The Long and Short (Run) of Trade Elasticities

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Motivation

- Trade elasticity central to international economics
  - Trade: size of the welfare gains
  - Macro: transmission of shocks
- Gravity-based estimation approaches

$$X_{i,j,t} \propto \phi_{i,j,t}^{\theta} \cdot S_{i,t} \cdot D_{j,t}$$

  - Assume $\phi_{i,j,t} = \kappa_{i,j,t} \cdot \tau_{i,j,t}$, treat tariff variation as exogenous
  - Often no distinction between short and long run
  - Wide range of estimates
- This paper: propose new method to estimate elasticity at different horizons

This Paper

- Tackle endogeneity of tariff changes
  1. Instrument: MFN tariff changes
     - Treatment group: MFN tariff rate is binding and changing between $t-1$ and t
     - Control group: Countries with preferential tariffs, countries outside the WTO
     - Refinement: Limit analysis to small trading partners
  2. Expanded fixed effects
- Dynamics/multiple horizons
  - Explicit distinction between short- and long-run
  - Internally consistent estimates at multiple horizons
    - Macro-econometric tools: Local projections (Jordà, 2005)
- Quantification
  - Long run: gains from trade
  - Short run: speed of adjustment and time-varying elasticities

Summary of Results

- Trade elasticities significantly different across horizons, increase over time
- Elasticities a year after impact ≈ -0.76
- Long run tariff-exclusive elasticity ≈ -1.75 to -2.25
  - "Long" run appears to be about 7-10 years
- Higher "conventional wisdom" numbers due to not controlling for omitted variables
- IV estimates larger than OLS at all horizons
- Implications:
  - Welfare gains from trade over 5-6X higher than under conventional values
  - Substantial curvature in the adjustment costs to exporting

Related Literature

- Alternative estimates:
  - **Gravity-based:** Head and Ries (2001), Romalis (2007), Caliendo and Parro (2015)
  - **Price-based:** Eaton and Kortum (2002), Simonovska and Waugh (2014), Giri, Yi, and Yilmazkuday (2020)
  - **Armington:** Feenstra (1994), Broda and Weinstein (2006), Soderbery (2015,2018), Feenstra, Luck, Obstfeld and Russ (2019), Alessandria and Choi (2019)
  - **Firm-level:** Bas, Mayer, and Thoenig (2017), Fitzgerald and Haller (2018), Fontagne, Martin, and Orefice (2018)
- Implications/ Interpreting estimates:
  - **Welfare:** Arkolakis, Costinot, Rodriguez Clare (2012)
  - **Short vs long run:** Ruhl (2008), Alessandria, Choi and Ruhl (2018)
- Trade Policy:
  - **Institutional background:** Bown and Crowley (2016), Bagwell and Staiger (2016)
  - **Other tariff shocks:** Fajgelbaum et al (2020)

Estimation

Definition

The *horizon-h trade elasticity* ε^h is defined as

$$\varepsilon^h = \frac{\Delta_h \ln X_{i,j,p,t}}{\Delta_h \ln \phi_{i,j,p,t}} = \frac{\Delta_h \ln X_{i,j,p,t}}{\Delta_h \ln \tau_{i,j,p,t}}$$

- $\Delta_h x_t$ is $x_{t+h} - x_{t-1}$
- $X_{i,j,p,t}$ trade volumes between countries i and j in product p at time t
- $\phi_{i,j,p,t} = \kappa_{i,j,p,t} \cdot \tau_{i,j,p,t}$, ad valorem trade costs
- Long-run elasticity is the limit:

$$\varepsilon = \lim_{h\to\infty} \frac{\Delta_h \ln X_{i,j,p,t}}{\Delta_h \ln \phi_{i,j,p,t}}$$

Estimating Equations: Local Projections

- Trade Volumes:

$$\Delta_h \ln X_{i,j,p_6,t} = \beta_X^h \Delta_0 \tau_{i,j,p_6,t} + \delta_{i,p_4,t} + \delta_{j,p_4,t} + \delta_{i,j,p_4} + u^X_{i,j,p_6,t}$$

- Tariffs:

$$\Delta_h \tau_{i,j,p_6,t} = \beta_\tau^h \Delta_0 \tau_{i,j,p_6,t} + \delta_{i,p_4,t} + \delta_{j,p_4,t} + \delta_{i,j,p_4} + u^\tau_{i,j,p_6,t}$$

