Mind the gap: bridging academia with policy-making in the estimation of protectionism costs

Iván Kataryniuk Enrique Moral-Benito

Banco de España

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I: The why, what, and how of the paper

Why this paper?

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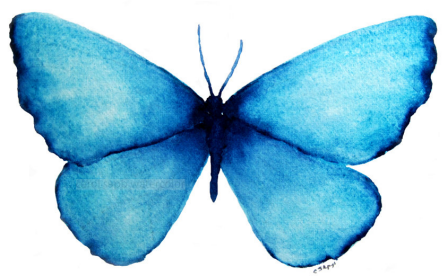


What we do

- We identify the industry-country pairs that are "too interconnected to fail" or "systemically important".
- We quantify the effects of trade shocks by bringing together policy and frontier research — Baqaee and Fahri (2019b).

Policy tool	Institution	Intermediates	Non-linearities	Trade shock
NIGEM	BdE, OECD	NO	NO	tariffs+demand
GVC	BdE, ECB, IMF	YES	NO	demand
THIS PROJECT	BdE	YES	YES	tariffs+iceberg

How we do it

- We compute country-industry-specific measures of centrality based on the networks literature.
- We outline a theoretical framework to bring together the literature on networks and the policy-oriented GVC propagation.
- We calibrate and solve the model in Baqaee and Fahri (2019b) to better understand the effects of tariff shocks:
  - As an illustration, we explore the European consequences of US tariffs to China.

II: Worldwide systemic industries

The global production network

- From an I-O table, the structure of the world economy can be represented by:

To			From: Country 1			...	Country C		
			Sector 1	...	Sector S	...	Sector 1	...	Sector S
			1	...	i	...	j	...	N
Country 1	Sector 1	1	a_{11}		a_{1i}		a_{1j}		a_{1N}
	...	...		...		...		...	
	Sector S	i	a_{i1}		a_{ii}		a_{ij}		a_{iN}
...	...	...		...		...		...	
	Sector 1	j	a_{j1}		a_{ji}		a_{jj}		a_{jN}
Country C	...	...		...		...		...	
	Sector S	N	a_{N1}		a_{Ni}		a_{Nj}		a_{NN}

- This is the direct requirement matrix A with entries $a_{ij} = \frac{p_j x_{ij}}{p_i y_i}$.
- a_{ij} captures the importance of industry j as a direct supplier of industry i.

The Leontief matrix

- Industry i requirements from industry j are not restricted to those captured by a_{ij} because industry i also uses inputs from e.g. industry k, which requires inputs from industry j.
- These indirect requirements are captured by the Leontief matrix:

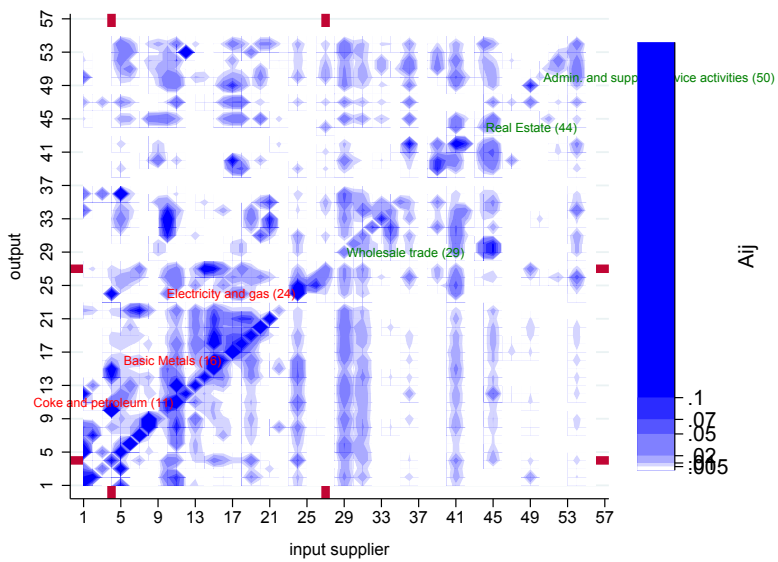
$$H \equiv (I - A)^{-1} = \sum_{k=0}^{\infty} A^k$$

- h_{ij} measures the importance of industry j as a direct and indirect input-supplier to industry i.
- Note also that $h_{ij} = a_{ij} + \sum_{r=1}^{n} a_{ir}a_{rj} + ...$ for $i \neq j$.
- $h_{i \leftarrow j} \Rightarrow j$ **sells to** i **(**i **purchases from** j**)**

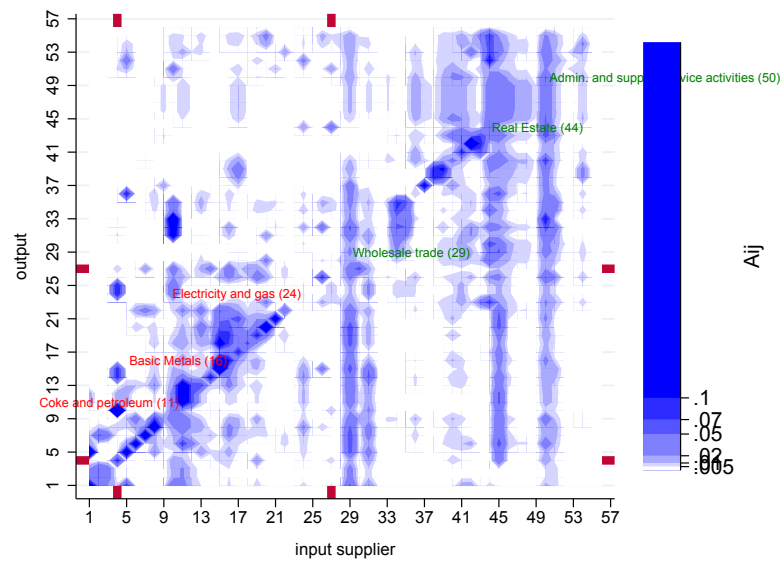
WIOD data

- We use the World Input-Output Database (WIOD) covering I-O tables for 43 countries and 56 industries over the period 2000-2014.

