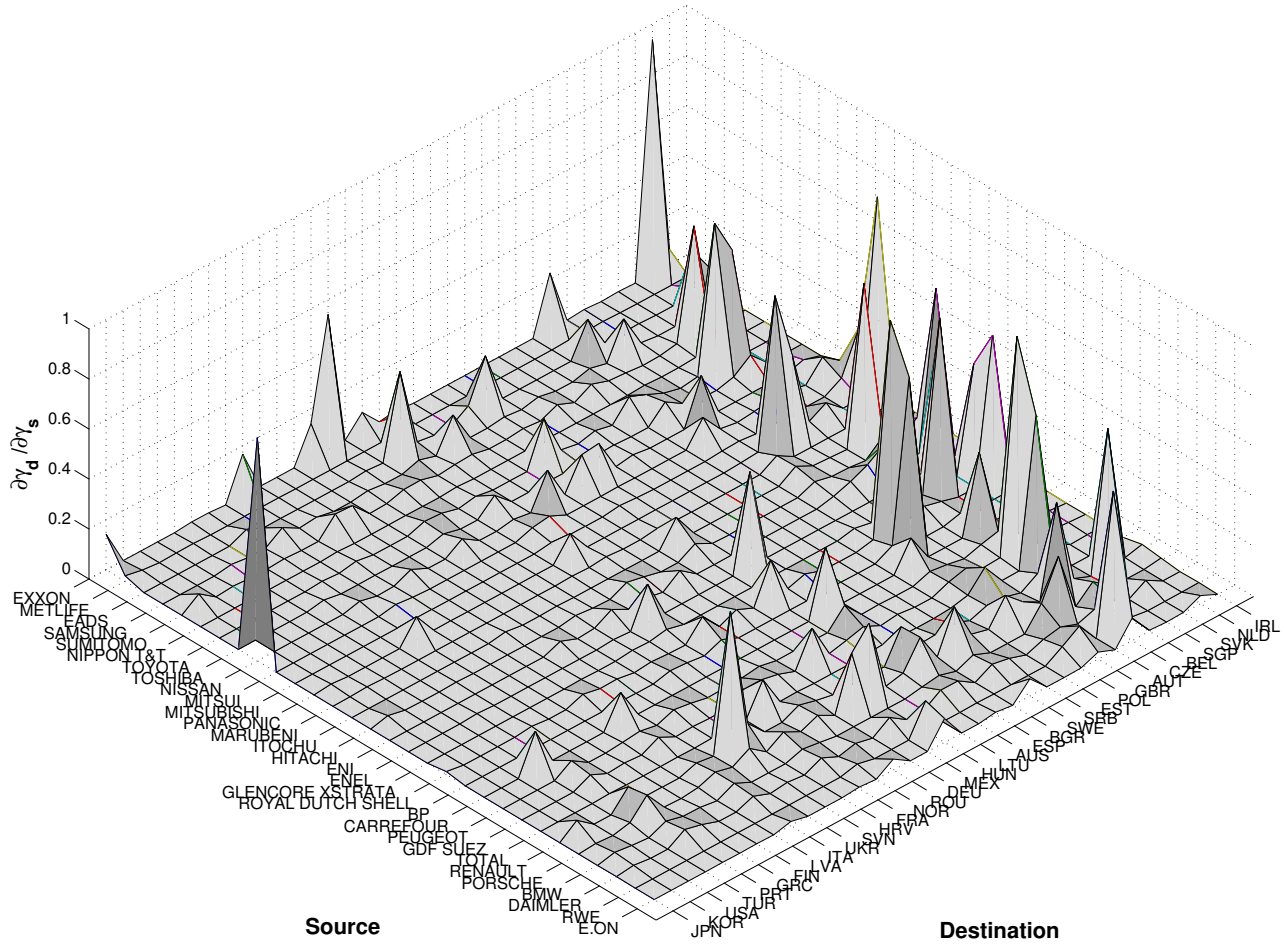
- Q: How does Ireland respond to a firm-level shock to that increases US output by 1%?
- Elasticity of growth in n to a shock in i

$$\frac{\partial \gamma_n}{\partial z_i(f)} = \psi \omega_{in}(f)\left[\phi + (1-\phi)\mathbb{I}_{i=n}\right]$$

