Global Reallocations in the US-China Trade War

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Motivation

- In 2018-19, US-China engaged in a trade war, taxing $450b of annual trade
  - thousands of goods tariffed, avg US tariffs from about 4% to 25%
  - US and China tariffs targeted 3.6% of US GDP and 5.5% of China GDP

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- Trade war is a natural experiment to understand the key forces driving world trade
  - Substitution/complementarities?
  - Scale?
  - Specialization?

This Paper

1. Framework to guide empirical analysis that captures these elements
2. Estimate impacts of tariffs on bystanders' exports to US, CH, rest of world (RW)
3. Examine possible forces driving the responses

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Method:

- model motivates product-level regressions to estimate impact of trade-war tariffs on countries' exports
- ...allowing for country-, sector-, and size-specific tariff responses

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     - ★ COL, UKR: not beneficiaries bc they complement US and China

Related Literature

- Interdependency across export destinations
  - Morales et al 19, Alfaro et al 23, Alumnia et al 18, Mau 17, Flaaen et al 20, Albornoz et al 21
- Cross-country variation in trade elasticities
  - Anderson VW 03, Eaton Kortum 02, Costinot et al 12, Caliendo Parro 15, Adao et al 17, Lind Ramondo 18
- Scale economies
  - Antweiler Trefler 02, Costinot et al 19, Bartelme et al 19, Lashkaripir Lugovskyy 22
- US-China Trade War
  - Amiti et al. 19, Fajgelbaum et al. 20, Cavallo et al. 21, Flaaen et al. 20, Flaaen Pierce 19, Waugh 19

Framework

- Ricardian-Armington trade model
- Translog aggregator of varieties (origins) of product ω from sector j in country n:

$$s^n_{i\omega} = a^n_{i\omega} + \sum_{i' \in \mathcal{I}} \sigma^j_{i'i} \ln p^n_{i'\omega}$$

  - with prices $p^n_{i'\omega} = \tau^n_{i'\omega} T^n_{i\omega} p_{i'\omega}$
  - σ^j_{iCH}, σ^j_{iUS} capture i's substitution with CH and US
  - assume $\sigma^j_{ii'} = \sigma^j_{RW}$ for $i' \neq i$ and $i \neq US, CH$

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  - σ_{iCH}^{j}, σ_{iUS}^{j} capture i's substitution with CH and US
  - assume $\sigma_{ii'}^{j} = \sigma_{RW}^{j}$ for $i' \neq i$ and $i \neq US, CH$
- Supply (sales) curve of exporter i of product ω:

$$X_{i\omega} \equiv A_{ij} p_{i\omega}^{\frac{1}{b_i^j}} Z_{i\omega}$$

  - A_{ij}: endogenous sector (j)-level cost shifters (ie, wages, input costs)
  - $Z_{i\omega}$ exogenous cost shifter
  - $b_i^j = \frac{1}{\epsilon_i^j} - \gamma_i^j$, where ϵ_i^j reflects factor mobility & γ_i^j reflects scale
- Equilibrium: prices $\{p_{i\omega}\}$ such that goods markets clear

Impact of US-China Tariffs on Third-Country Exports

Proposition

Given tariff shocks $\{T^n_{i\omega}\}$*, first-order approximation around an arbitrary initial equilibrium:*

$$\begin{aligned}\Delta \ln X^n_{i\omega} =& \beta^n_{1i\omega} \Delta \ln T^{US}_{CH,\omega} + \beta^n_{2i\omega} \Delta \ln T^{CH}_{US,\omega} + \beta^n_{3i\omega} \Delta \ln T^{US}_{i,\omega} + \beta^n_{4i\omega} \Delta \ln T^{CH}_{i,\omega} \\ &+ \beta^n_{5i\omega} \sum_{j \neq CH,US,i} \Delta \ln T^{US}_{j,\omega} + \beta^n_{6i\omega} \sum_{j \neq CH,US,i} \Delta \ln T^{CH}_{j,\omega} + \eta^n_{i\omega}\end{aligned}$$

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- $\beta^n_{1i\omega}$: tariff response to US tariff on China:

$$\beta^n_{1i\omega} \equiv \left(1_{n=US} + \frac{E^{US}_\omega}{E_\omega} \frac{1}{\frac{X_{i\omega}/E_\omega}{b^j_i \sigma^j_{ii}} - 1} \right) \frac{\sigma^j_{CHi}}{s^n_{i\omega}}$$

  - substitutability: σ^j_{CHi}
  - scale: $b^j_i \sigma^j_{ii}$
  - size: $\frac{E^n_\omega}{E_\omega}$, $\frac{X_{i\omega}}{E_\omega}$, $\frac{X^n_{i\omega}}{E^n_\omega}$

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- $\eta^n_{i\omega}$: other goods prices, factor prices, aggregate demand shifts

$$\eta^n_{i\omega} = \frac{\left(\sum_{n' \in \mathcal{I}} \frac{X^{n'}_{i\omega}}{X_{i\omega}} \hat{E}^{n'}_{\omega} - \hat{A}_{ij} \right) b^j_i \sigma^j_{ii} + \sum_{i'=US,CH} \sigma^j_{CHi} \hat{p}_{i'\omega} + \sigma^j_{RW} \sum_{i' \neq i} \hat{p}_{i'\omega}}{1 - \frac{\sigma^j_{ii} b^j_i}{X_{i\omega}/E_{\omega}}} \frac{1}{s^n_{i\omega}} + \hat{E}^n_{\omega}$$

  - vanishes with
    - ★ Cobb-Douglas product-level shifters
    - ★ $\to 0$ price changes in US and China
    - ★ $\to 0$ cross-substitutions ($\sigma^j_{RW} = 0$)
  - implementation: exporter-importer-sector FEs, size controls, assess pre-trends

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- Set $\beta_5 = \beta_6 = 0$ because of lack of tariff variation

Parameter Regions Implied by Export Responses

Proposition

When the US imposes a tariff on China in product ω, then:
(i) if $\sigma_{CHi} > 0$ ($\sigma_{CHi} < 0$), exports from i to the US generally increase (decrease)
(ii) if $\sigma_{CHi} > 0$ ($\sigma_{CHi} < 0$) and $\sigma_{ii} < 0$, exports increase (decrease) from i to RW iff $\frac{X_{i\omega}/E_{\omega}}{\sigma_{ii}} < b_i < 0$.

	Exports:	
	Decrease to US $\left(\beta_{1i\omega}^{US} < 0\right)$	Increase to US $\left(\beta_{1i\omega}^{US} > 0\right)$
Increase to RW $\left(\beta_{1i\omega}^{RW} > 0\right)$		
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- Same logic applies to Chinese tariffs on US
  - In that case, sign of σ_{USi} is revealed

Data

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  - Top 50 countries, 95.9% of world trade
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  - ω: products (hs6)
  - j: 9 sectors
  - $\Delta \ln X^{US}_{CH\omega}$: exports from CH to US

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- Aggregate data to 24-month periods, study long differences
  - Examine 2016/17 to 2018/19 export growth in response to tariffs
  - Scale tariffs in proportion to their duration through the 24-month interval

Summary Statistics: World Trade in 2017

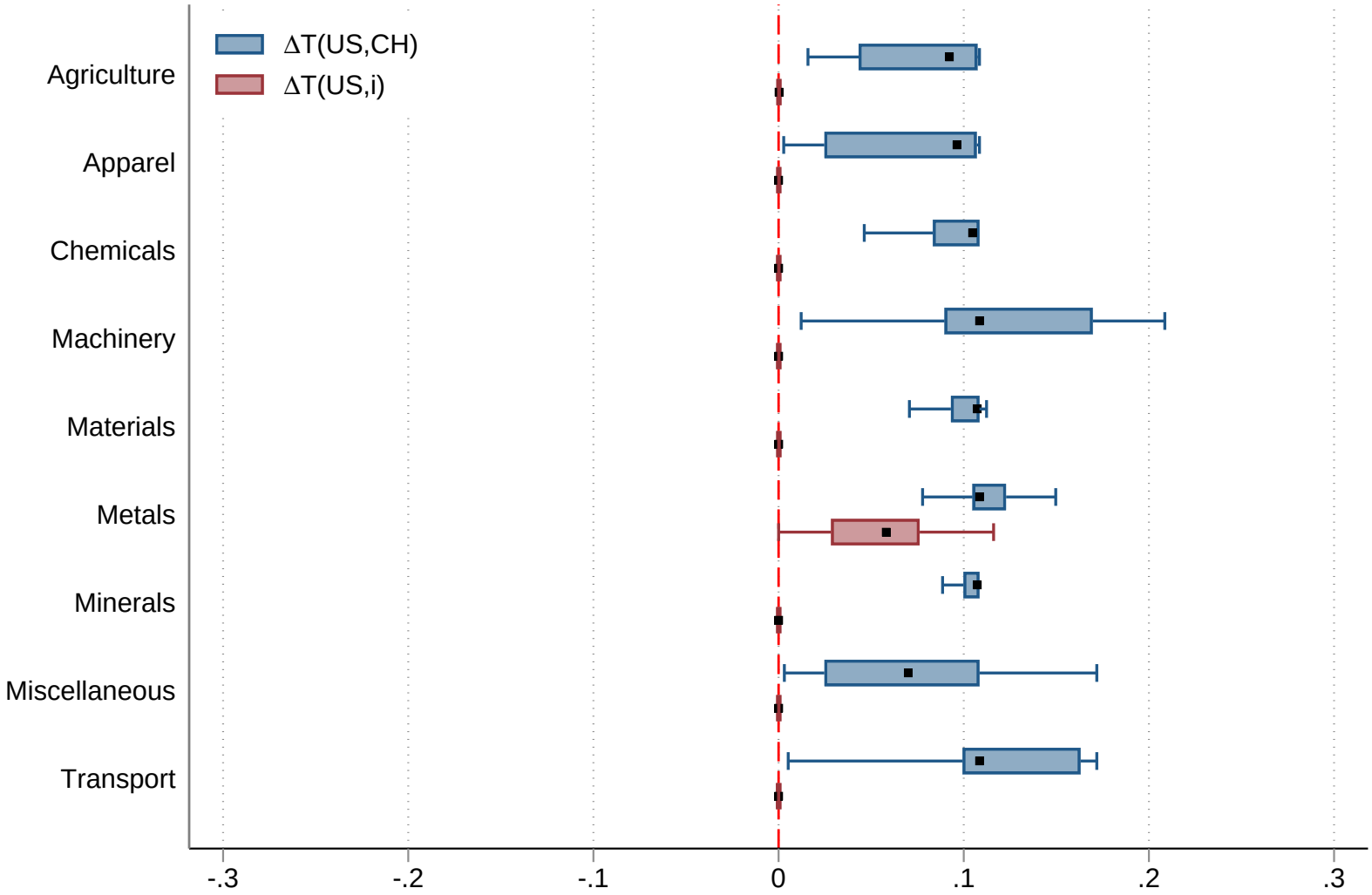
Industry	Examples	USD	Share	# HS6	Share
Machinery	Engines, computers, cell phones	5,632	0.30	771	0.15
Materials	Plastics, lumber, stones, glass	2,246	0.12	639	0.12
Transport	Vehicles, airplanes, parts	2,121	0.11	130	0.02
Chemicals	Medications, cosmetics, vaccines	1,884	0.10	787	0.15
Agriculture	Soy beans, wine, coffee, beef	1,617	0.09	899	0.17
Minerals	Oil, coal, salt, electricity	1,586	0.08	148	0.03
Metals	Copper, steel, iron, aluminum	1,350	0.07	563	0.11
Apparel	Footwear, t-shirts, hand bags	1,100	0.06	912	0.18
Miscellaneous	Medical devices, furniture, art	1,255	0.07	354	0.07