CHINA

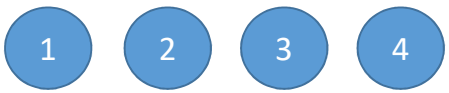


USA

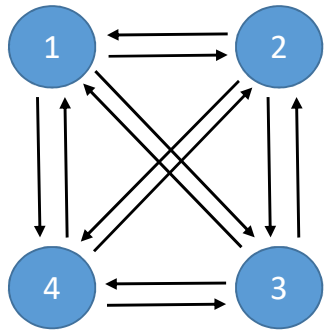


Three production networks on four nodes

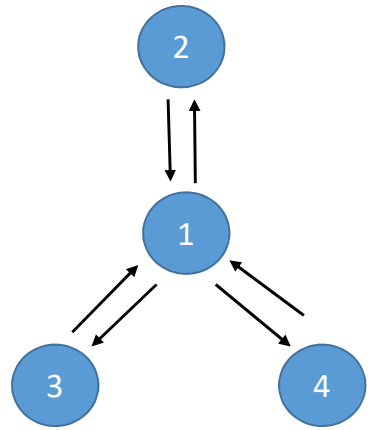
Horizontal economy



Web economy



Star economy



Measuring centrality

- Importance of j as an input-supplying sector (weighted outdegree):

$$c_{out}^{j} = \sum_{i=1}^{N} a_{ij}$$

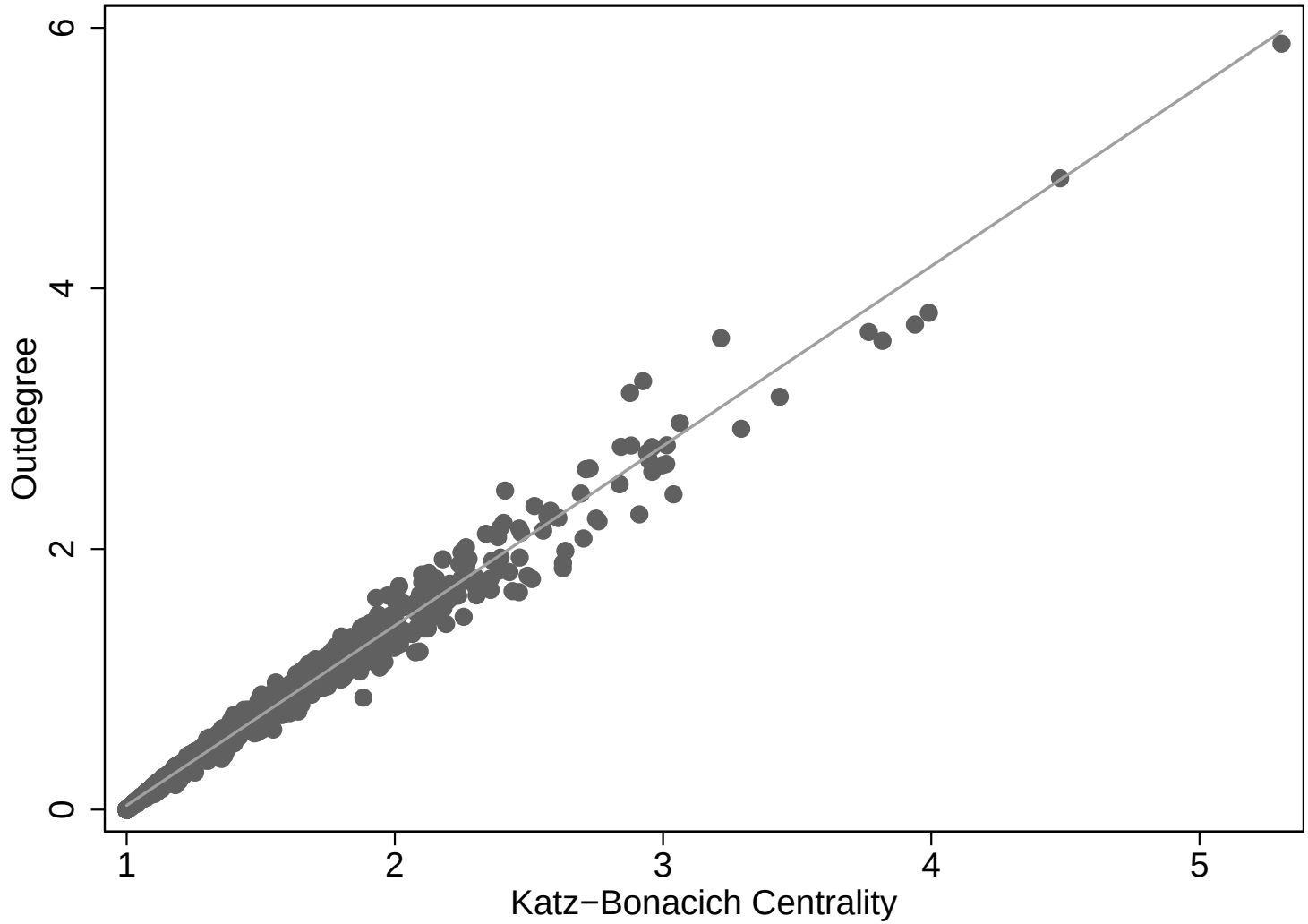
- Importance of j as a direct and indirect input-supplying sector (Katz-Bonacich centrality):