- Relative to i:

$$\frac{\partial \gamma_n}{\partial z_i(f)} \Big/ \frac{\partial \gamma_i}{\partial z_i(f)} = \frac{\omega_{in}(f)\phi}{\omega_{ii}(f)\left[\phi + (1-\phi)\right]} \quad n \neq i.$$

Response to firm-shock that increases source country GDP by 1%



Preferences

- Utility:

$$u(C_{n,t}, L_{n,t}) = \sum_t \delta^t \nu \left(C_{n,t} - \frac{\psi_0}{\bar{\psi}} L_{n,t}^{\bar{\psi}} \right)$$

- Labor supply:

$$L_{n,t} = \left[\frac{W_{n,t}}{P_t^W} \right]^{\frac{1}{\bar{\psi}-1}}$$

- where $W_{n,t}$ is the wage.

Affiliate-parent correlations

	(1) Parent-affiliate in the same service sub-sector	(2) Services, excluding wholesale trade	(3) Services, excluding retail trade	(4) Excluding NDL and IRE
ϕ	0.191***	0.179***	0.225***	0.228***
	(0.0201)	(0.0205)	(0.0123)	(0.0118)
Obs.	73856	111795	169790	170135
N. mult.	7095	12824	17270	18173
R^2	0.746	0.829	0.727	0.717

Affiliate-parent correlations

	(5) Excluding crisis years (2008-2012)	(6) Small affiliates only	(7) Value added	(8) Placebo
ϕ	0.179***	0.276***	0.140***	-0.0134
	(0.0209)	(0.0264)	(0.0163)	(0.00891)
Obs.	55796	79626	68627	181978
N. mult.	10953	9013	7594	18881
R^2	0.720	0.797	0.733	0.711

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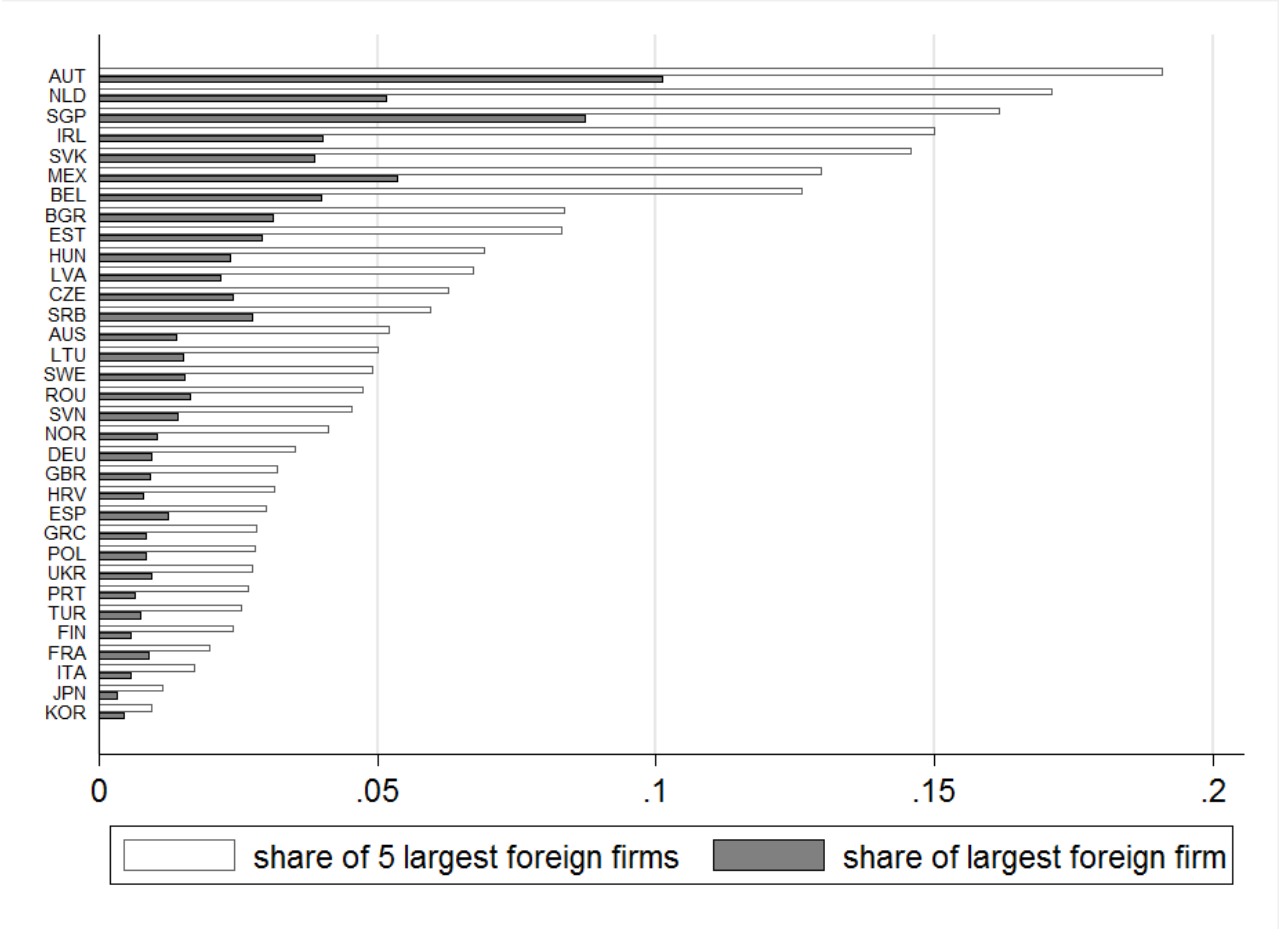
Largest firms