- 5203 HS6 products classified into 9 sectors

▸ specialization

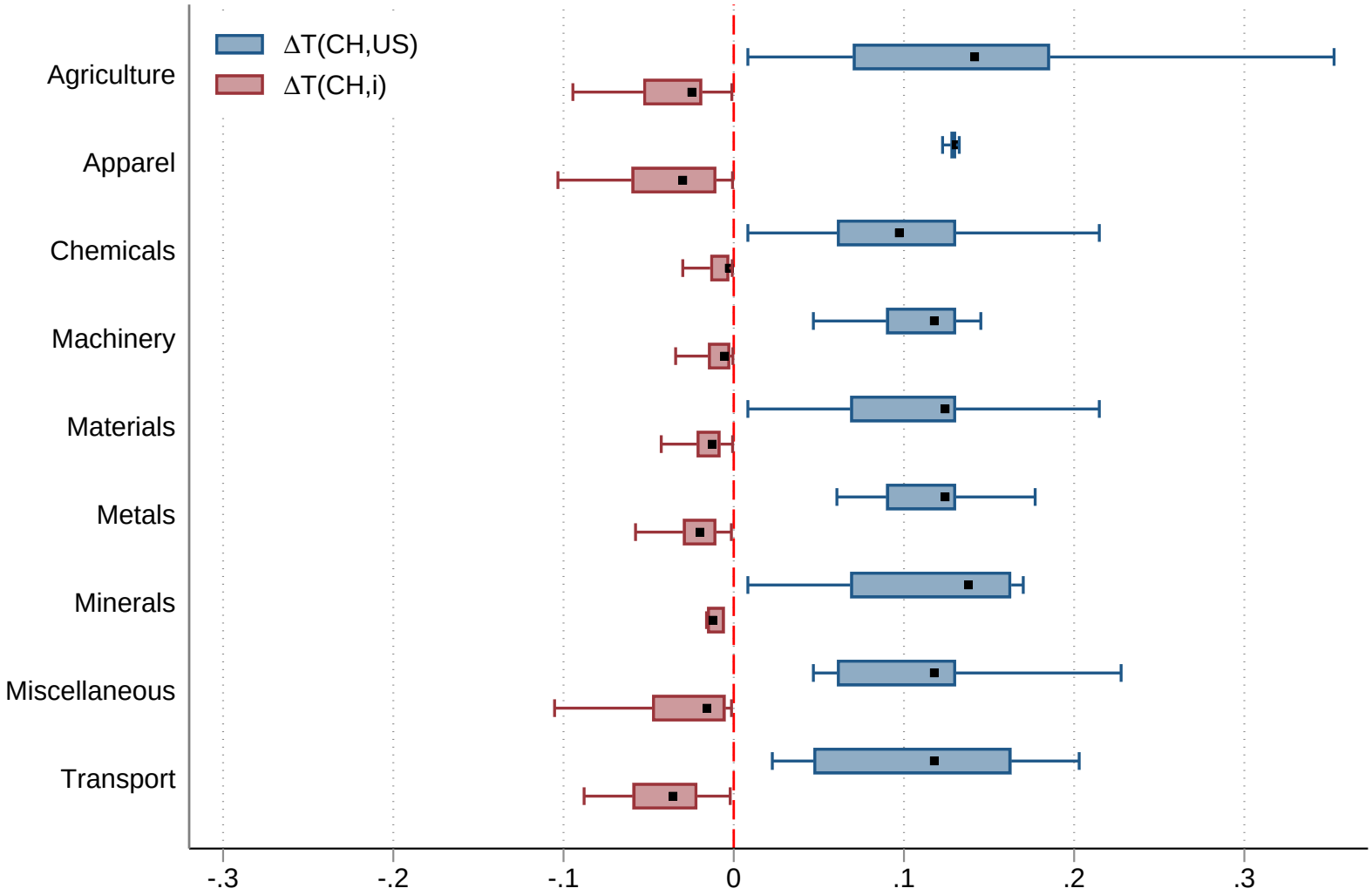
US Tariff Changes

ΔT_{CH}^{US} & ΔT_{i}^{US}



China Tariff Changes

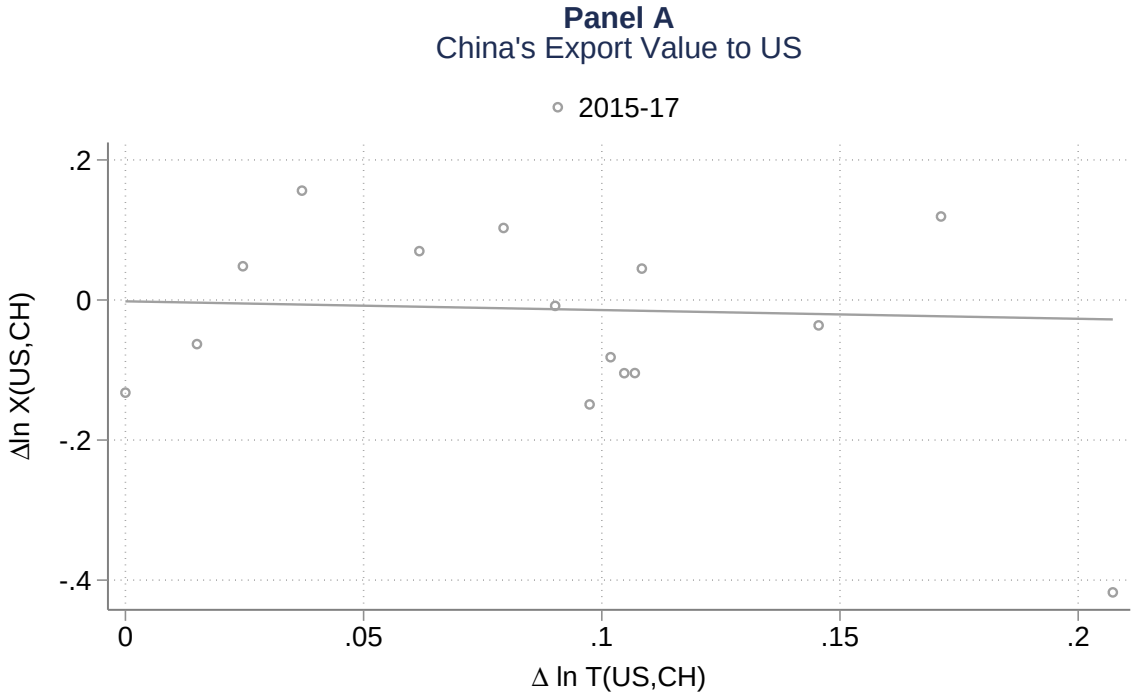
ΔT_{US}^{CH} & ΔT_{i}^{CH}



China Exports to US on ΔT_{CH}^{US}

China's exports to US fall with US tariff

$$\Delta X_{CH\omega}^{US} = \alpha + \beta \Delta T_{CH\omega}^{US} + \epsilon_{CH\omega}^{US}$$



Pre-period: β=-0.12 (0.29).

▸ fe

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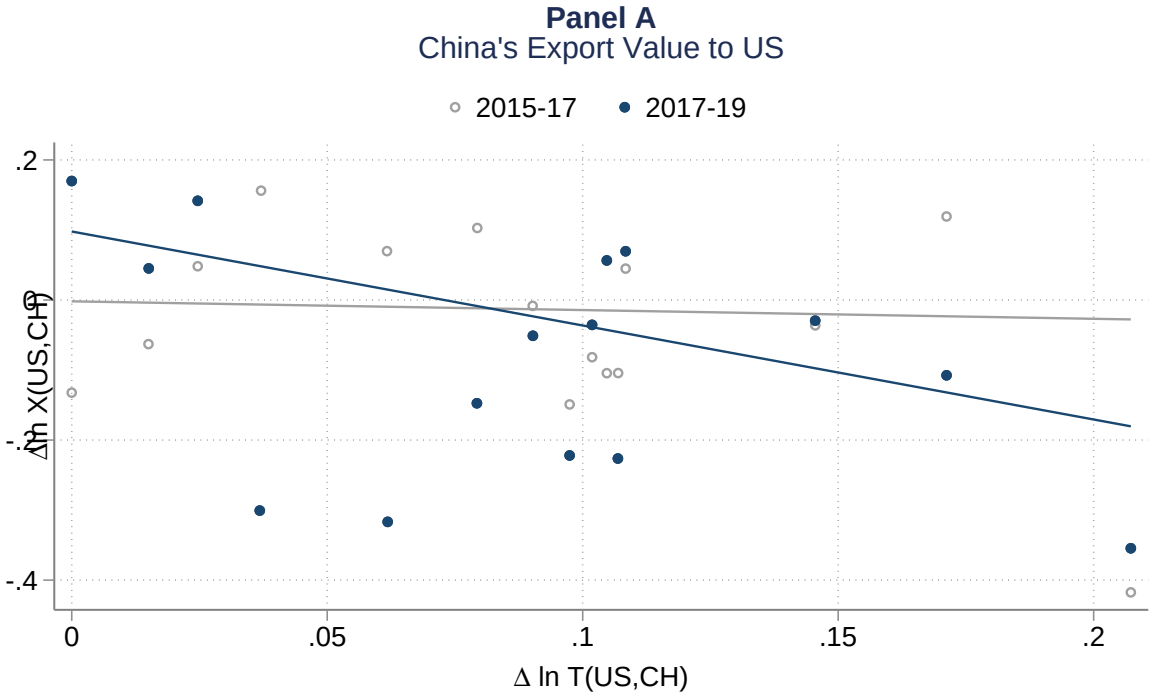


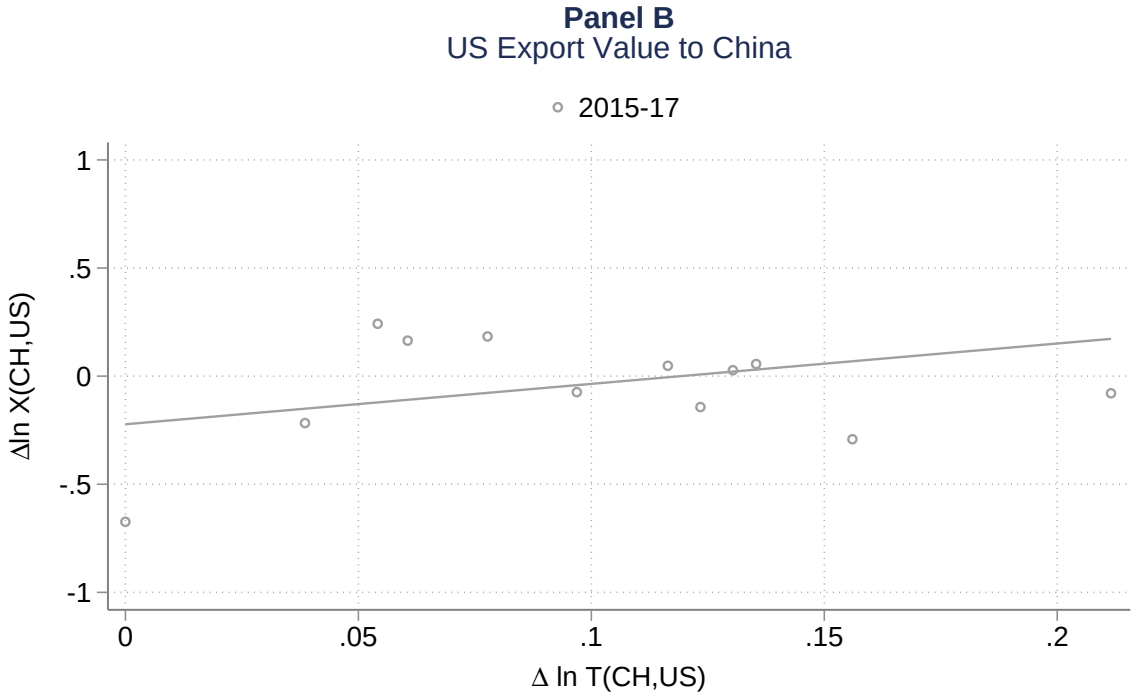
Pre-period: β=-0.12 (0.29). Post-period: β=-1.34 (0.27).

▸ fe

US Exports to China on ΔT_{US}^{CH}

US exports to CH fall with CH tariff

$$\Delta X_{US\omega}^{CH} = \alpha + \beta \Delta T_{US\omega}^{CH} + \epsilon_{US\omega}^{CH}$$



Pre-period: β=1.87 (0.46).

▸ fe

US Exports to China on ΔT_{US}^{CH}

US exports to CH fall with CH tariff

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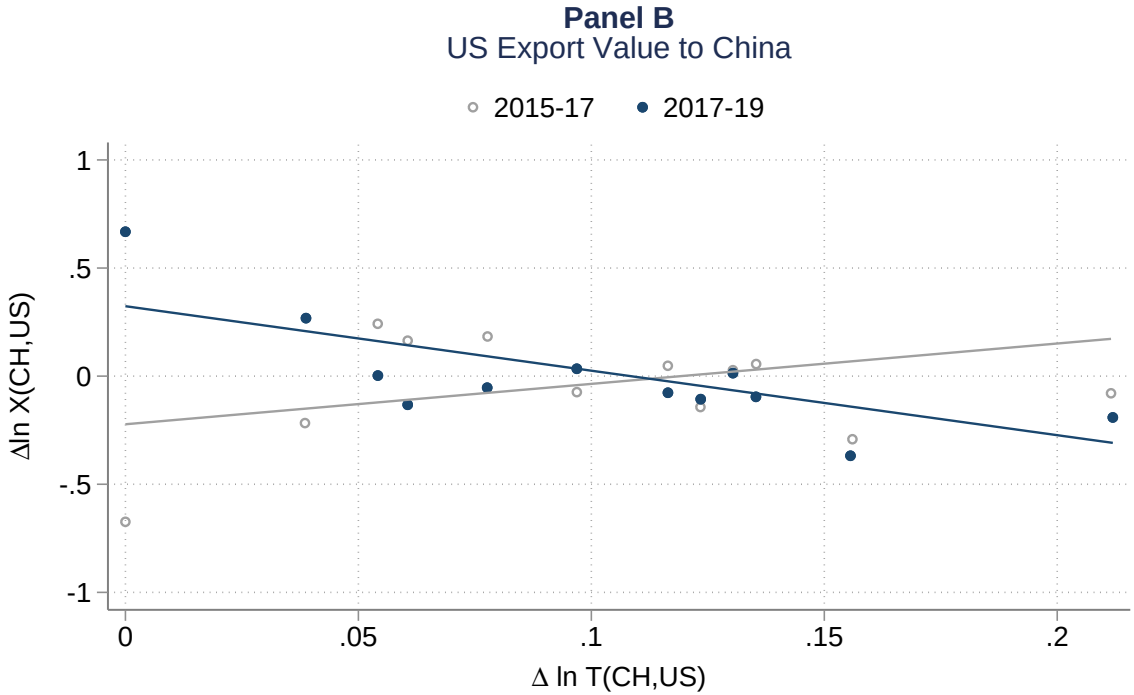


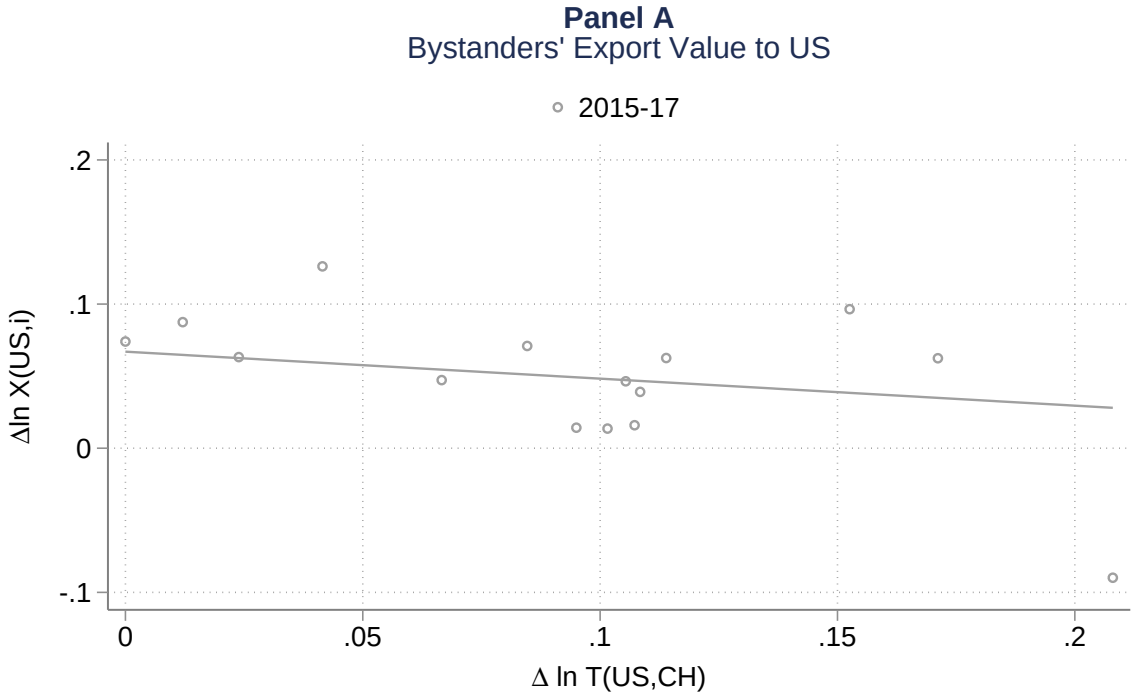
Pre-period: β=1.87 (0.46). Post-period: β=-2.98 (0.42).

▸ fe

RW Exports to US on ΔT_{CH}^{US}

Takeaway 1: RW exports to US increase with US tariff

$$\Delta X_{RW\omega}^{US} = \alpha + \beta \Delta T_{CH\omega}^{US} + \epsilon_{RW\omega}^{US}$$



Pre-period: β=-0.19 (0.10).