$$\mathbf{c}_{kb} = (I - \lambda A)^{-1}\mathbf{1}$$

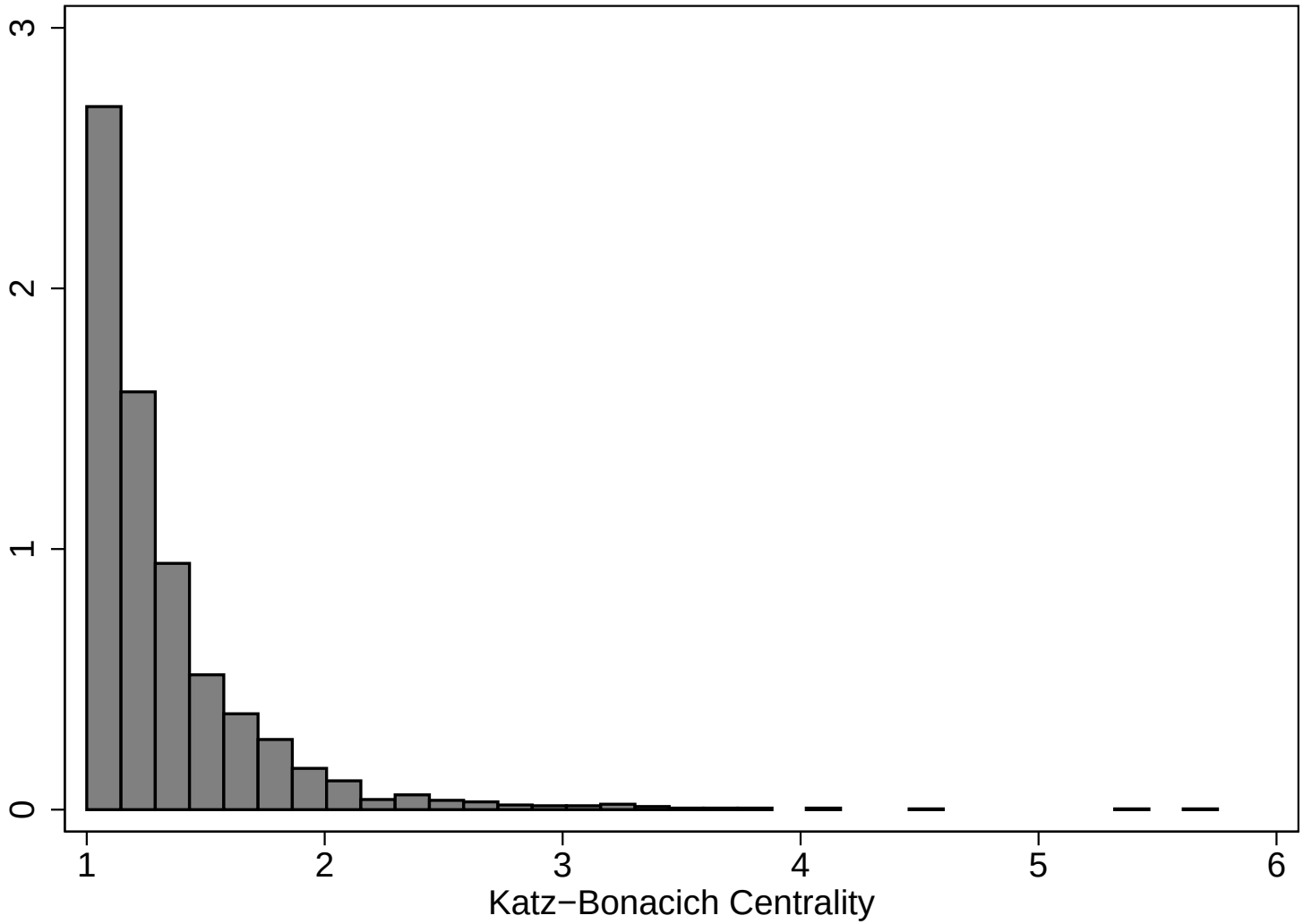
$$c_{kb}^{j} = \sum_{k=1}^{\infty}\sum_{i=1}^{N} \lambda^{k}(A^{k})_{ij}$$

- Intuitively, you replace a_{ij} by $\tilde{h}_{ij}$...
- ... and weight each connection by the distance between nodes λ^{k} with $\lambda = 0.5$, the share of intermediate inputs in production (Carvalho 2014).