- Large share of revenues concentrated in a few multinationals

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Estimating ϕ with bilateral data

- ϕ enters relationship between source and destination shocks

$$d_{n,t} = \left[\frac{\psi}{\rho-1}-1\right]\sum_i \omega_{in,t}\left[a_{in,t}+s_{i,t}\right]+\frac{\psi}{\rho-1}\frac{1-\phi}{\phi}s_{n,t}$$

- We can write:

$$\phi = \frac{\sigma_{s,t}}{\sigma_{s,t}+\sigma_{\Phi t}}$$

- $\sigma_{\Phi t}$ combines destination and GE effects. $\sigma_{\Phi t}=\sigma_{d,t}$ in special case of $\psi=\rho-1$
- Intuition: ϕ is related to the variance of the source and destination effects. Low ϕ means small source effects, and large destination effects

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Estimating ϕ with bilateral data

Year	$\frac{\psi}{\rho-1}=1$	$\frac{\psi}{\rho-1}=2$	$\frac{\psi}{\rho-1}=\frac{2}{3}$
2005	0.470	0.552	0.375
2006	0.449	0.531	0.373
2007	0.390	0.472	0.319
2008	0.373	0.482	0.286
2009	0.395	0.532	0.294
2010	0.400	0.518	0.308
2011	0.379	0.491	0.289
2012	0.357	0.444	0.289
Mean	0.401	0.503	0.317
Median	0.392	0.505	0.301

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Country sample

Country	Number of Firms	Number of Multinationals	Correlation between ORBIS growth and GDP growth	Ratio of ORBIS revenue to total revenue
Austria	15,300	2,202	0.83	0.63
Australia	766	208	0.60	
Belgium	18,362	3,606	0.91	0.70
Bulgaria	120,520	1,444	0.92	0.71
Czech Republic	85,422	7,007	0.86	0.81
Germany	224,395	10,010	0.89	0.69
Estonia	47,132	1,537	0.96	0.71
Spain	519,129	9,034	0.82	1.07
Finland	106,222	2,301	0.93	0.93
France	751,859	14,581	0.96	0.81
United Kingdom	194,711	22,459	0.59	0.69
Greece	24,639	1,262	0.74	0.54
Croatia	60,527	2,293	0.96	0.75
Hungary	174,795	822	0.99	0.76
Ireland	14,131	2,579	0.56	1.03
Italy	556,874	12,640	0.96	0.79
Japan	217,024	282	0.81	0.84
Korea, Rep.	95,112	598	0.68	0.78
Lithuania	7,473	631	0.96	0.53
Latvia	43,887	1,093	0.91	0.59
Mexico	6,102	485	0.49	0.93
Netherlands	10,061	2,163	0.81	0.40
Norway	148,599	3,708	0.80	0.81
Poland	56,414	6,780	0.82	0.68
Portugal	212,761	2,047	0.89	0.93
Romania	319,347	4,700	0.86	0.55
Serbia	48,083	2,428	0.62	0.74
Sweden	222,882	3,942	0.79	0.93
Singapore	1,249	351	0.64	
Slovenia	29,868	559	0.90	0.77
Slovak Rep.	30,377	3,004	0.75	0.88
Turkey	7,975	286	0.77	
Ukraine	218,489	2,489	0.79	0.80
United States	97,378	605	0.84	0.09
Mean	179,273	5,270	0.83	0.78
Median	100,667	2,297	0.87	0.76