▸ fe

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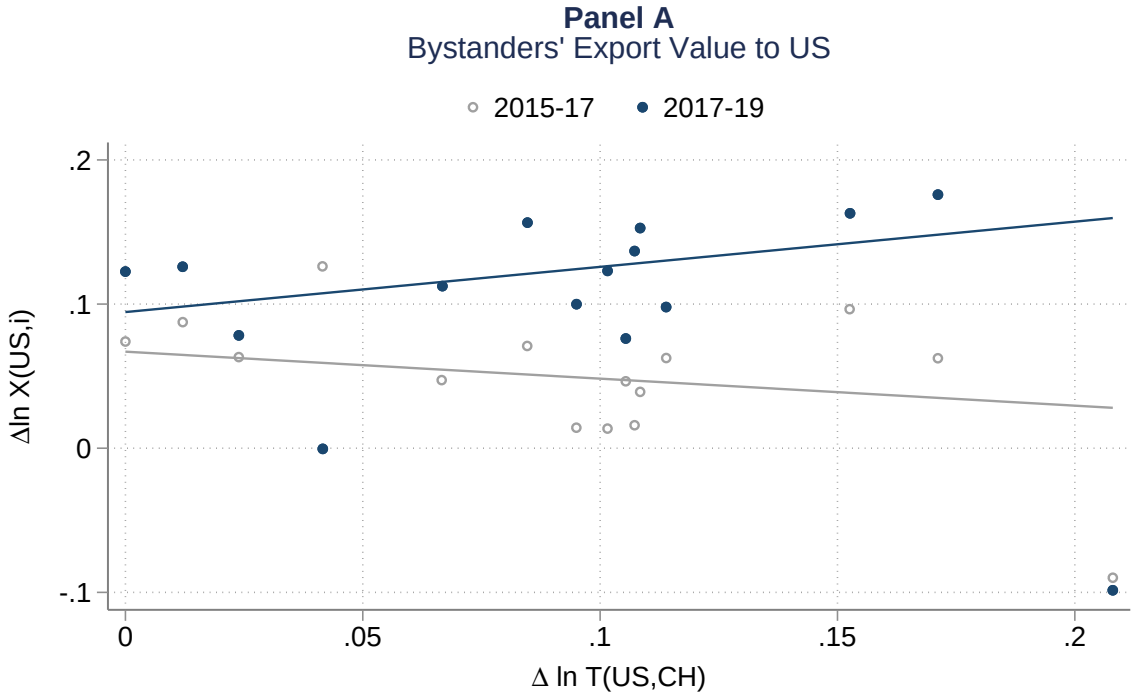


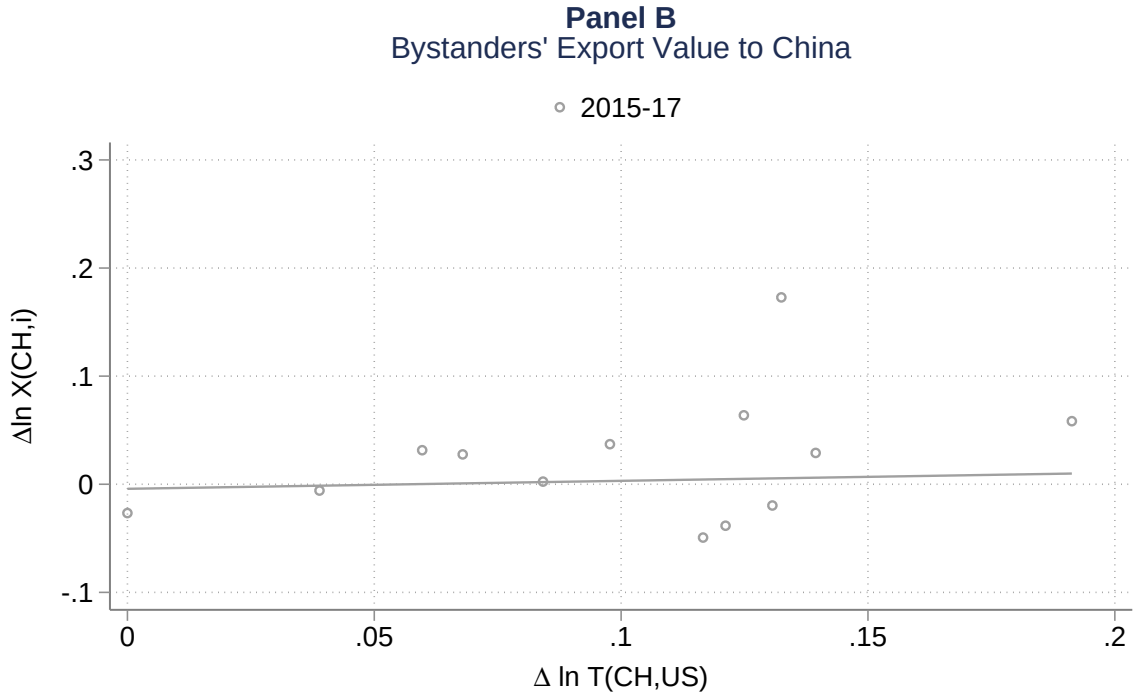
Pre-period: β=-0.19 (0.10). Post-period: β=0.31 (0.10).

▸ fe

RW Exports to CH on ΔT_{US}^{CH}

Takeaway 1: RW exports to CH flat with CH tariff

$$\Delta X_{RW\omega}^{CH} = \alpha + \beta \Delta T_{US\omega}^{CH} + \epsilon_{RW\omega}^{CH}$$



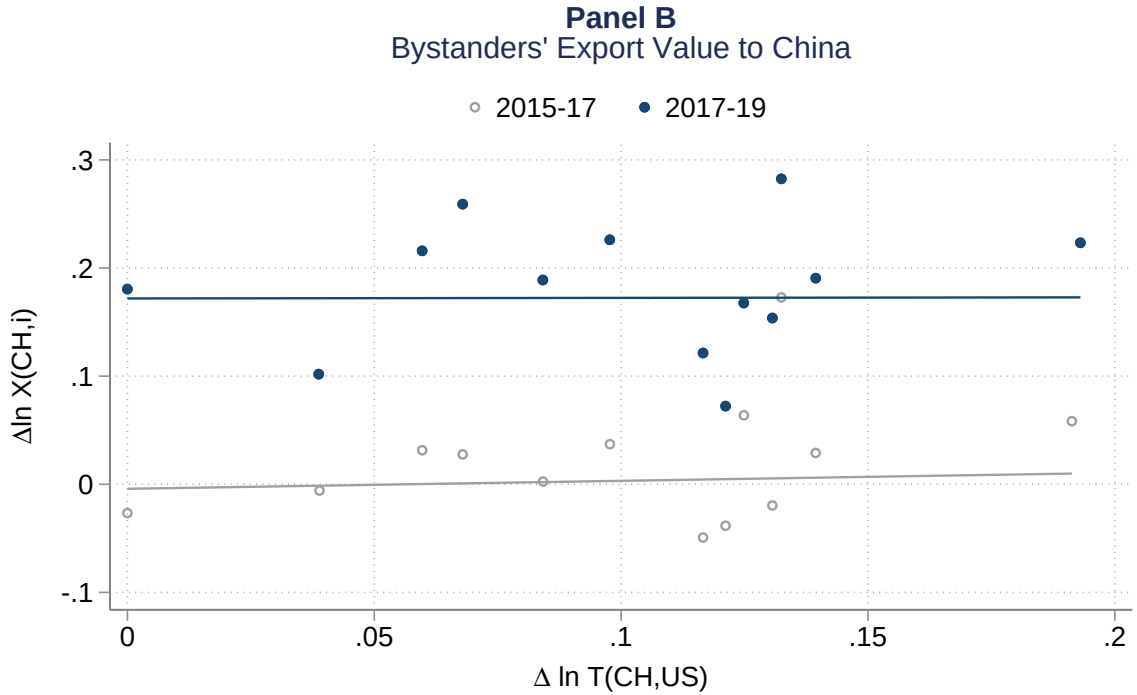
Pre-period: β=0.07 (0.18).

▸ fe

RW Exports to CH on ΔT_{US}^{CH}

Takeaway 1: RW exports to CH flat with CH tariff

$$\Delta X_{RW\omega}^{CH} = \alpha + \beta \Delta T_{US\omega}^{CH} + \epsilon_{RW\omega}^{CH}$$



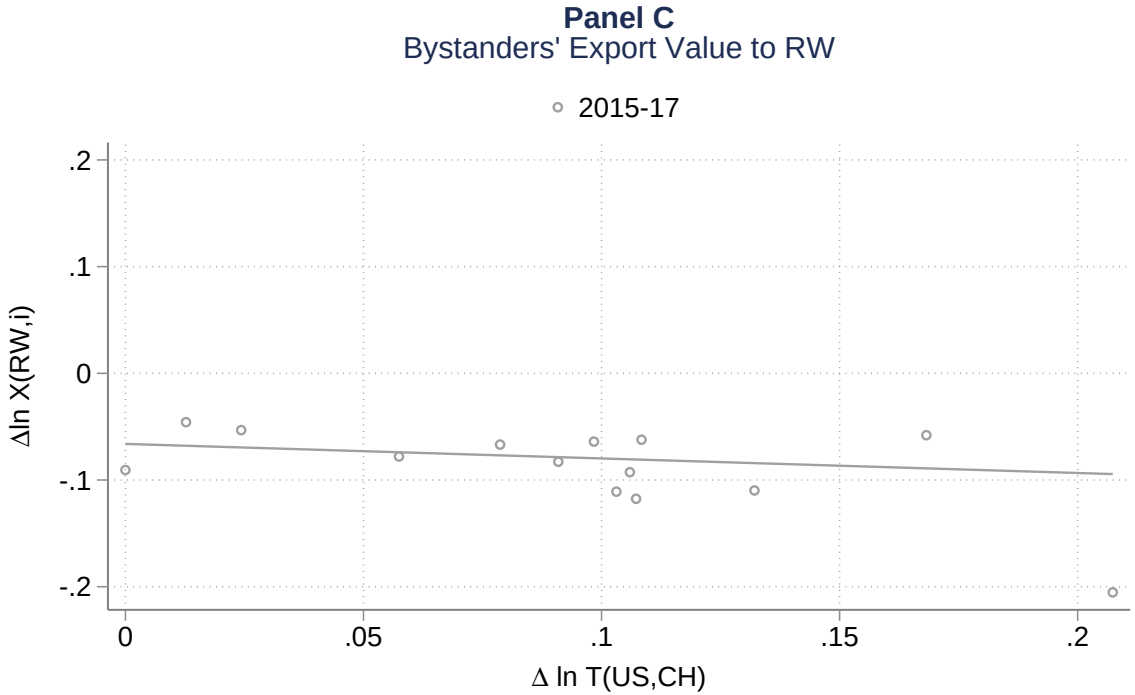
Pre-period: β=0.07 (0.18). Post-period: β=0.01 (0.19).

▸ fe

RW Exports to RW on ΔT_{CH}^{US}

Takeaway 1: RW exports to RW increase with US tariff

$$\Delta X_{RW\omega}^{RW} = \alpha + \beta \Delta T_{CH\omega}^{US} + \epsilon_{RW\omega}^{RW}$$



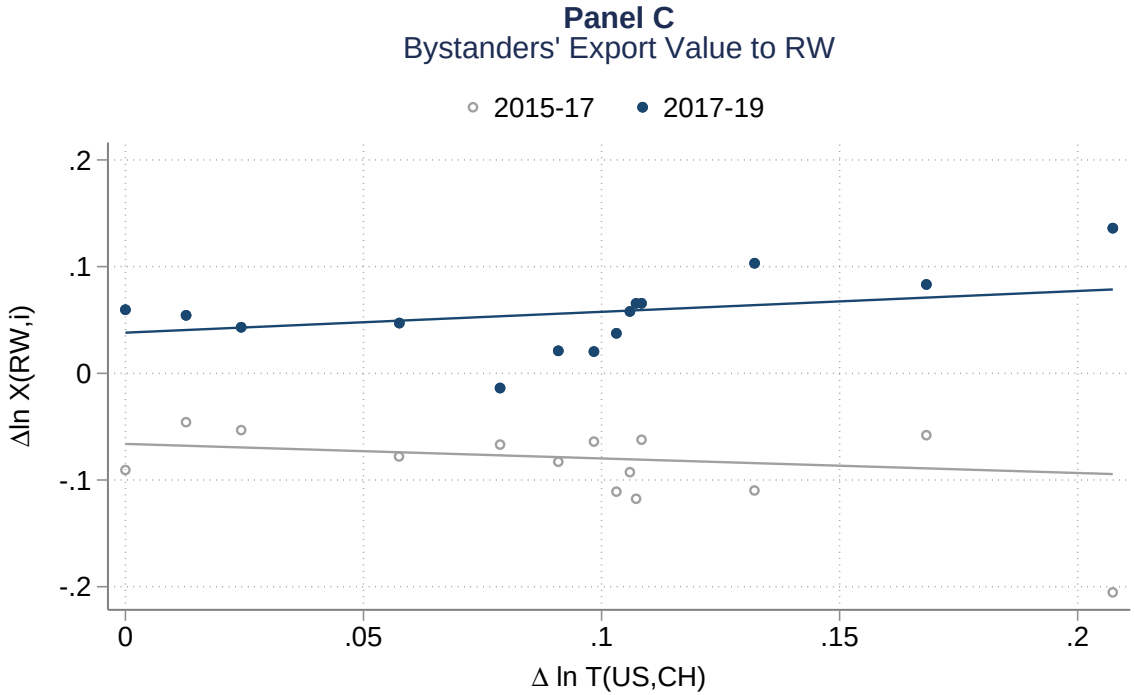
Pre-period: β=-0.14 (0.08).

▸ fe

RW Exports to RW on ΔT_{CH}^{US}

Takeaway 1: RW exports to RW increase with US tariff

$$\Delta X_{RW\omega}^{RW} = \alpha + \beta \Delta T_{CH\omega}^{US} + \epsilon_{RW\omega}^{RW}$$



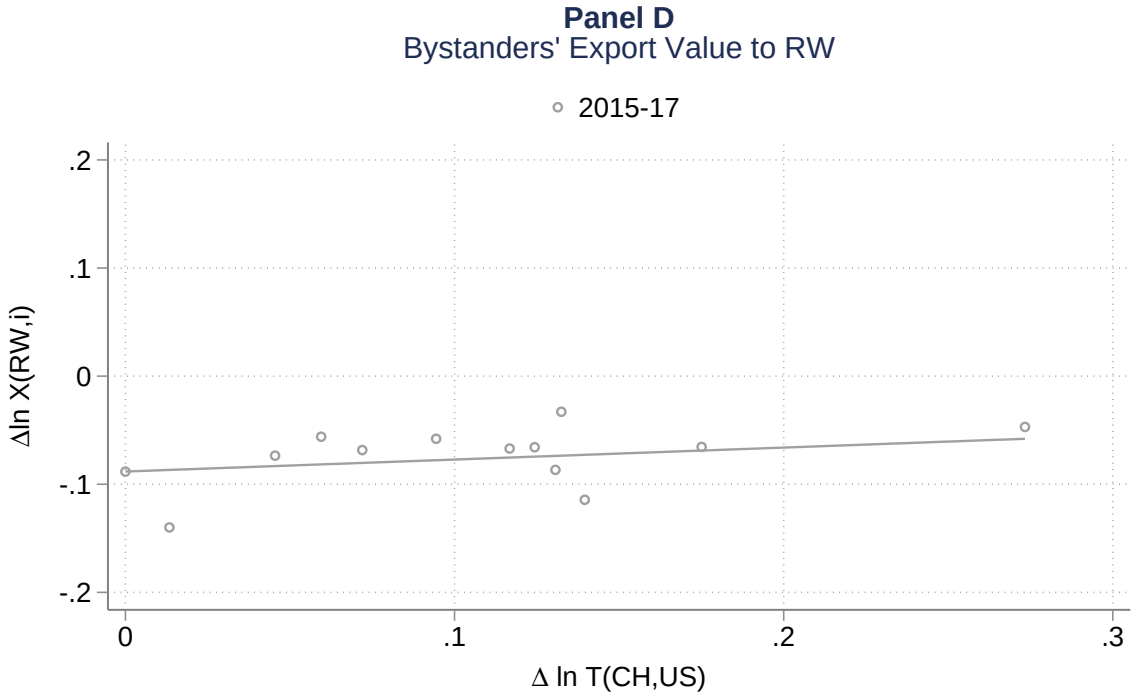
Pre-period: β=-0.14 (0.08). Post-period: β=0.20 (0.08).