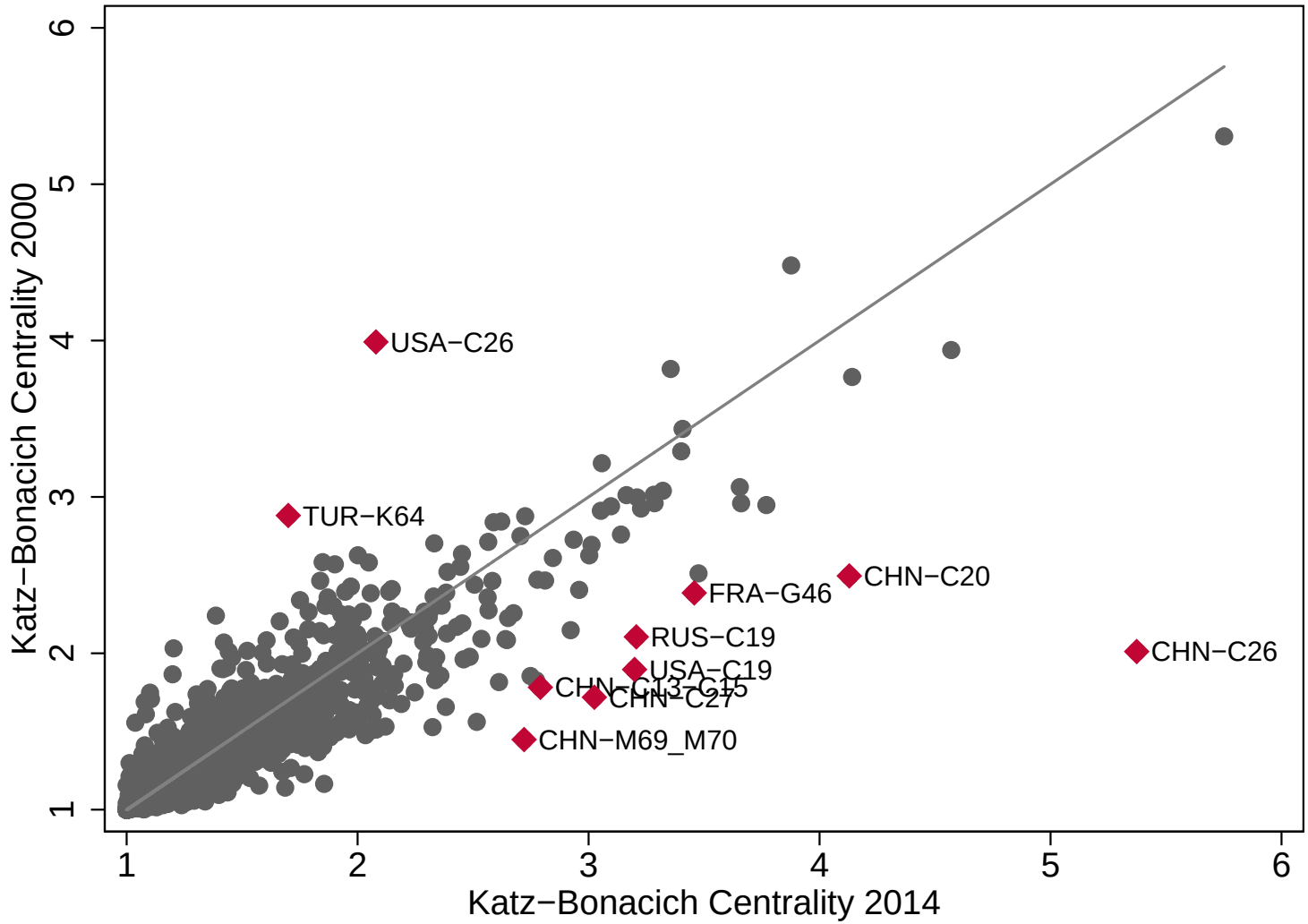
Outdegree and centrality



Distribution of centralities



Evolution over time of centralities



Top 10 industries in 2000

Code	Industry	Country	Centrality
C20	Manufacture of chemicals and chemical products	DEU	5.31
N	Administrative and support service activities	USA	4.48
C26	Manufacture of computer, electronic and optical products	USA	3.99
B	Mining and quarrying	RUS	3.94
G46	Wholesale trade, except of motor vehicles and motorcycles	RUS	3.82
C24	Manufacture of basic metals	DEU	3.77
C20	Manufacture of chemicals and chemical products	USA	3.44
G46	Wholesale trade, except of motor vehicles and motorcycles	DEU	3.29
G46	Wholesale trade, except of motor vehicles and motorcycles	HRV	3.22
C28	Manufacture of machinery and equipment n.e.c.	DEU	3.06

Top 10 industries in 2014

Code	Industry	Country	Centrality
C20	Manufacture of chemicals and chemical products	DEU	5.75
C26	Manufacture of computer, electronic and optical products	CHN	5.37
B	Mining and quarrying	RUS	4.57
C24	Manufacture of basic metals	DEU	4.14
C20	Manufacture of chemicals and chemical products	CHN	4.13
N	Administrative and support service activities	USA	3.88
C24	Manufacture of basic metals	RUS	3.77
B	Mining and quarrying	NOR	3.66
C28	Manufacture of machinery and equipment n.e.c.	DEU	3.65
C24	Manufacture of basic metals	CHN	3.48

III: Setting the stage

A simple model of production networks

- See e.g. Carvalho and Tahbaz-Salehi (2018)
- Perfectly competitive economy consisting of n sectors, each producing a different product under Cobb-Douglas technologies.
- Each sector requires for production both labor and the intermediate inputs produced by the other sectors.
- A larger a_{ij} means that good j is a more important input for the production of good i.

$$y_i = e^{z_i} l_i^{\alpha_i^l} \prod_{j=1}^{n} x_{ij}^{a_{ij}}$$

- A representative household who supplies labor and has some preferences over the n products.

Equilibrium

- The representative firm in industry i chooses their demand for labor and intermediate goods to maximizes profits ($\pi_i = p_i y_i - w l_i - \sum_{j=1}^{n} p_j x_{ij}$) and take prices $p_1, ..., p_n$ and the wage w as given.
- Households decide labor supply (l) and the consumption bundle ($c_1, ..., c_n$) by maximizing the utility function ($u(c_1, c_2, ..., c_n, l) = \gamma(l) \prod_{i=1}^{n} c_i^{\beta_i}$) subject to the budget constraint $wl - T = \sum_{i=1}^{n} p_i c_i$ for a given collection of prices $p_1, ..., p_n$ and the wage w.
- FOCs from these optimization problems yield a system of n equations (one for each industry) to solve for all relative prices in terms of productivity shocks.
- The market clearing condition implies that the output produced in each industry should be either used as intermediate input by other sectors or consumed by someone:

$$y_i = \sum_{j=1}^{n} x_{ji} + c_i + G_i$$

Downstream and upstream propagation

- We highlight the presence of two different sector-specific shocks.
- Supply shocks given by exogenous changes in productivity z_i that affect relative prices (if industry i becomes more productive, its relative price will change).
- Demand shocks given by exogenous changes in the demand of product i and included in the model through the G_i term in the market clearing condition.
- The impact on sector i of a productivity shock of sector j is given by:

$$d\ln y_i = \underbrace{\sum_{j=1}^{n} h_{ij} dz_j}_{\text{total effect}} = \underbrace{dz_i}_{\text{direct effect}} + \underbrace{\sum_{j=1}^{n} (h_{ij} - \mathbf{1}_{j=i}) \times dz_j}_{\text{downstream propagation}}$$