  - δs fixed effects (country-product-time, country-pair-product)

- Horizon h Trade Elasticity: $\varepsilon^h = \frac{\beta_X^h}{\beta_\tau^h}$

Estimating Equations: One-Step Estimation

- 2SLS estimation ("OLS"):

$$\Delta_h \ln X_{i,j,p_6,t} = \varepsilon^{h,OLS} \Delta_h \tau_{i,j,p_6,t} + \delta_{i,p_4,t} + \delta_{j,p_4,t} + \delta_{i,j,p_4} + u^X_{i,j,p_6,t}$$

  - Where $\Delta_h \tau_{i,j,p_6,t}$ is instrumented by $\Delta_0 \tau_{i,j,p_6,t}$

- 2SLS estimation with instrument ("IV"):

$$\Delta_h \ln X_{i,j,p_6,t} = \varepsilon^{h} \Delta_h \tau_{i,j,p_6,t} + \delta_{i,p_4,t} + \delta_{j,p_4,t} + \delta_{i,j,p_4} + u^X_{i,j,p_6,t}$$

  - Where $\Delta_h \tau_{i,j,p_6,t}$ is instrumented by $\Delta_0 \tau^{inst}_{i,j,p_6,t}$

- Horizon h Trade Elasticity: ε^h, correct standard errors

Tariff Changes are Likely Endogenous

- Omitted factors: e.g. business cycles, changes in governments (Bown and Crowley, 2013; Lake and Linask, 2016)
- Reverse causality: e.g. lobbying, domestic (Trefler, 1993) or foreign (Gawande, Krishna, and Robbins, 2006; Antràs and Padró i Miquel, 2011)
- **Implication:** need fixed effects to soak up destination-product-time variation, possibly partner-specific variation
- Even with fixed effects, tariff changes could be endogenous

Instrument

- Exogenous shocks to tariffs hard to find – trade agreements typically between large trading partners
- Insight: WTO MFN principle can provide basis for instrument

Institutional background:

- MFN bounds (maximum product-level tariffs) set upon WTO accession
- Not all products covered by bounds (US 100%, India 70%), bounds country-product specific
- Countries legally free to vary applied tariffs below bounds
  - India raises and lowers MFN tariffs every year across products
  - China lowered MFN tariffs on a range of products in response to US trade war
- **Key:** any MFN tariff change applies to *all* MFN partners, and about 60% of trade is MFN-basis

Instrument

- Insight: WTO MFN principle – apply same tariff to all partners

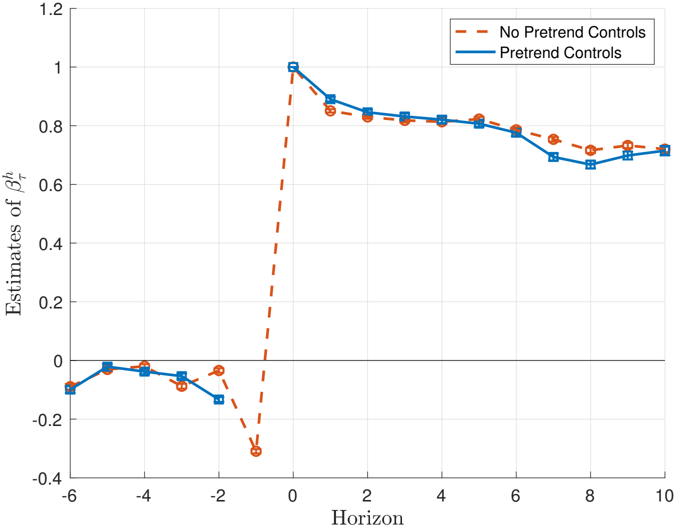
Baseline:

$$
\begin{aligned}
\Delta_0 \tau^{instr}_{i,j,p,t-1} \quad = \quad & \mathbf{1}\left(\tau_{i,j,p,t} = \tau^{\text{applied MFN}}_{i,j,p,t}\right) \times \mathbf{1}\left(\tau_{i,j,p,t-1} = \tau^{\text{applied MFN}}_{i,j,p,t-1}\right) \\
& \times \mathbf{1}\left(\text{not a major trading partner in } t-1 \text{ in aggregate}\right) \\
& \times \mathbf{1}\left(\text{not a major trading partner in } t-1 \text{ at product level}\right) \\
& \times \mathbf{1}\left(\text{not a major trading partner in } t \text{ in aggregate}\right) \\
& \times \mathbf{1}\left(\text{not a major trading partner in } t \text{ at product level}\right) \\
& \times \left[\tau^{\text{applied MFN}}_{i,j,p,t} - \tau^{\text{applied MFN}}_{i,j,p,t-1}\right]
\end{aligned}
$$