▸ fe

RW Exports to RW on ΔT_{US}^{CH}

Takeaway 1: RW exports to RW increase with CH tariff

$$\Delta X_{RW\omega}^{RW} = \alpha + \beta \Delta T_{US\omega}^{CH} + \epsilon_{RW\omega}^{RW}$$



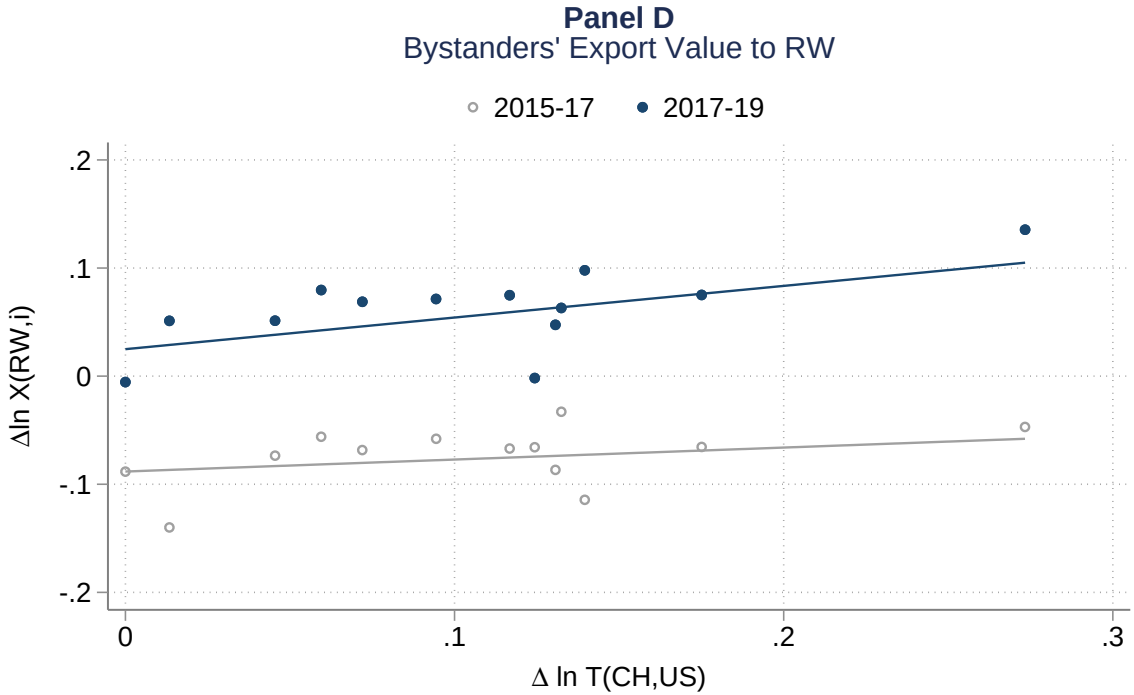
Pre-period: β=0.11 (0.08).

▸ fe

RW Exports to RW on ΔT_{US}^{CH}

Takeaway 1: RW exports to RW increase with CH tariff

$$\Delta X_{RW\omega}^{RW} = \alpha + \beta \Delta T_{US\omega}^{CH} + \epsilon_{RW\omega}^{RW}$$



Pre-period: β=0.11 (0.08). Post-period: β=0.29 (0.08).

▸ fe

Main Specification

- Full specification:

$$\begin{aligned}\Delta \ln X_{i\omega}^{n} =& \beta_{1i\omega}^{n} \Delta \ln T_{CH,\omega}^{US} + \beta_{2i\omega}^{n} \Delta \ln T_{US,\omega}^{CH} + \beta_{3i\omega}^{n} \Delta \ln T_{i,\omega}^{US} + \beta_{4i\omega}^{n} \Delta \ln T_{i,\omega}^{CH} \\ &+ \alpha_{ij}^{n} + \Omega^{n} SIZE_{i\omega} + \pi^{n} \Delta \ln X_{i\omega,t-1}^{n} + \epsilon_{i\omega}^{n},\end{aligned}$$

  - $\beta_{zi\omega}^{n} = \beta_{zi}^{n} + \beta_{zj(\omega)}^{n} + \Gamma_{z}^{n} SIZE_{zi\omega} \qquad z = 1, 2, 3, 4$
  - run separately to destinations $n = US, CH, RW$
  - country-sector fixed effects, lagged growth controls for pretrends

Main Specification

- Full specification:

$$\Delta \ln X^n_{i\omega} = \beta^n_{1i\omega} \Delta \ln T^{US}_{CH,\omega} + \beta^n_{2i\omega} \Delta \ln T^{CH}_{US,\omega} + \beta^n_{3i\omega} \Delta \ln T^{US}_{i,\omega} + \beta^n_{4i\omega} \Delta \ln T^{CH}_{i,\omega} + \alpha^n_{ij} + \Omega^n SIZE_{i\omega} + \pi^n \Delta \ln X^n_{i\omega,t-1} + \epsilon^n_{i\omega},$$

  - $\beta^n_{zi\omega} = \beta^n_{zi} + \beta^n_{zj(\omega)} + \Gamma^n_z SIZE_{zi\omega} \qquad z = 1, 2, 3, 4$
  - run separately to destinations $n = US, CH, RW$
  - country-sector fixed effects, lagged growth controls for pretrends
  - $SIZE_{zi\omega}$ contains three proxies:
    - ★ share US (or CH) imports in global imports in ω
    - ★ share of exporter i exports in global imports in ω
    - ★ share of variety $i\omega$ in destination n imports

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- Full specification:

$$\Delta \ln X_{i\omega}^{n} = \beta_{1i\omega}^{n} \Delta \ln T_{CH,\omega}^{US} + \beta_{2i\omega}^{n} \Delta \ln T_{US,\omega}^{CH} + \beta_{3i\omega}^{n} \Delta \ln T_{i,\omega}^{US} + \beta_{4i\omega}^{n} \Delta \ln T_{i,\omega}^{CH} + \alpha_{ij}^{n} + \Omega^{n} SIZE_{i\omega} + \pi^{n} \Delta \ln X_{i\omega,t-1}^{n} + \epsilon_{i\omega}^{n},$$

  - $\beta_{zi\omega}^{n} = \beta_{zi}^{n} + \beta_{zj(\omega)}^{n} + \Gamma_{z}^{n} SIZE_{zi\omega} \qquad z = 1, 2, 3, 4$
  - run separately to destinations $n = US, CH, RW$
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  - $SIZE_{zi\omega}$ contains three proxies:
    - ★ share US (or CH) imports in global imports in ω
    - ★ share of exporter i exports in global imports in ω
    - ★ share of variety $i\omega$ in destination n imports

- Predicted values:

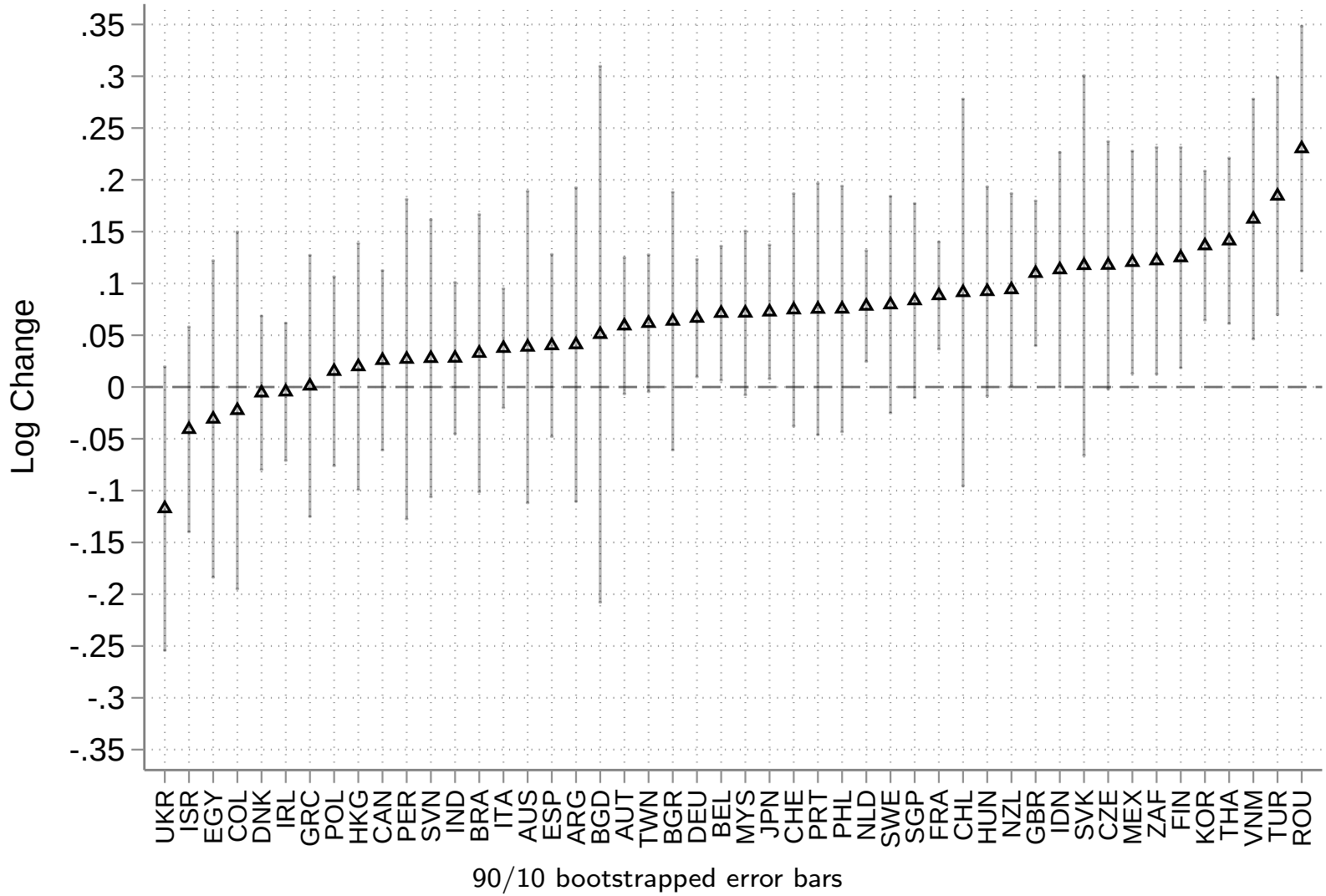
$$\widehat{\Delta \ln X_{i}^{WD}} = \sum_{\omega} \sum_{n} \lambda_{i\omega}^{n} \left(\widehat{\beta_{1i\omega}^{n}} \Delta \ln T_{CH,\omega}^{US} + \widehat{\beta_{2i\omega}^{n}} \Delta \ln T_{US,\omega}^{CH} + \widehat{\beta_{3i\omega}^{n}} \ln T_{i,\omega}^{US} + \widehat{\beta_{4i\omega}^{n}} \Delta \ln T_{i,\omega}^{CH} \right)$$

  - $\lambda_{i\omega}^{n}$ pre-war export shares of variety $i\omega$ in total exports of i to n

▸ homogenous ▸ rw

Relative Export Growth in Targeted Products

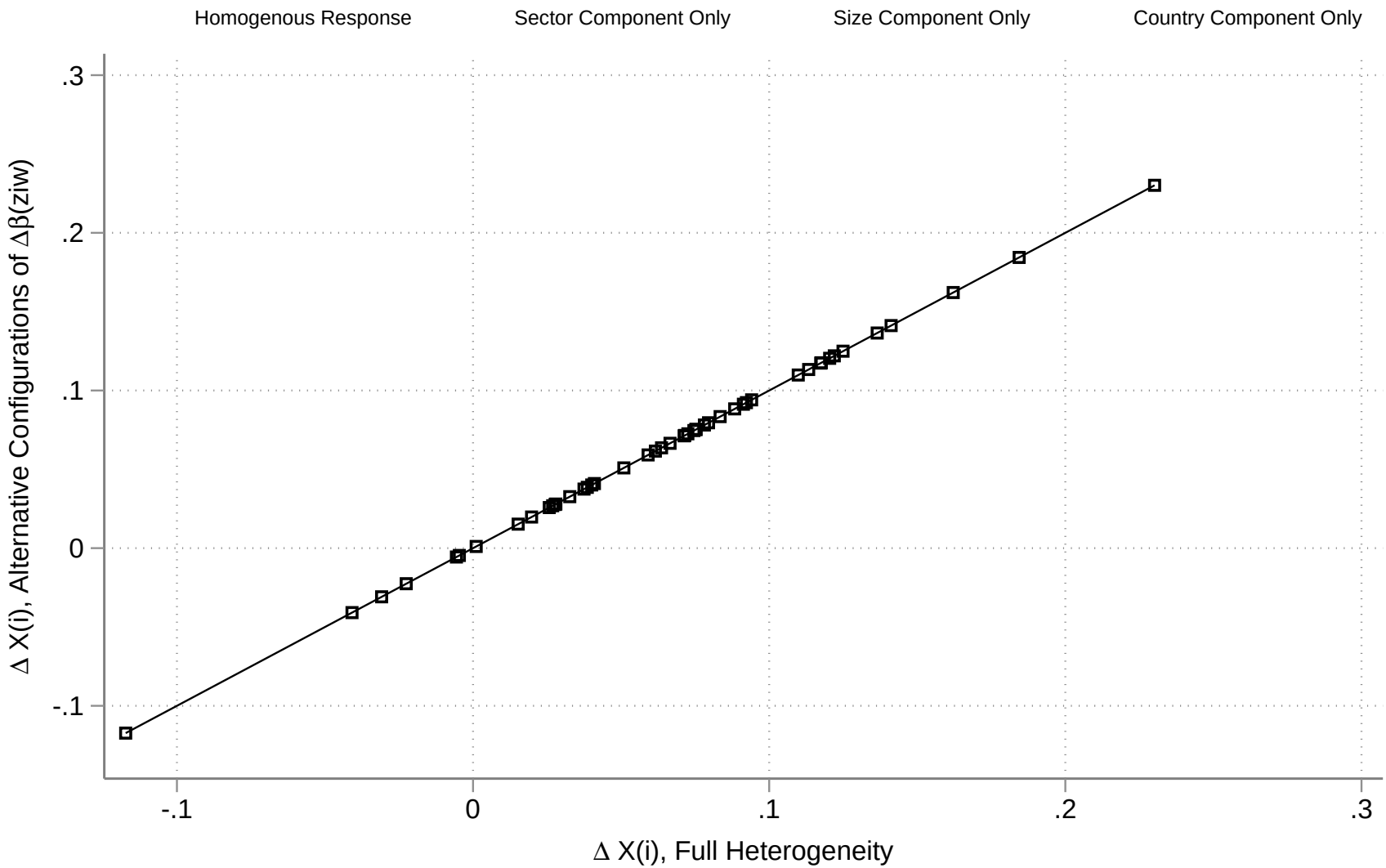
Takeaway 2: Large Heterogeneity in Predicted Exporter Growth