- The impact on sector i of a demand shock of sector j is given by:

$$d\ln y_i = \underbrace{\sum_{j=1}^{n} h_{ji} dG_j}_{\text{total effect}} = \underbrace{dG_i}_{\text{direct effect}} + \underbrace{\sum_{j=1}^{n} (h_{ji} - \mathbf{1}_{j=i}) \times dG_j}_{\text{upstream propagation}}$$

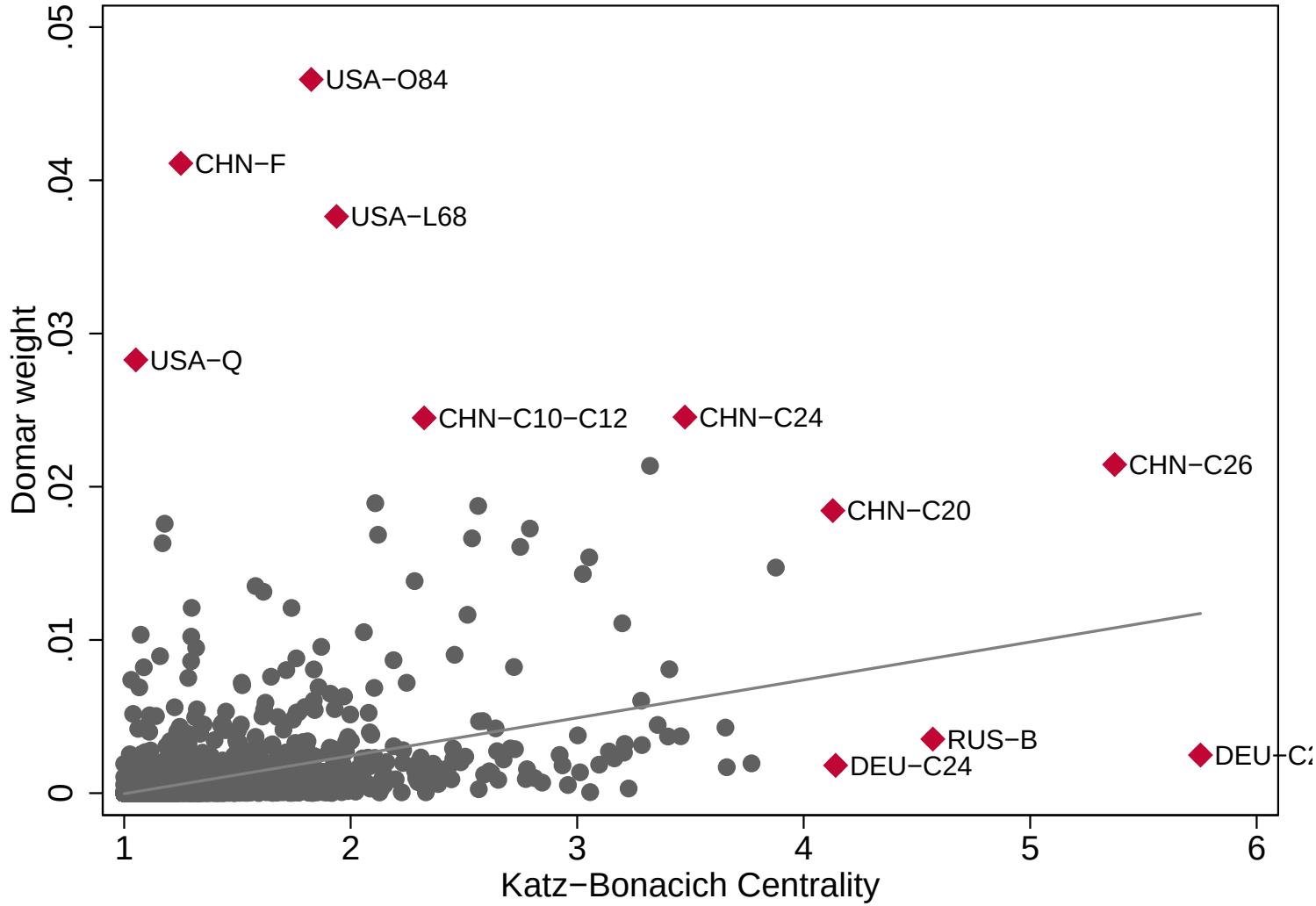
Hulten's theorem

- The aggregate effect of industry-specific shocks is given by:

$$d \ln y = \sum_{j=1}^{n} \lambda_j dz_j$$

- A sector-specific shock has an aggregate impact equal to its Domar weight ($\lambda_j = \frac{p_j y_j}{GDP}$) regardless of the I-O structure of the economy.
- Baqaee and Farhi (2019a) prove that Domar weights change in response to industry-specific shocks when second order approximations are considered in non-Cobb Douglas economies.
- Baqaee and Farhi (2019b) argue that trade policy concerns tariffs, which knowcks out the foundation of efficiency that Hulten's is built on.
- Summers made the point that "... electricity was only 4% of the economy, and so if you lost 80% of electricity, you couldn't possibly have lost more than 3% of the economy [...] we would understand that somehow, even if we didn't exactly understand it in the model, that when there wasn't any electricity, there wasn't really going to be much economy."