Available Variation

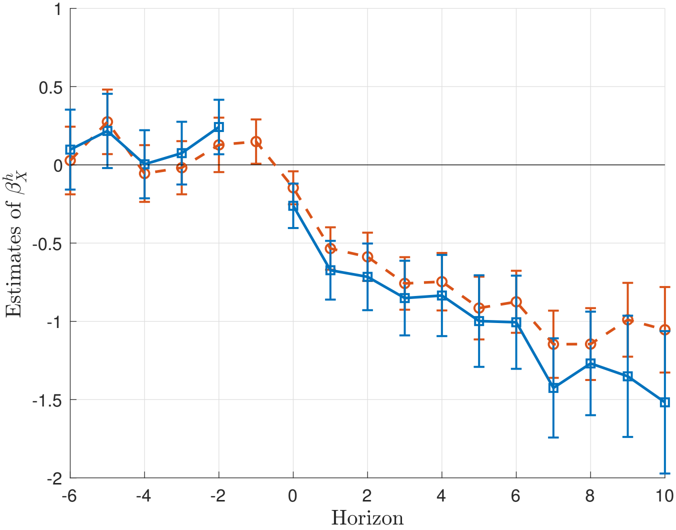
Results

Impulse response function of tariffs to shock



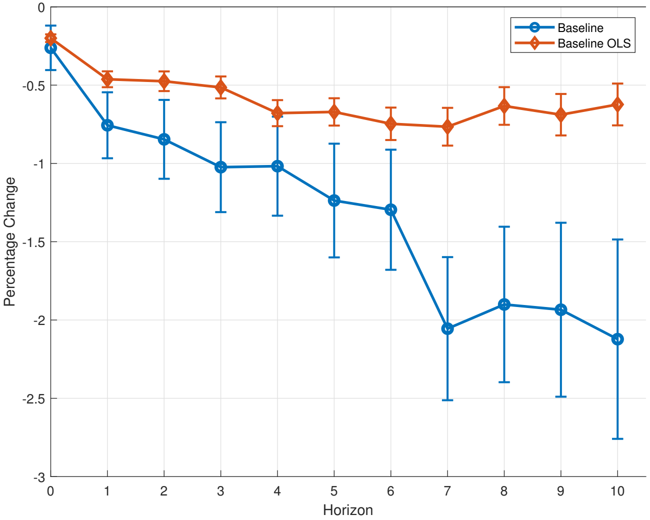
- Tariff increase persistent; Use pre-trend controls for robustness

Impulse response function of trade to shock



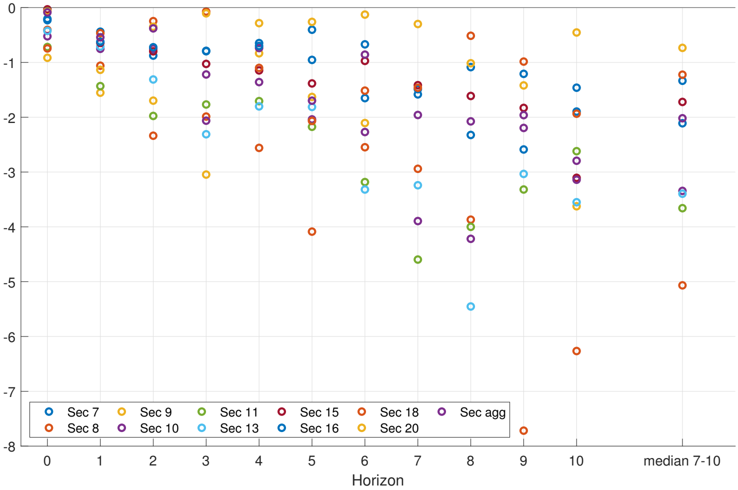
- Impact on trade flows builds slowly

Trade elasticity



- OLS biased towards zero
- IV and OLS estimates increase over time

Trade elasticity: Sectoral Estimates



- Heterogeneous effects across HS-Sections, elasticities diverge over longer horizons
- Footwear, Textiles higher elasticities, Articles of Stone/Cement and Plastics/Rubber small elasticities