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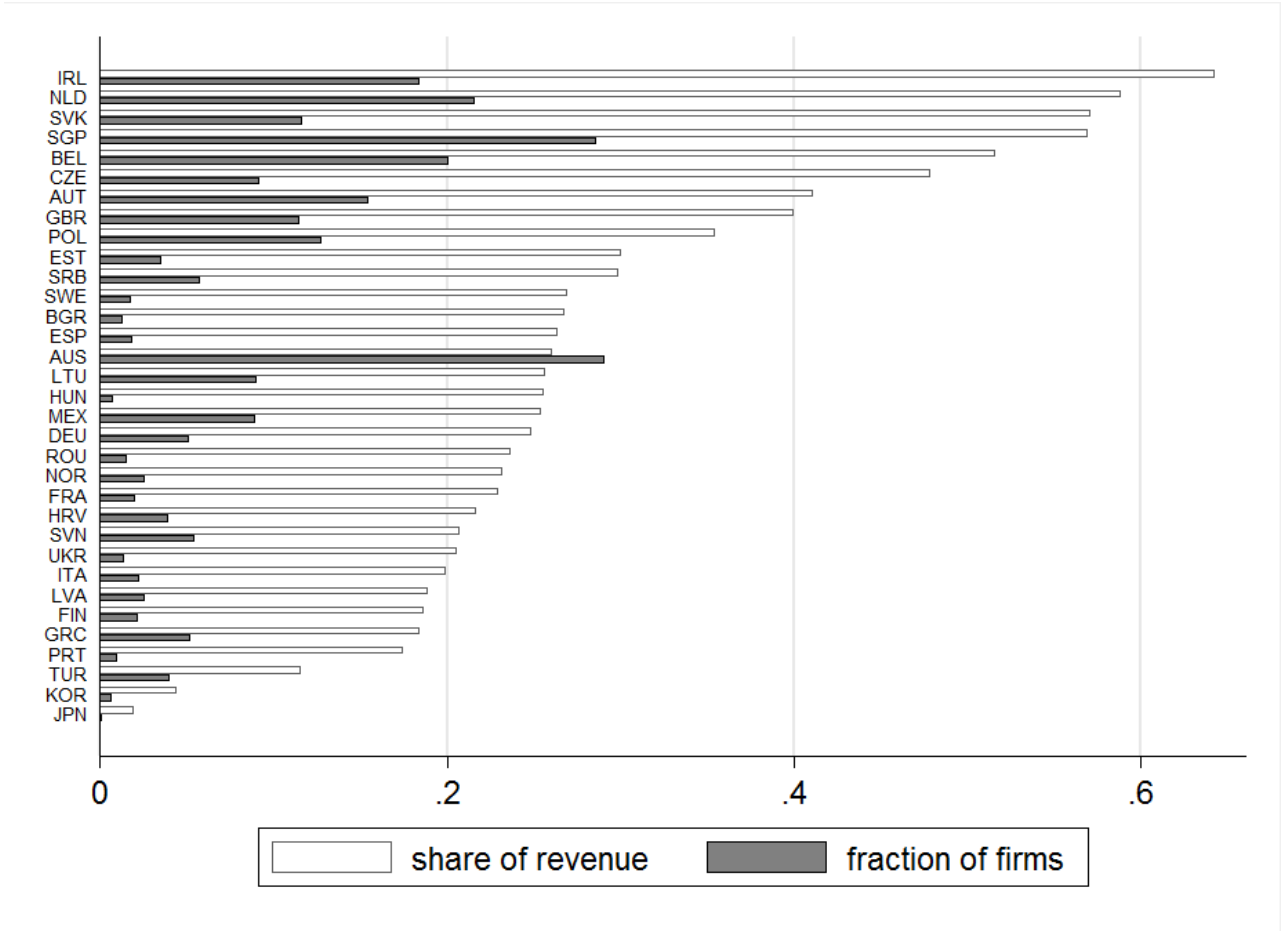