▸ correlates

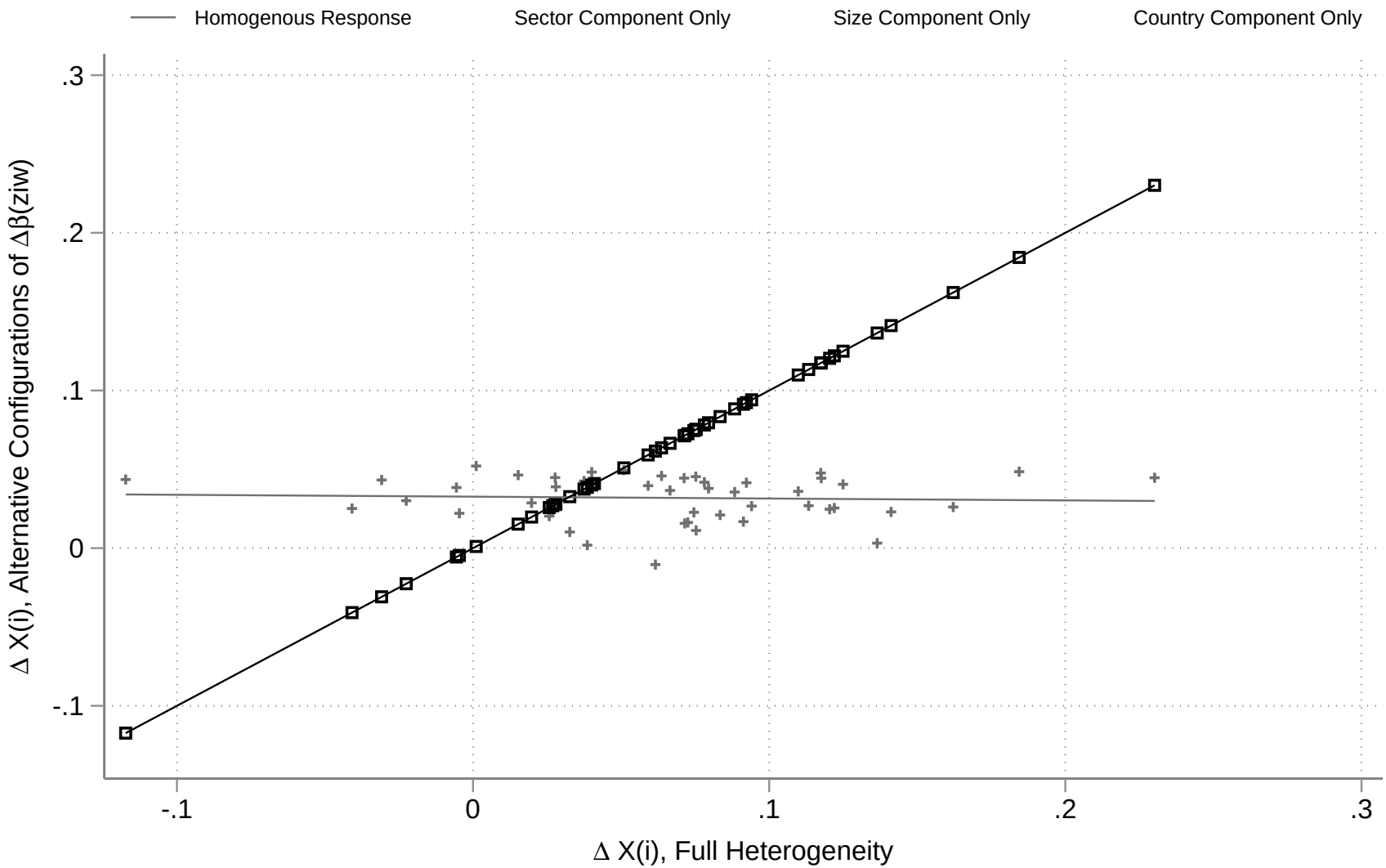
Decomposing Relative Exports, $\beta^n_{zi\omega} = \beta^n_{zi} + \beta^n_{zj(\omega)} + \Gamma^n_z SIZE_{zi\omega}$

Takeaway 3: Importance of Country Component



Decomposing Relative Exports, $\beta^n_{zi\omega} = \beta^n_{z\dot{\imath}} + \beta^n_{zj(\omega)} + \Gamma^n_z SIZE_{zi\omega}$

Takeaway 3: Importance of Country Component



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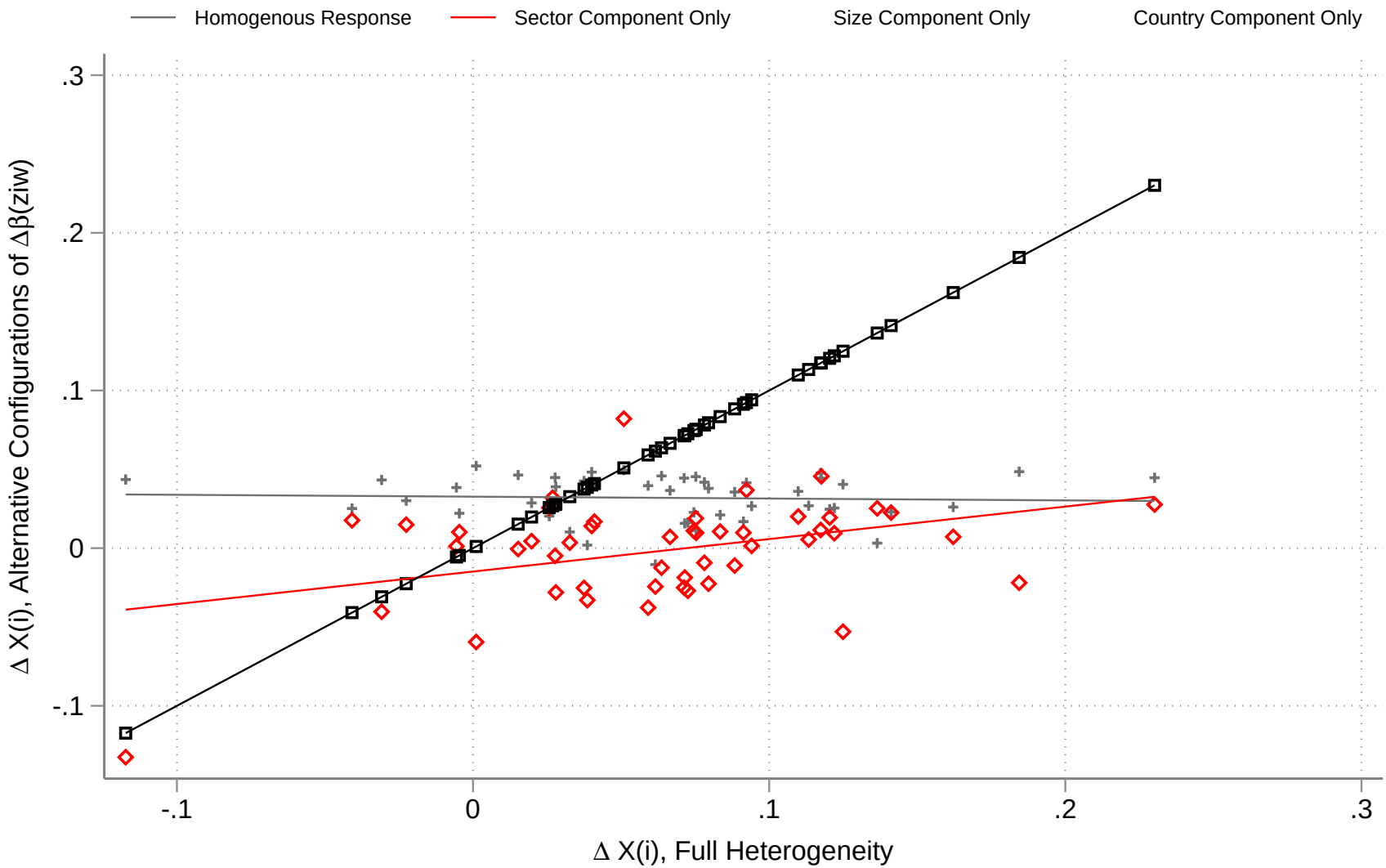

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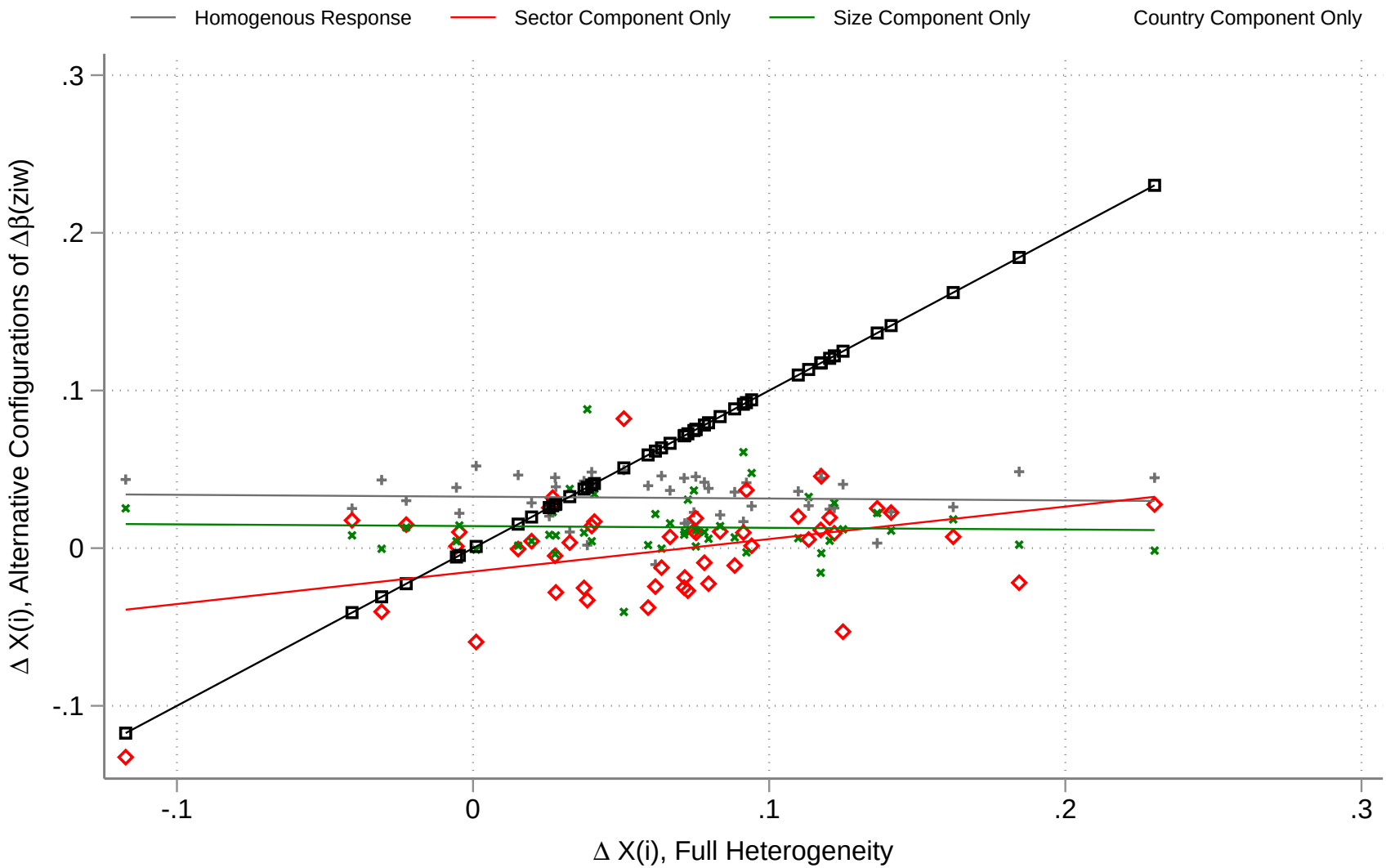