Domar weights and Katz-Bonacich centralities



Industry codes

IV: Networks, barriers, and trade

Baqaee and Fahri (2019b)

- In terms of departures from the basic model outlined above:
  - Instead of industries, country-industry pairs and trade imbalances in the budget constraint.
  - Instead of Cobb-Douglas, nested-CES allowing for non-linearities in both consumption and production.
  - Instead of labor, several factors of production: capital, high-, medium-, low-skilled labor.
  - Instead of an efficient economy, it allows for markups/tariffs.
  - Iceberg trade costs isomorphic to foreign productivity shocks.
- PROS: more flexible setting allowing for trade diversion and a rich set of mechanisms.
- CONS: computational burden is not negligible.

The effect of tariffs

- Baqaee and Fahri (2019b) show that the effect of tariffs on output of country C is, up to the second order, given by three terms:

  1. Change in quantity of each good l produced in country C coming from substitutions by all producers j in response to changes in all tariffs, holding factor wages constant.
  2. Change in quantity of each good l produced in country C coming from substitutions by all producers j in response to the endogenous changes in factor wages.
  3. Change in quantity of each good l coming from redistribution across agents with different spending patterns, in response to the endogenous changes in factor wages and prices.

The US - China trade war

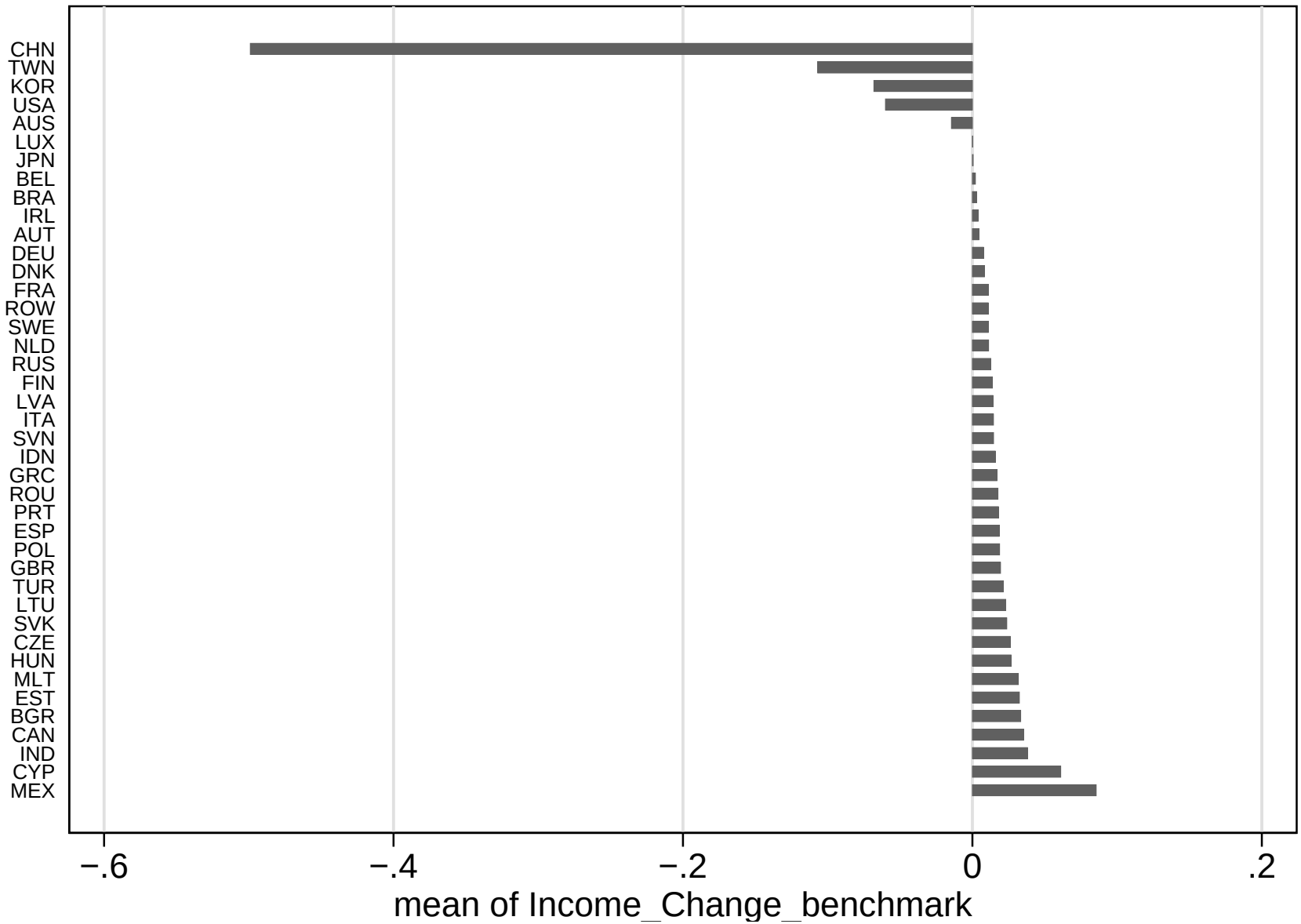
- We consider a increase of 25% in US tariffs to imports from China in all industries.
- The effects triggered by this policy in third countries (e.g. Spain) are difficult to estimate with standard tools.
- Moreover, non-linearities when increasing tariffs are crucial but they absent in traditional GVC exercises where tariff shocks are translated to demand shocks linearly.
- Moreover, intermediates and complementarities matter a lot for properly assessing trade diversion.
- Parameters calibrated as in Baqaee and Fahri (2019b).

US taxes China — world effects

Table: World output losses from US tariffs to imports from China.