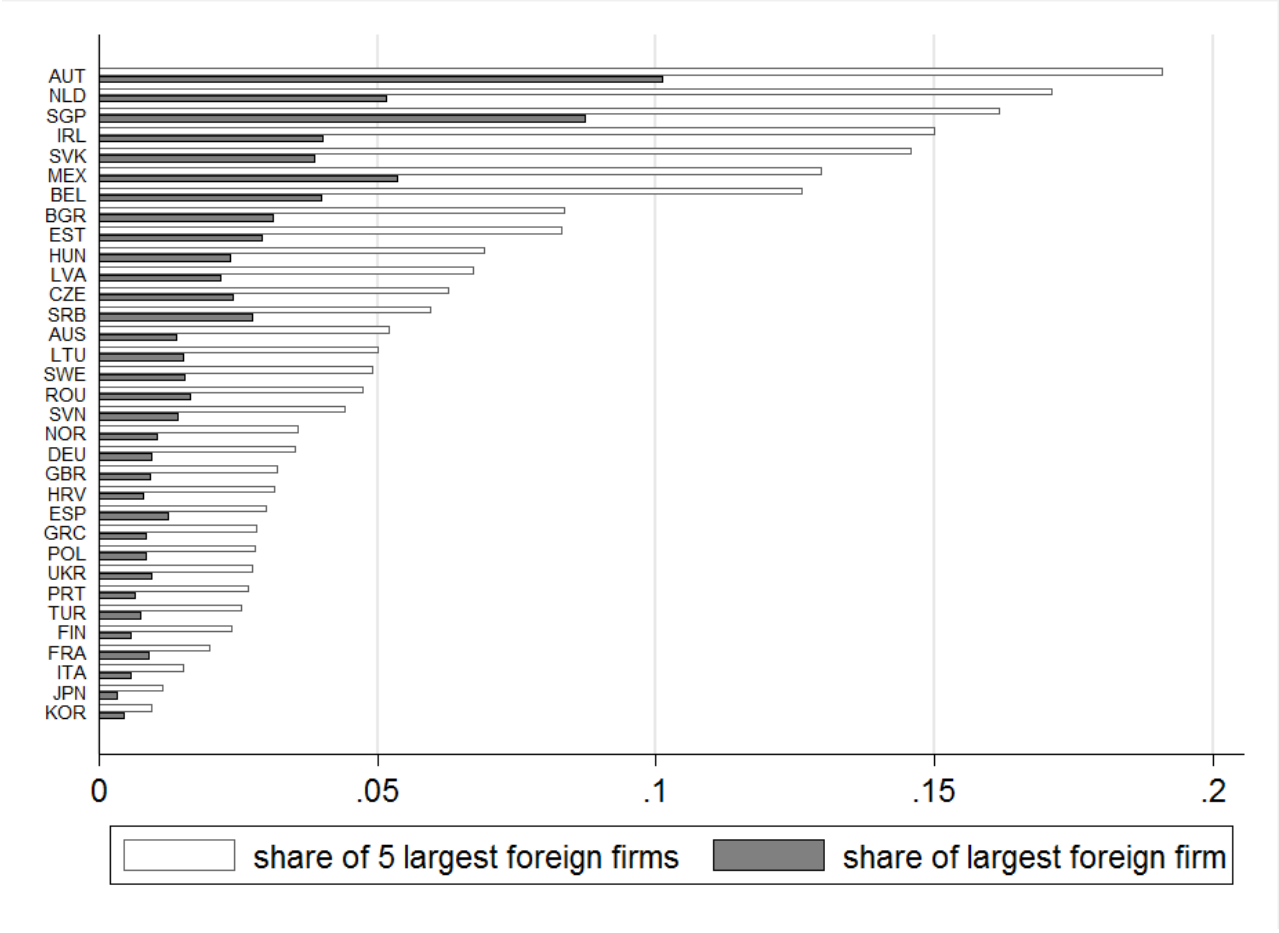
The importance of multinationals