Comparison to Existing Estimates

	(1)	(2)	(3)	(4)	(5)
Panel A: Log-levels, OLS					
$\tau_{i,j,p,t}$	-3.696	-4.468	-6.696	-2.734	-1.040
Panel B: 5-year log-differences, OLS					
$\Delta_5 \tau_{i,j,p,t}$	-1.882	-1.583	-0.664	-1.659	-0.518
Panel C: 5-year log-differences, 2SLS, instrumented w/ 1-year tariff change					
$\Delta_5 \tau_{i,j,p,t}$	-1.337	-0.968	-0.470	-1.019	-0.448
Panel D: 5-year log-differences, 2SLS, baseline instrument					
$\Delta_5 \tau_{i,j,p,t}$	-3.259	-2.206	-1.170	-2.000	-1.112
Fixed effects					
importer x hs4	no	yes	no	no	no
exporter x hs4	no	yes	no	no	no
importer x hs4 x year	no	no	yes	no	yes
exporter x hs4 x year	no	no	yes	no	yes
importer x exporter x hs4	no	no	no	yes	yes

- All estimates significantly different from 0 at the 1% level

Trade elasticity: Other Estimates and Robustness

- Alternative fixed effects, SEs
  - Twoway clustering of SEs – country-pair-HS4 and year
  - HS6 fixed effects (country-product-time, country-pair-product)
- Alternative samples
  - Balanced panel
  - Fixed effect groups with $>$50 observations
  - Alternative thresholds for major partners
  - Extensive margin with all zeros
  - Alternative pretrend controls
  - No tariff variation within HS6 product line
  - No tariff changes in the control group
- Alternative outcomes: Unit values
- Alternative estimation strategy: Distributed lag model

Quantification

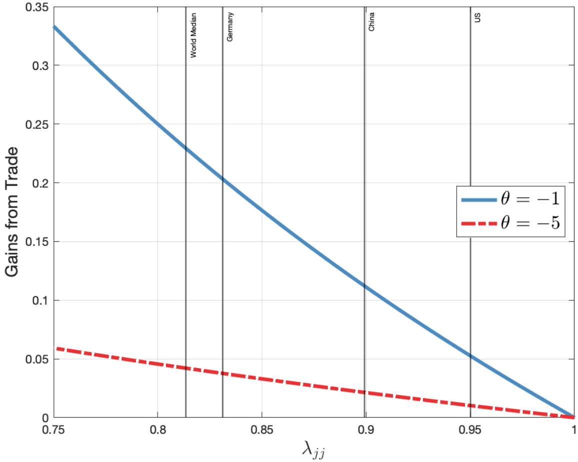
Welfare Relevant Long-Run Elasticity

1. Our estimation allows for autocorrelated, non-permanent tariff shocks
   - Transitional dynamics depends on tariff process, ε response of trade flows after tariffs converge
2. Theoretical gravity relates spending by agents *inclusive* of tariffs to trade cost
   - We are estimating a tariff-exclusive elasticity

Approach:

- ACR formula
- Estimated tariff process stabilizes in 2-3 years, trade in 7-10 years
- Long-run welfare relevant trade elasticity: $\varepsilon^{10} - 1 \approx -1$

Gains from Trade – Single Sector



- Our estimate: large welfare losses from reducing trade/output ratios ▸ Multiple Sectors

Dynamics of Trade Elasticities: Simple Model

Setup

- Exports

$$X_t = p_t^x q_t n_t$$

- Exporter price $p_t^x = p^x(\tau_t)$, define $\eta_{p,\tau} := \frac{\partial \ln p}{\partial \ln \tau}$
- Demand $q_t = q(p_t^x, \tau_t)$, with $\eta_{q,p} := \frac{\partial \ln q}{\partial \ln p^x} < 0, \eta_{q,\tau} := \frac{\partial \ln q}{\partial \ln \tau} < 0$
- Flow profits $\pi_t = \pi(\tau_t)$, with $\eta_{\pi,\tau} := \frac{\partial \ln \pi}{\partial \ln \tau} < 0$
- Mass n_t and value v_t
  - Krugman (1980): n_t mass of exporters; v_t value of exporting, Melitz (2003) similar
  - Arkolakis (2010): n_t mass of customers; v_t marginal value of customer