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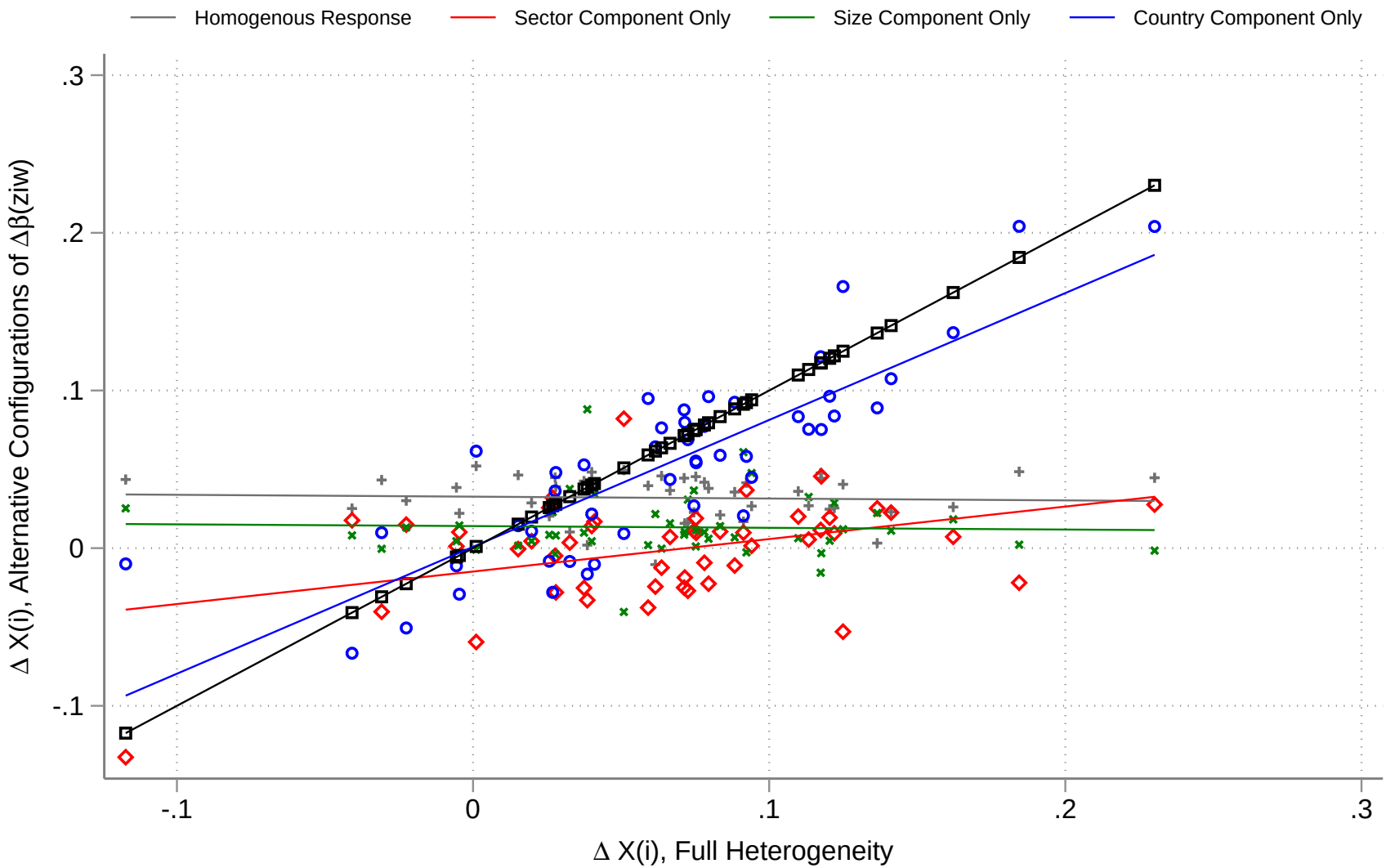
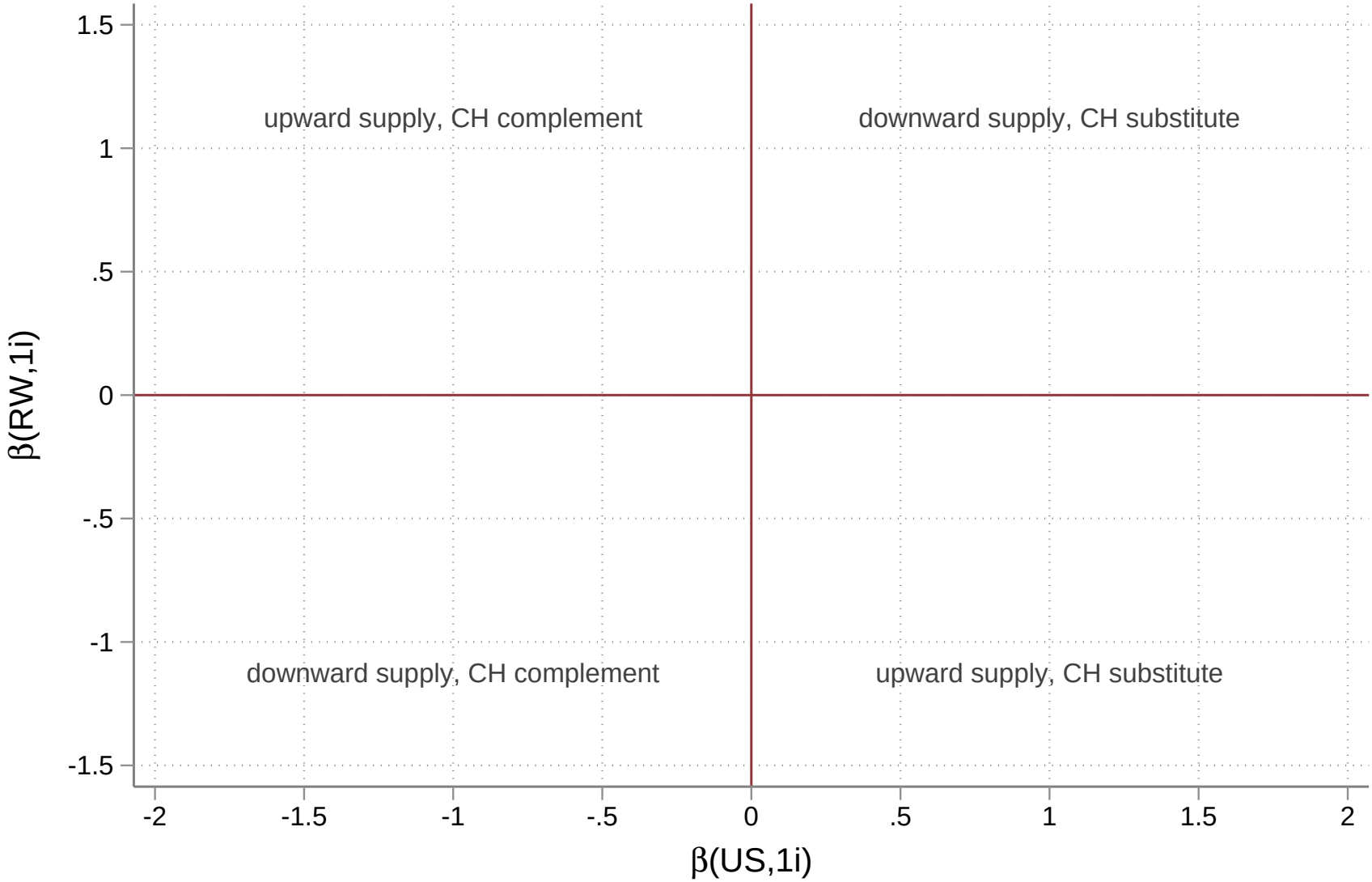
Takeaway 3: Importance of Country Component



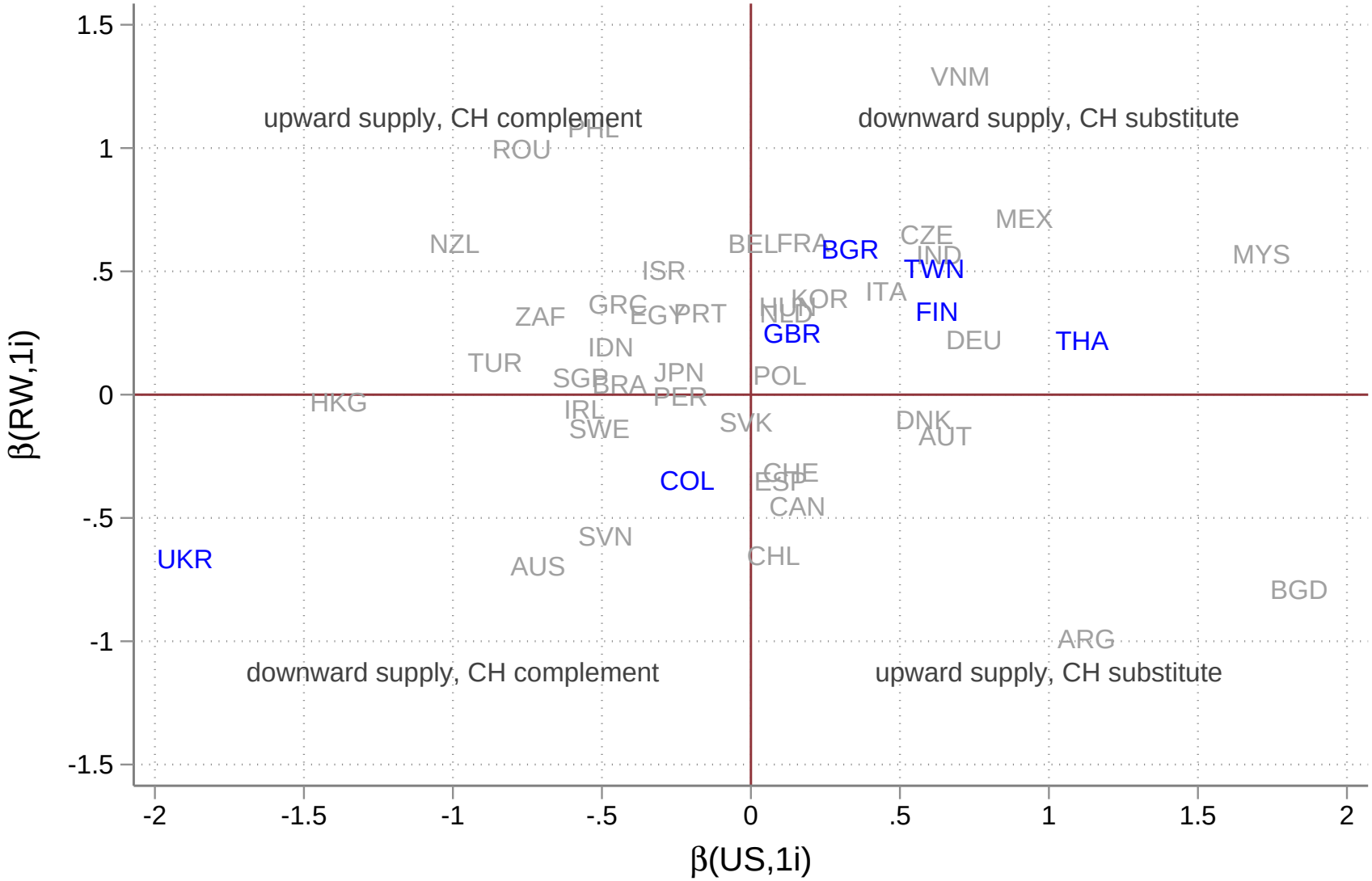
Supply and Demand Forces

Takeaway 4: Supply and Demand Forces Driving Response



Supply and Demand Forces

Takeaway 4: Supply and Demand Forces Driving Response



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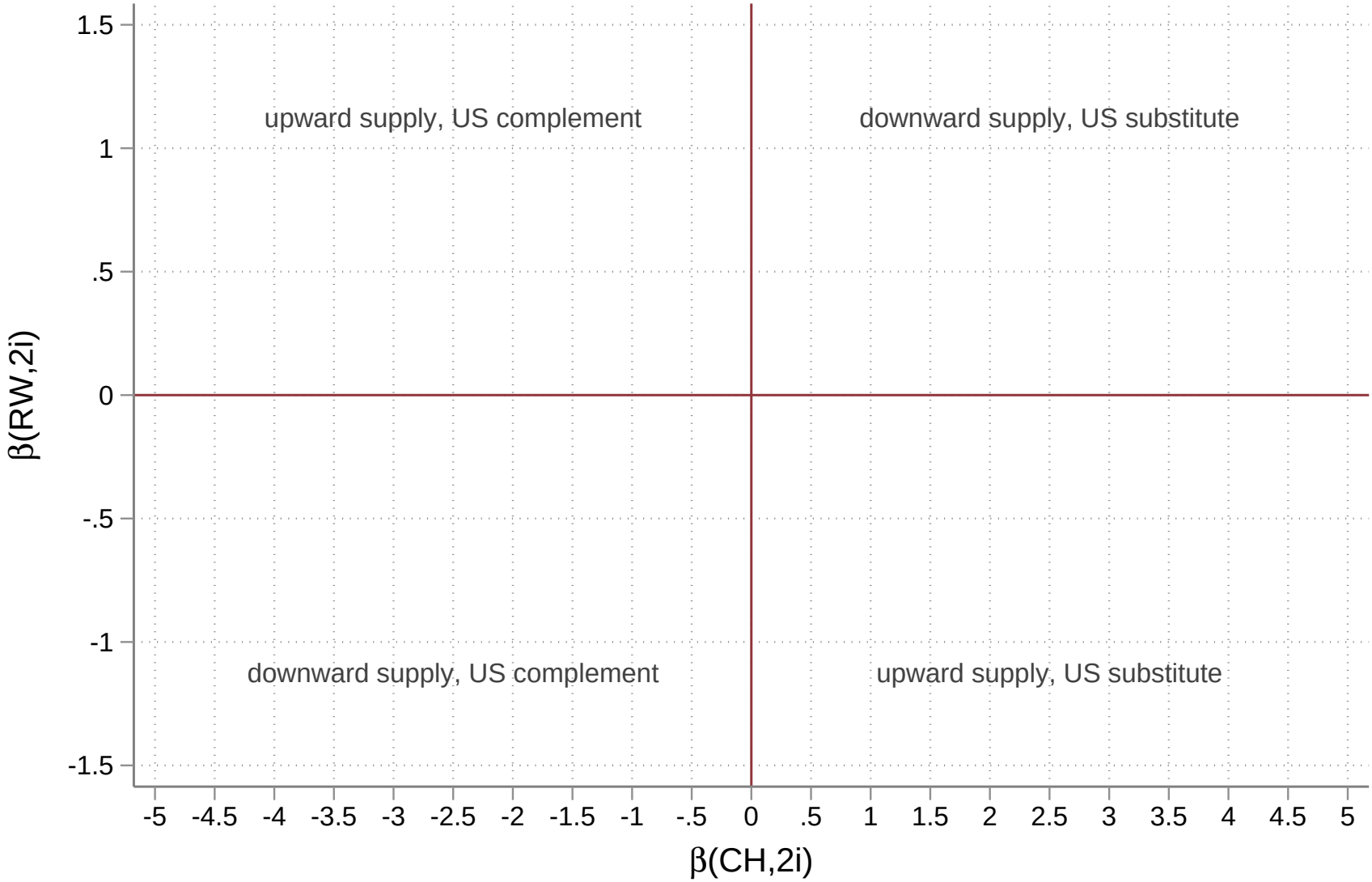