Intermediates	NO	NO	YES	**YES**	YES	YES
Non-linearities	NO	YES	NO	**YES**	YES	YES
Tariff change	25%	25%	25%	**25%**	10%	50%
Effect in %	-0.02	-0.04	-0.05	**-0.16**	-0.07	-0.44

US taxes China — winners and losers

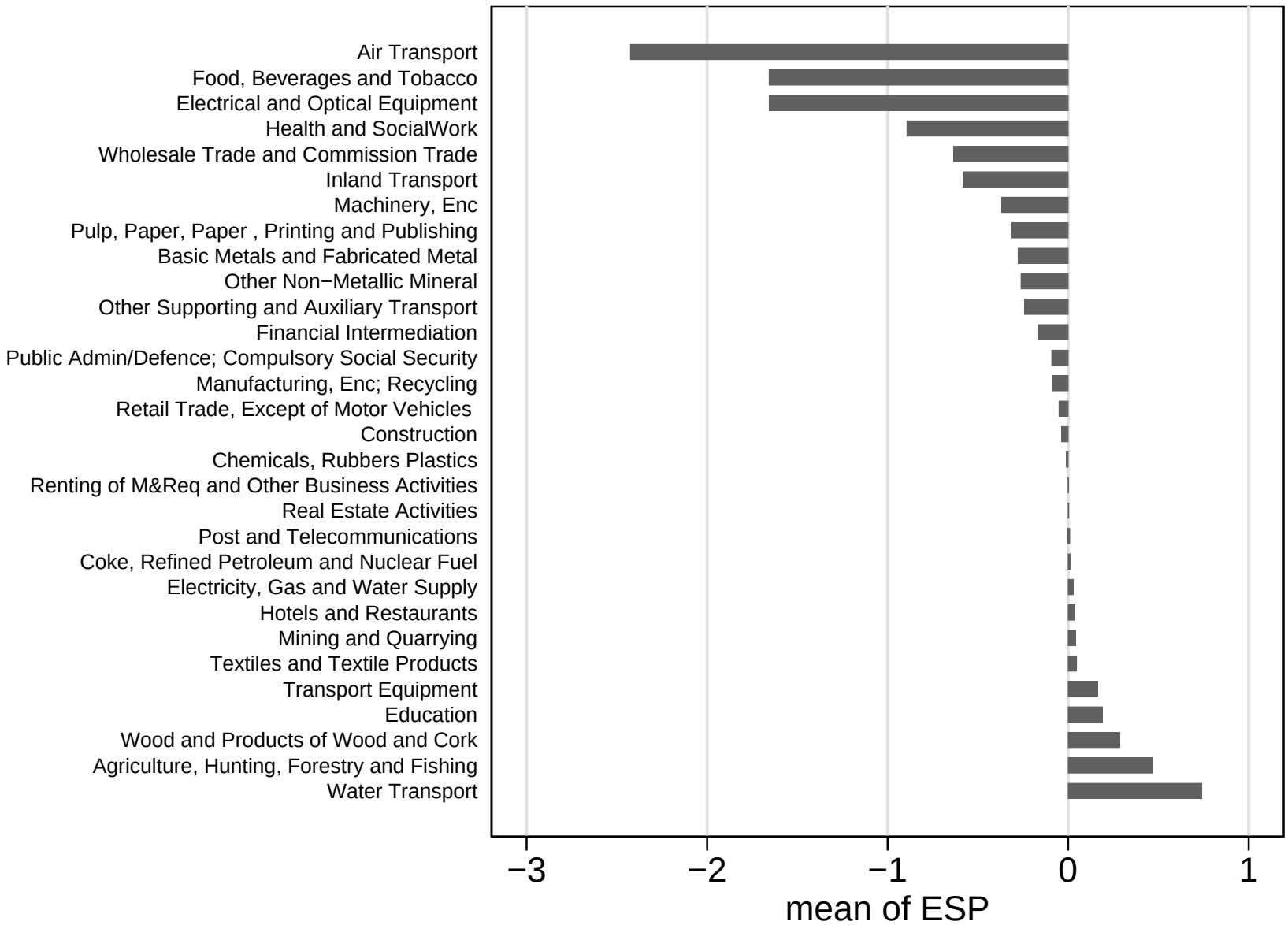


US taxes China — selected countries

Table: Country-specific effects of US tariffs to imports from China.