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- *Dynamics*

$$\begin{aligned} v_t &= \frac{1}{1+r}\mathbb{E}_t\left[\pi_{t+1} + (1-\delta)\, v_{t+1}\right] \\ n_t &= n_{t-1}(1-\delta) + G(v_{t-1}) \end{aligned}$$

  - interest rate r, "depreciation" rate δ, "investment" $G(v_{t-1})$
  - one period "time-to-build"

Short and Long-run Elasticities

- Short-run trade elasticity

$$\varepsilon^0 := \frac{d \ln X_{t_0}}{d \ln \tau_{t_0}} = (1 + \eta_{q,p})\, \eta_{p,\tau} + \eta_{q,\tau}$$

  - reflects static quantity and price response
  - n_t predetermined, drops out
  - $-\sigma$ in standard CES-monopolistic competition framework

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- Long-run trade elasticity

$$\varepsilon := \frac{d \ln X}{d \ln \tau} = \varepsilon^0 + \frac{d \ln n}{d \ln \tau} = \varepsilon^0 + \chi \eta_{\pi,\tau}$$

  - compares steady states
  - $\eta_{\pi,\tau} < 0$: elasticity of flow profits w.r.t tariffs
  - $\chi > 0$: elasticity of n wrt v
    - Krugman (1980), Melitz (2003): probability mass at the margin of entry
    - Arkolakis (2010): inverse curvature of cost of adding new customers

Dynamics of Trade Elasticities

- Horizon-h trade elasticity

$$\varepsilon^h = \underbrace{\varepsilon^0}_{\substack{\text{“static”}\\ \text{quantity and}\\ \text{price response}}} + \underbrace{\frac{d \ln n_{t_0+h}}{d \ln \tau_{t_0}} \Big/ \frac{d \ln \tau_{t_0+h}}{d \ln \tau_{t_0}}}_{\text{“dynamic” response}}$$

- Proposition 1:

$$\frac{d \ln n_{t_0+h}}{d \ln \tau_{t_0}} = \chi \eta_{\pi,\tau} \frac{\delta + r}{1+r} \delta \sum_{k=0}^{h-1} (1-\delta)^{h-1-k} \, \mathbb{E}_{t_0+k} \left[\sum_{\ell=0}^{\infty} \left(\frac{1-\delta}{1+r} \right)^{\ell} \frac{d \ln \tau_{t_0+k+\ell+1}}{d \ln \tau_{t_0}} \right]$$

Dynamics of Trade Elasticities

- Horizon-h trade elasticity

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- Geometric convergence for one time permanent tariff change: $\varepsilon^h = \chi\eta_{\pi,\tau}\left(1-(1-\delta)^h\right)+\varepsilon^0$
- Proposition 2: If $\lim_{h\to\infty}\frac{d\ln \tau_{t_0+h}}{d\ln \tau_{t_0}} \neq 0$ and is finite, then $\lim_{h\to\infty}\varepsilon^h = \varepsilon$

Dynamics of Trade Elasticities

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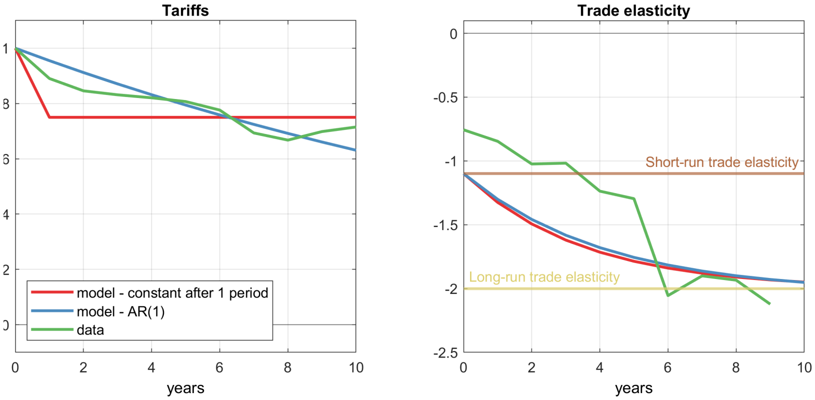
- Proposition 3: The model delivers the estimating equations used above