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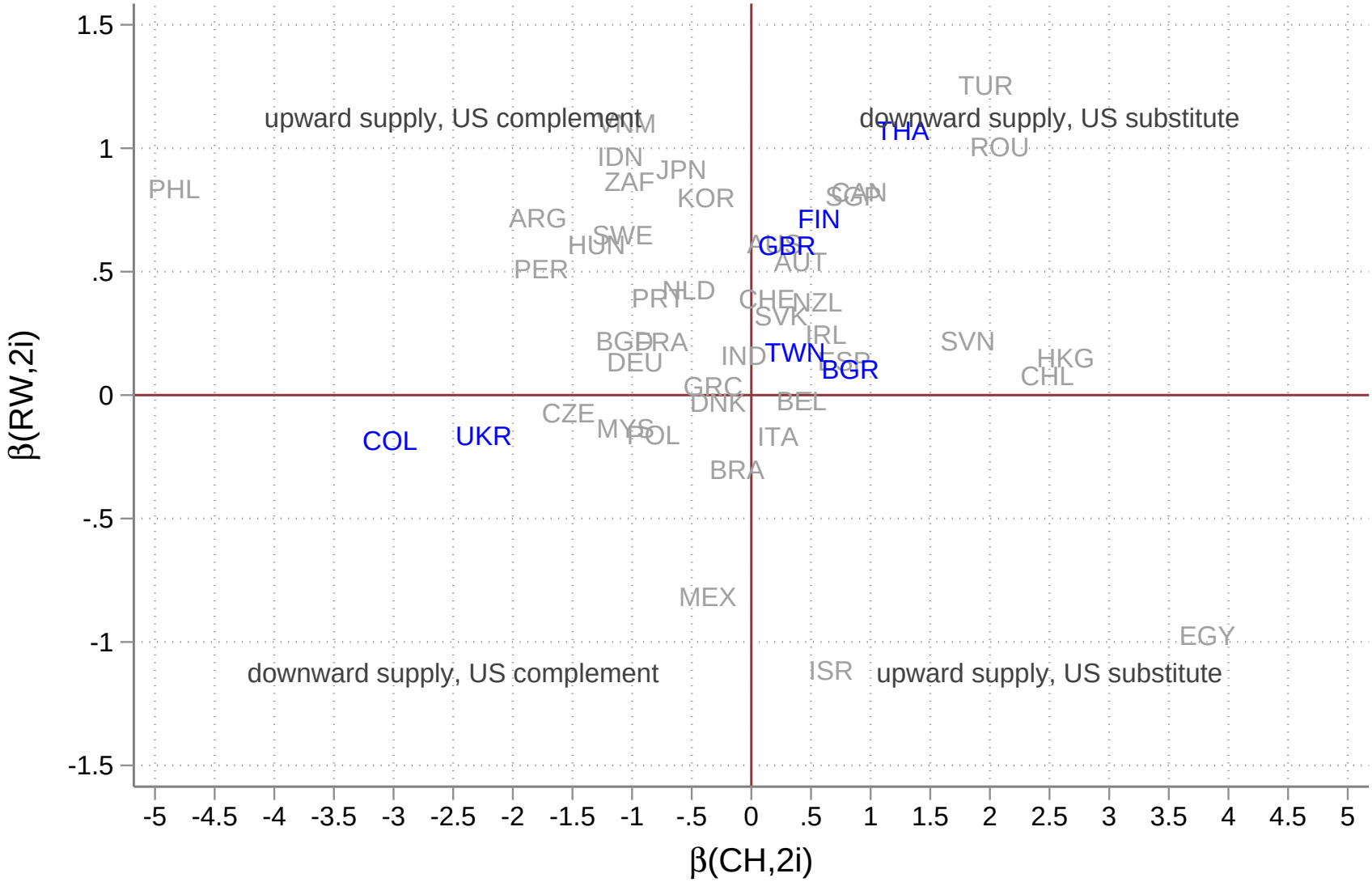
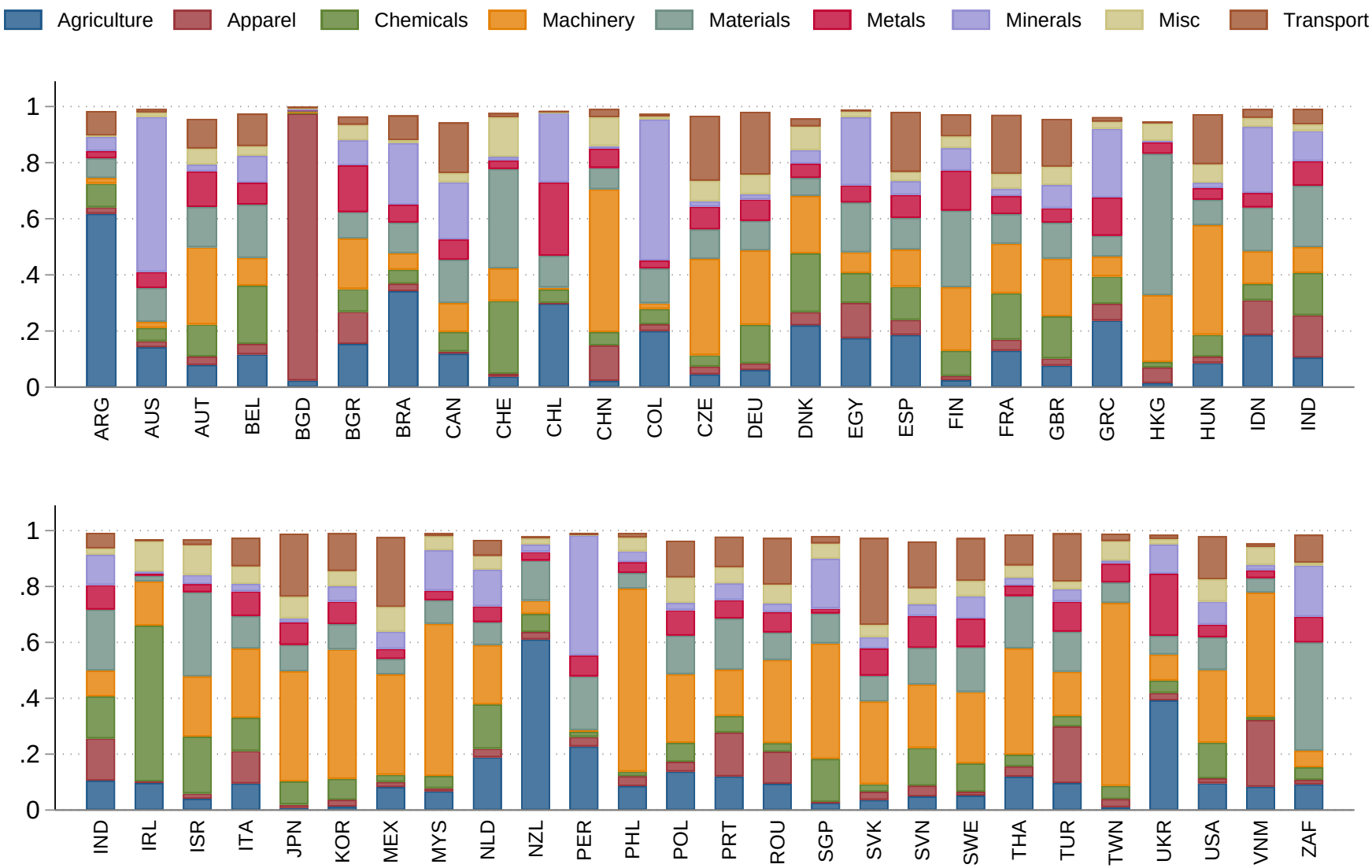


Conclusion

- US-China trade war was seen as a major turning point in the globalization era
  - our results do not support this view, at least for the time horizon we analyze
  - several countries increased global exports in products with higher US-China tariffs, relative to non-taxed products

- Future work to uncover the factors driving the country-component of tariff elasticities

Countries' Pre-War Export Baskets



back

Export Response to *US*, *CH*, *RW*, All Coefficients

	(1) $\Delta \ln X^{US}_{i,\omega,t}$	(2) $\Delta \ln X^{CH}_{i,\omega,t}$	(3) $\Delta \ln X^{RW}_{i,\omega,t}$
$\Delta T^{US}_{CH,\omega}$ (β_1)	0.21*	-0.84***	0.12
	(0.11)	(0.18)	(0.09)
$\Delta T^{CH}_{US,\omega}$ (β_2)	-0.02	-0.06	0.35***
	(0.11)	(0.20)	(0.08)
$\Delta T^{US}_{i,\omega}$ (β_3)	-0.59**	-0.12	0.09
	(0.29)	(0.34)	(0.20)
$\Delta T^{CH}_{i,\omega}$ (β_4)	-0.15	-1.46***	-0.19
	(0.21)	(0.40)	(0.20)
Pre-trend control?	Yes	Yes	Yes
Country $\times$ Sector FE	Yes	Yes	Yes
R2	0.07	0.08	0.11
N	102,901	90,128	223,556

back

Robustness: RW to RW

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\Delta T^{US}_{CH,\omega}$ (β_1)	0.12	0.12	0.10	0.29**	0.11	0.08	0.07
	(0.09)	(0.08)	(0.09)	(0.11)	(0.09)	(0.08)	(0.08)
$\Delta T^{CH}_{US,\omega}$ (β_2)	0.35***	0.32***	0.29***	0.37***	0.34***	0.33***	0.34***
	(0.08)	(0.07)	(0.08)	(0.09)	(0.08)	(0.08)	(0.08)
$\Delta T^{US}_{i,\omega}$ (β_3)	0.09	0.09	0.26	-0.19	0.12	0.52***	0.54***
	(0.20)	(0.18)	(0.20)	(0.26)	(0.20)	(0.19)	(0.19)
$\Delta T^{CH}_{i,\omega}$ (β_4)	-0.19	-0.20	-0.01	0.73***	-0.21	0.30	0.26
	(0.20)	(0.19)	(0.20)	(0.27)	(0.20)	(0.18)	(0.18)
Pre-trend control	Yes	Yes	No	Yes	Yes	Yes	Yes
Fixed Effects	cty-ind9	cty-ind9	cty-ind9	cty-hs2	ind9	cty	none
Winsorized	No	Yes	No	No	No	No	No
R2	.11	.097	.009	.14	.099	.1	.098
N	223,556	223,556	223,556	223,552	223,556	223,556	223,556
Exporters	48	48	48	48	48	48	48

Outcome is the log change in bystander countries' exports to countries other than the US and China. Column 1 is the baseline specification. Column 2 winsorizes the top and bottom 1% of the outcome. Column 3 excludes the pre-trend control. Columns 4-7 show robustness to alternative fixed effects: respectively, country-hs2, industry only, country only, and none.

return

Framework Details

- In country i, a bundle K_{ij} of inputs is used in tradeable sector j
- Each unit $k \in K_{ij}$ solves:

$$\max_{\omega} \max_{x} \left(p_{i\omega} z_{i\omega}^{0} e_{\omega}^{k} \right)^{1-\alpha_j^I} x^{\alpha_j^I} - c_{ij}^I x,$$

  - $z_{i\omega}^{0} = Z_{i\omega} K_{i\omega}^{\gamma_i}$ captures scale effects
  - e_{ω}^{k} is distributed Frechet with shape parameter ε_i
  - c_{ij}^I is the cost of intermediates

- Yields $X_{i\omega} \equiv A_{ij} p_{i\omega}^{\frac{1}{b_i}} Z_{i\omega}$ where

$$A_{ij} \equiv \left(\frac{c_{ij}^I}{\alpha_j^I} \right)^{\frac{\alpha_j^I}{\alpha_j^I - 1}} K_{ij}^{\frac{1}{b_i \varepsilon_i}} r_{ij}^{\frac{b_i - 1}{b_i}}$$

where

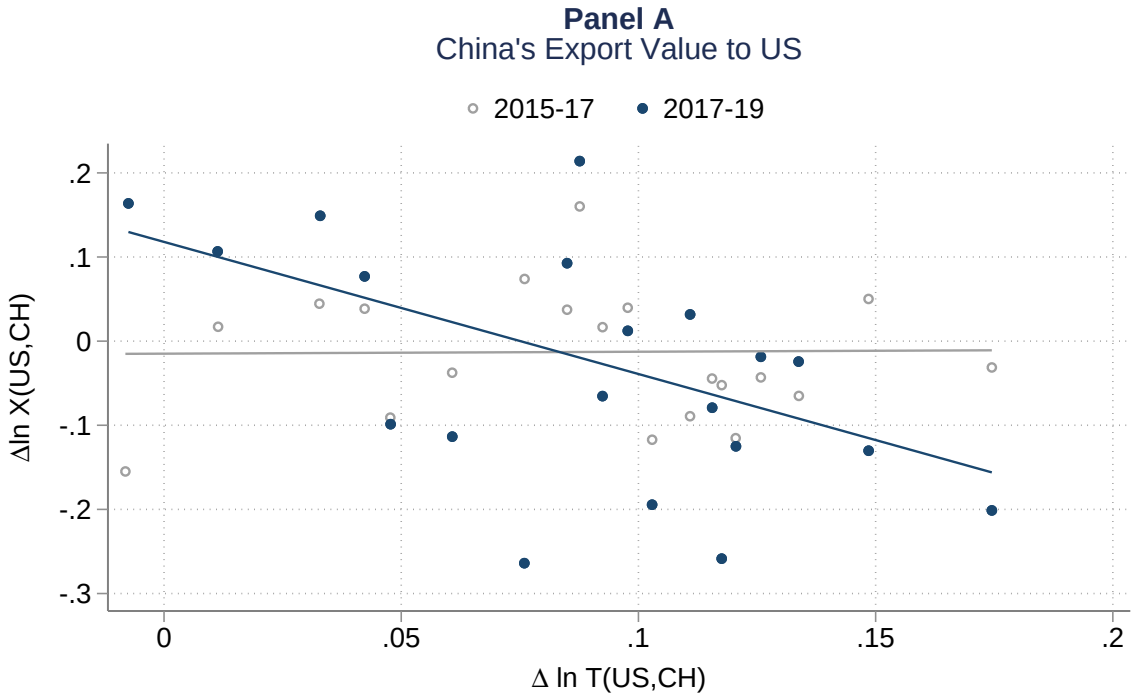
$$r_{ij}^{\varepsilon_i} = \sum_{\omega \in \Omega^j} \left(p_{i\omega} \left(c_{ij}^I / \alpha_j^I \right)^{\frac{\alpha_j^I}{\alpha_j^I - 1}} z_{i\omega}^{0} \right)^{\varepsilon_i}$$

return

China Exports to US on ΔT_{CH}^{US}

China's exports to US fall with US tariff

$$\Delta X_{CH\omega}^{US} = \alpha_j + \beta \Delta T_{CH\omega}^{US} + \epsilon_{CH\omega}^{US}$$



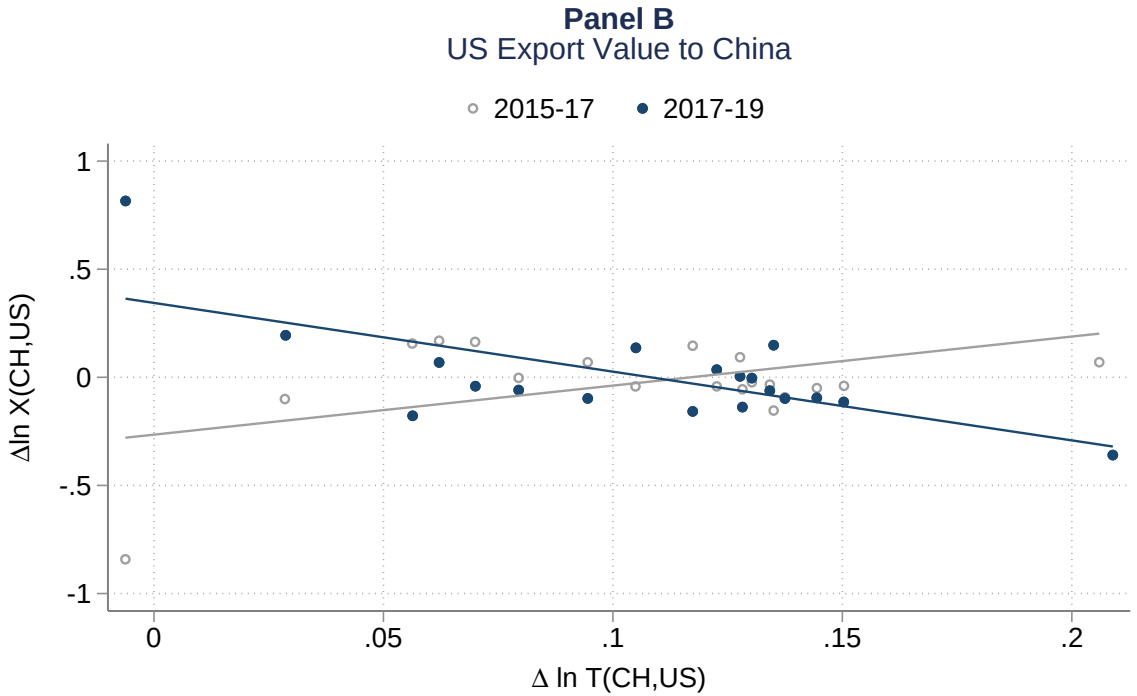
Pre-period: β=0.02 (0.30). Post-period: β=-1.58 (0.29).

back

US Exports to China on ΔT_{US}^{CH}

US exports to CH fall with CH tariff

$$\Delta X_{US\omega}^{CH} = \alpha_j + \beta \Delta T_{US\omega}^{CH} + \epsilon_{US\omega}^{CH}$$