- Account for a large share of revenue (1/4 at the median)
- Larger than domestic firms back

Largest firms



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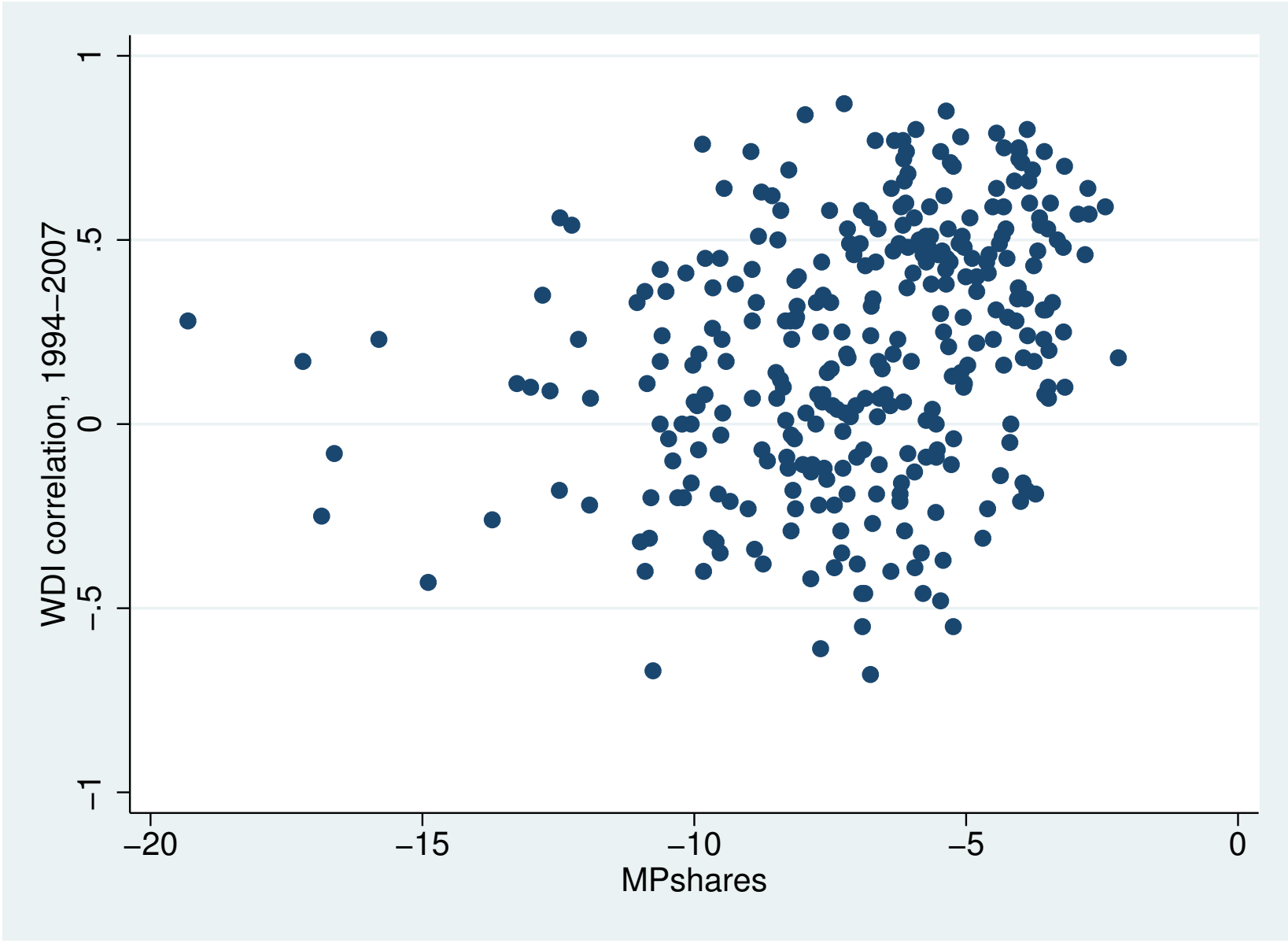
Growth correlations



Counterfactual variances: correlation in parent-affiliate growth