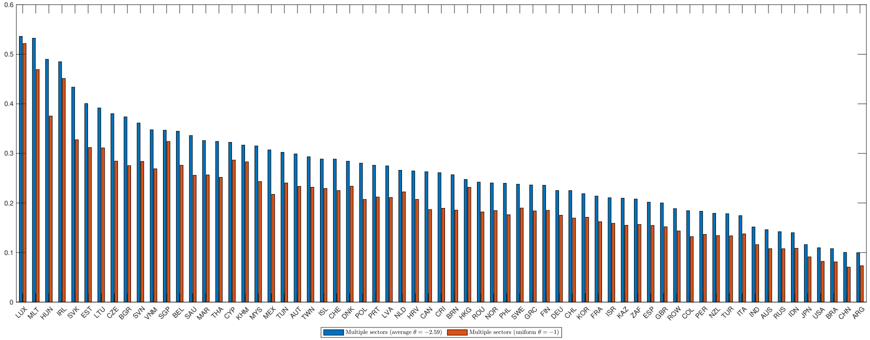
Quantification



Conclusion

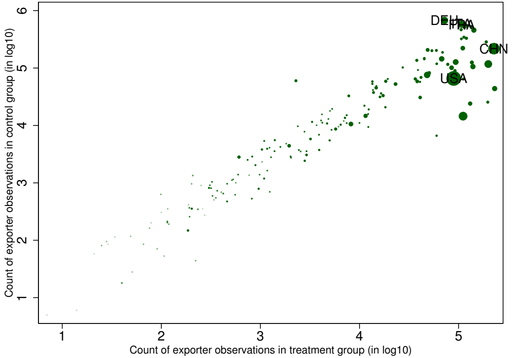
- New estimates of trade elasticities
  - Causality: new instrument to tackle endogeneity of tariff changes
  - Multiple horizons: internally consistent; time series methods
- Short-run: about -0.76
- Long-run [7-10 years]: about -1.75 to -2.25
- Implications: large welfare gains from trade, market access costs, dynamics of adjustment to trade shocks...

Gains from Trade – Multiple Sectors

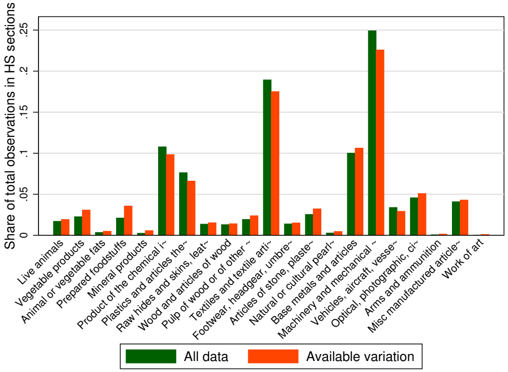


▸ Single Sector

Identifying Variation



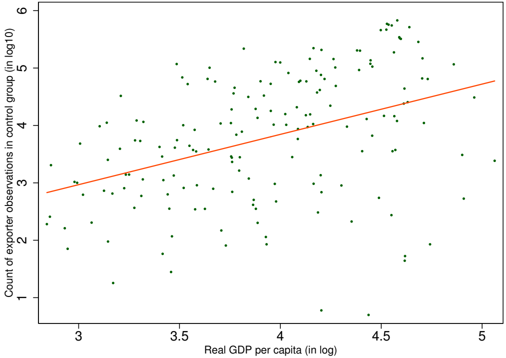
Countries



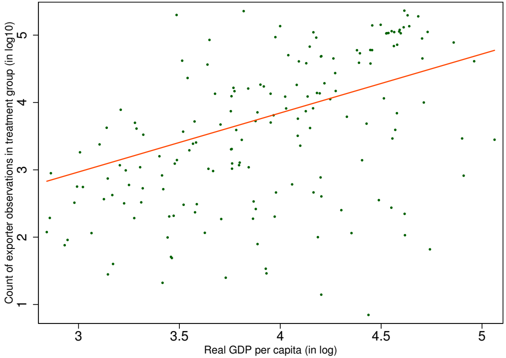
HS Sections

Back

Explaining Country Variation



Control



Treatment

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