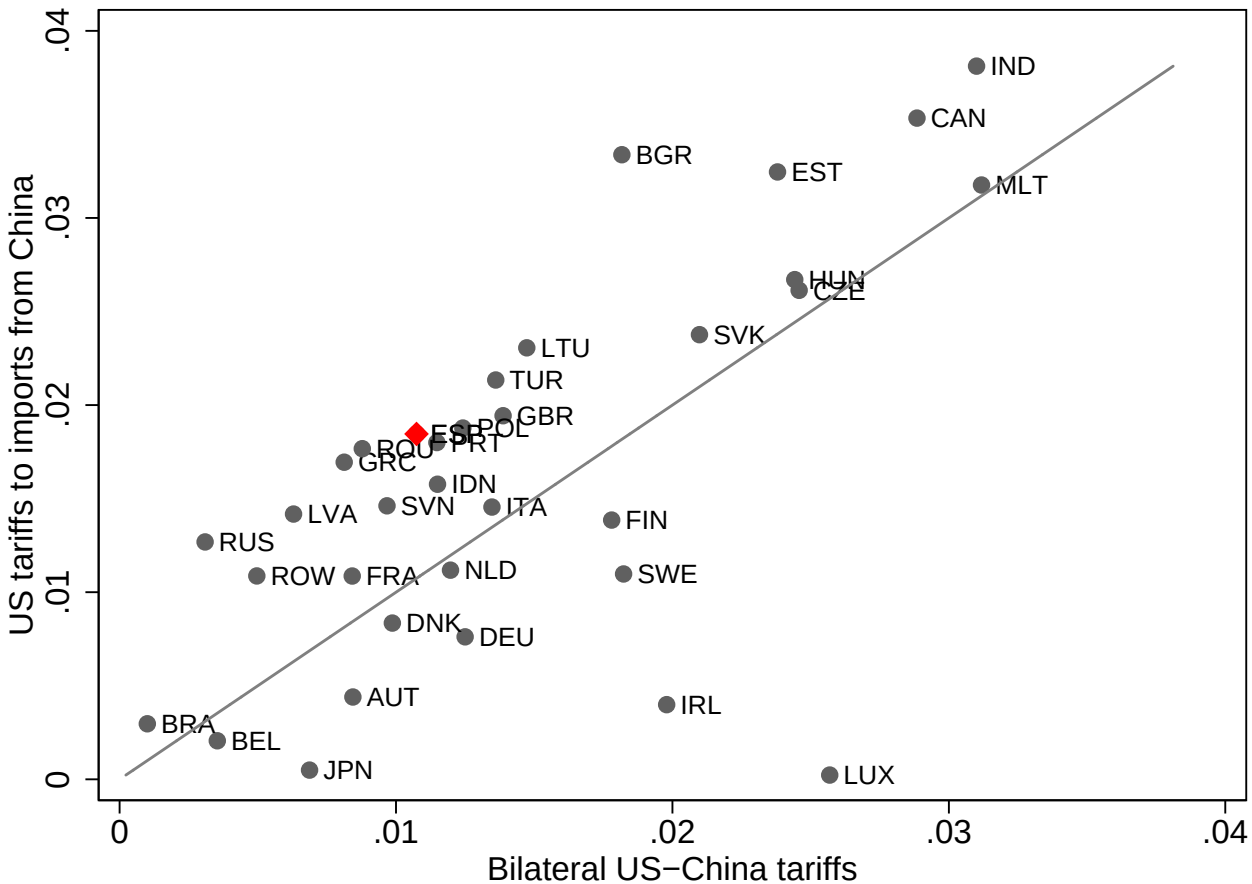
Intermediates	NO	NO	YES	**YES**	YES	YES
Non-linearities	NO	YES	NO	**YES**	YES	YES
Tariff change	25%	25%	25%	**25%**	10%	50%
CHN	-0.26	-0.08	-1.62	-0.50	-0.31	-0.60
DEU	-0.02	0.00	-0.07	0.01	0.00	0.01
ESP	0.02	0.00	0.09	0.02	0.01	0.02
MEX	0.09	0.02	0.15	0.09	0.05	0.10
TWN	-0.04	-0.01	-0.54	-0.11	-0.08	-0.12
USA	0.07	-0.01	0.32	-0.06	0.01	-0.16

US taxes China — the case of Spain



US taxes China — China retaliates

- World GDP falls by -0.22 instead of -0.16.
- China -0.53 (vs -0.50). USA -0.10 (vs -0.06). Mexico +0.08 (vs +0.09) Taiwan -0.04 (vs -0.11).



To do list

- We have the model working in our hands — thanks to David Baqaee for sharing the code.
- We can now turn to:
  - Dig deeper into the model's mechanisms: alternative complementarities, prices and pass-trough, factor shares, redistribution...
  - Explore alternative trade shocks: tariffs to specific goods, iceberg trade costs, Brexit...

ISIC code	Description
A01	Crop and animal production, hunting and related service activities
A02	Forestry and logging
A03	Fishing and aquaculture
B	Mining and quarrying
C10-C12	Manufacture of food products, beverages and tobacco products
C13-C15	Manufacture of textiles, wearing apparel and leather products
C16	Manufacture of wood and of products of wood and cork, except furniture;
C17	Manufacture of paper and paper products
C18	Printing and reproduction of recorded media
C19	Manufacture of coke and refined petroleum products
C20	Manufacture of chemicals and chemical products
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
C22	Manufacture of rubber and plastic products
C23	Manufacture of other non-metallic mineral products
C24	Manufacture of basic metals
C25	Manufacture of fabricated metal products, except machinery and equipment
C26	Manufacture of computer, electronic and optical products
C27	Manufacture of electrical equipment
C28	Manufacture of machinery and equipment n.e.c.
C29	Manufacture of motor vehicles, trailers and semi-trailers
C30	Manufacture of other transport equipment
C31_C32	Manufacture of furniture; other manufacturing
C33	Repair and installation of machinery and equipment
D35	Electricity, gas, steam and air conditioning supply
E36	Water collection, treatment and supply
E37-E39	Sewerage; waste collection, treatment and disposal activities; materials recovery;
F	Construction
G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
G46	Wholesale trade, except of motor vehicles and motorcycles
G47	Retail trade, except of motor vehicles and motorcycles
H49	Land transport and transport via pipelines
H50	Water transport
H51	Air transport
H52	Warehousing and support activities for transportation
H53	Postal and courier activities
I	Accommodation and food service activities
J58	Publishing activities
J59_J60	Motion picture, video and television programme production, sound recording and music
J61	Telecommunications
J62_J63	Computer programming, consultancy and related activities; information service activities
K64	Financial service activities, except insurance and pension funding
K65	Insurance, reinsurance and pension funding, except compulsory social security
K66	Activities auxiliary to financial services and insurance activities
L68	Real estate activities
M69_M70	Legal and accounting activities; activities of head offices; management consultancy activities
M71	Architectural and engineering activities; technical testing and analysis
M72	Scientific research and development
M73	Advertising and market research
M74_M75	Other professional, scientific and technical activities; veterinary activities
N	Administrative and support service activities
O84	Public administration and defence; compulsory social security
P85	Education
Q	Human health and social work activities
R_S	Other service activities

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