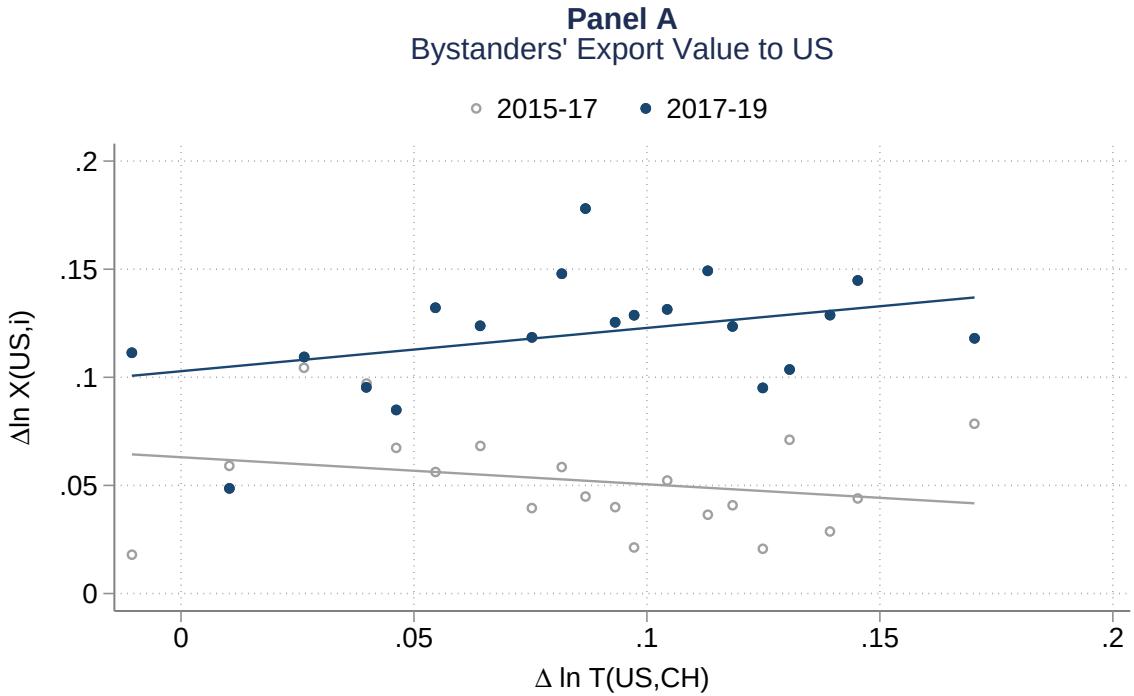
Pre-period: β=2.26 (0.48). Post-period: β=-3.18 (0.44).

back

RW Exports to US on ΔT_{CH}^{US}

Takeaway 1: RW exports to US increase with US tariff

$$\Delta X_{RW\omega}^{US} = \alpha_{ij} + \beta \Delta T_{CH\omega}^{US} + \epsilon_{RW\omega}^{US}$$



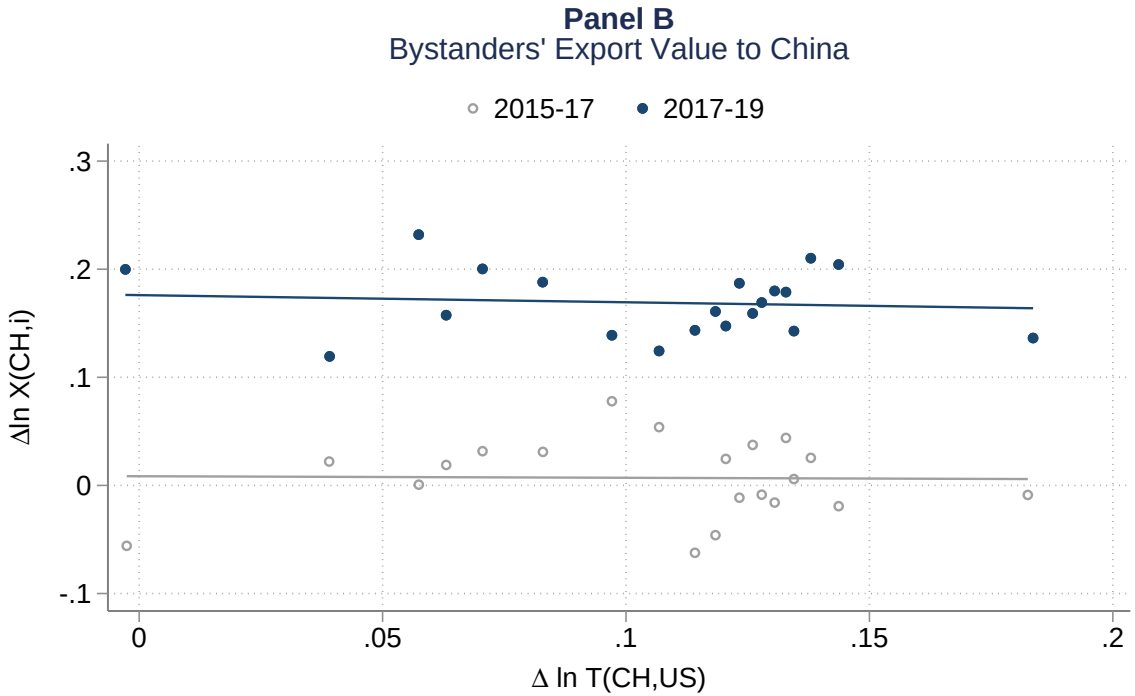
Pre-period: β=-0.12 (0.11). Post-period: β=0.20 (0.11).

back

RW Exports to CH on ΔT_{US}^{CH}

Takeaway 1: RW exports to CH flat with CH tariff

$$\Delta X_{RW\omega}^{CH} = \alpha_{ij} + \beta \Delta T_{US\omega}^{CH} + \epsilon_{RW\omega}^{CH}$$



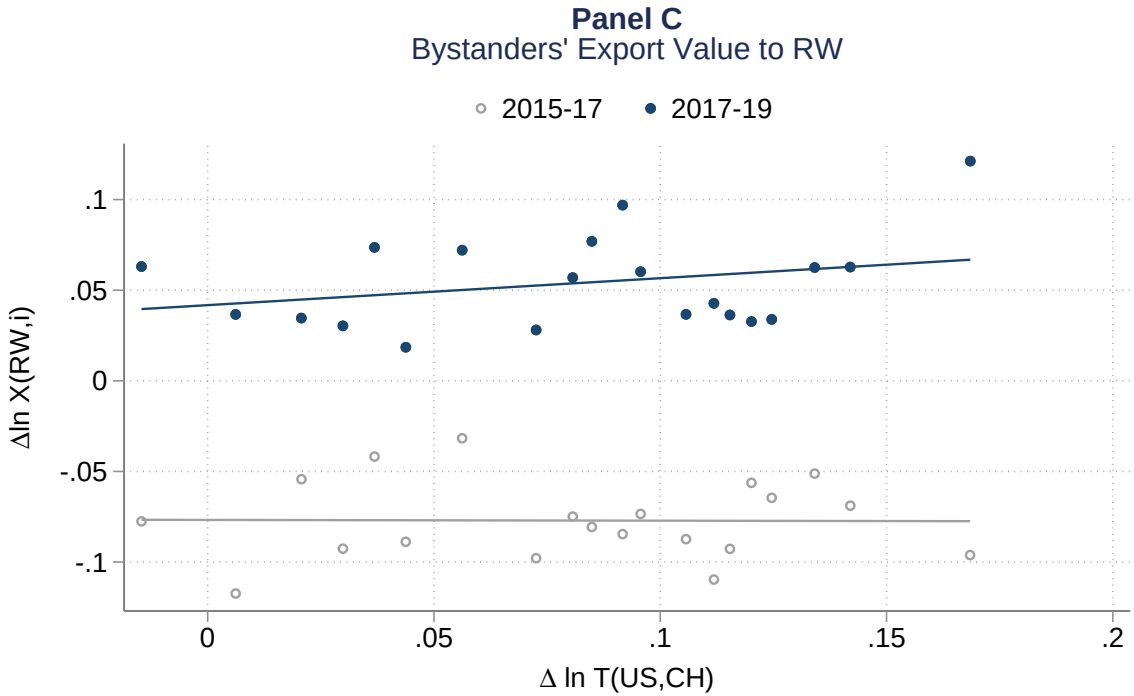
Pre-period: β=-0.01 (0.18). Post-period: β=-0.06 (0.20).

back

RW Exports to RW on ΔT_{CH}^{US}

Takeaway 1: RW exports to RW increase with US tariff

$$\Delta X_{RW\omega}^{RW} = \alpha_{ij} + \beta \Delta T_{CH\omega}^{US} + \epsilon_{RW\omega}^{RW}$$



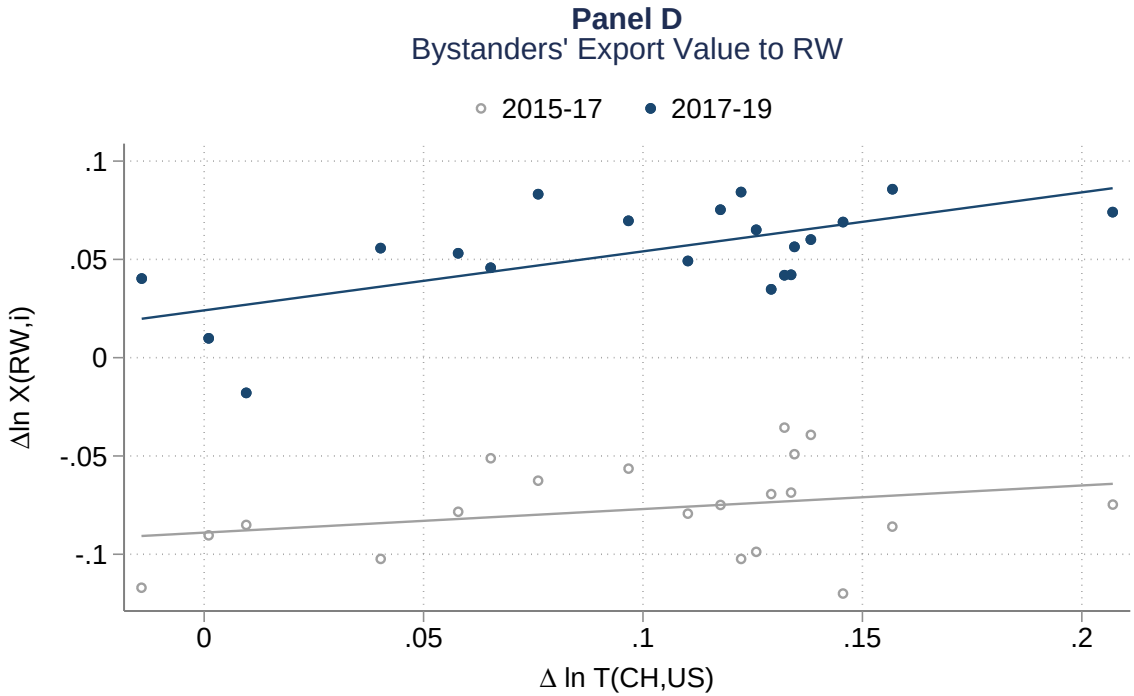
Pre-period: β=-0.00 (0.09). Post-period: β=0.15 (0.09).

back

RW Exports to RW on ΔT_{US}^{CH}

Takeaway 1: RW exports to RW increase with CH tariff

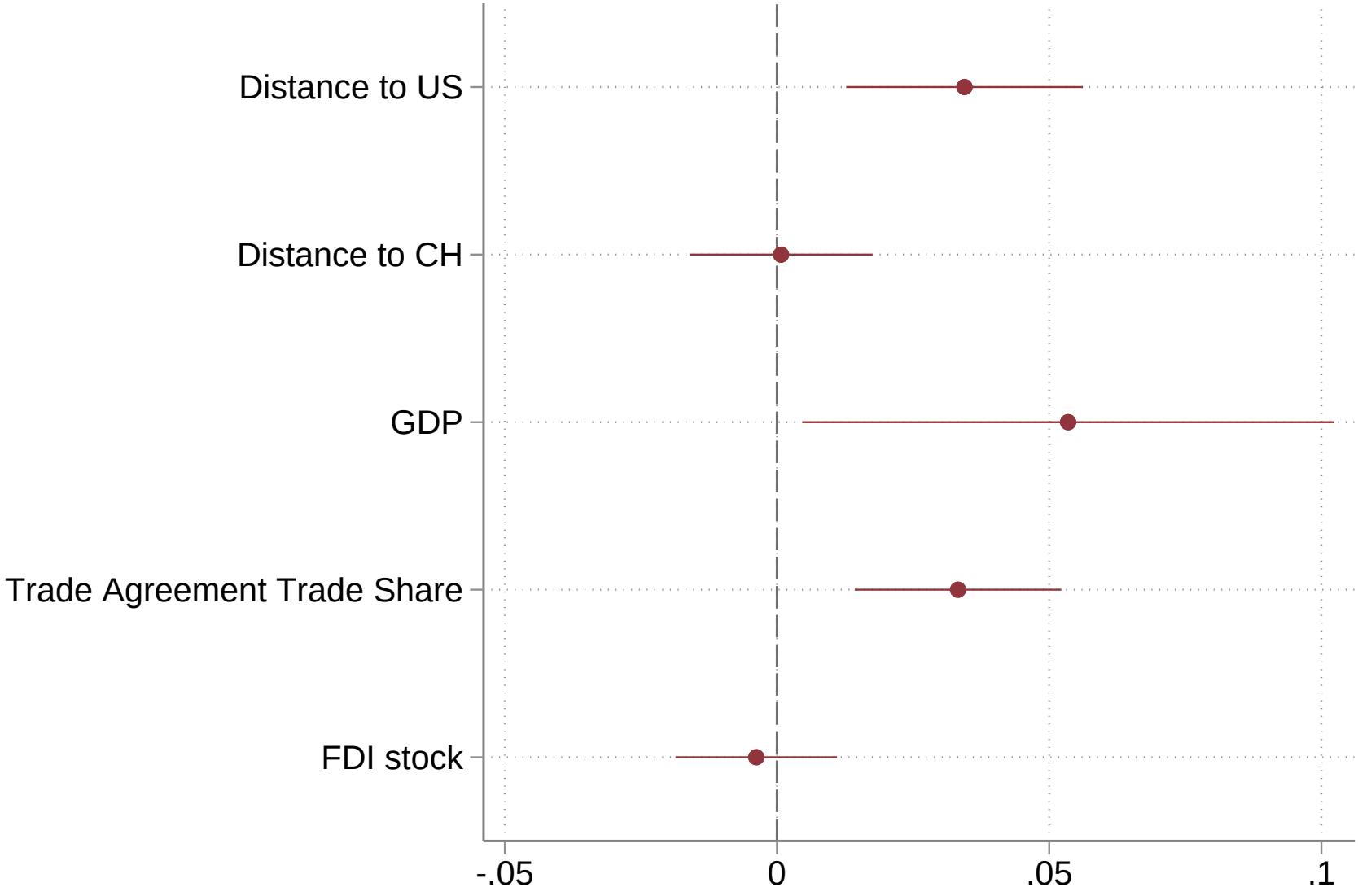
$$\Delta X_{RW\omega}^{RW} = \alpha_{ij} + \beta \Delta T_{US\omega}^{CH} + \epsilon_{RW\omega}^{RW}$$



Pre-period: β=0.12 (0.08). Post-period: β=0.30 (0.08).

back

Export Growth Correlates



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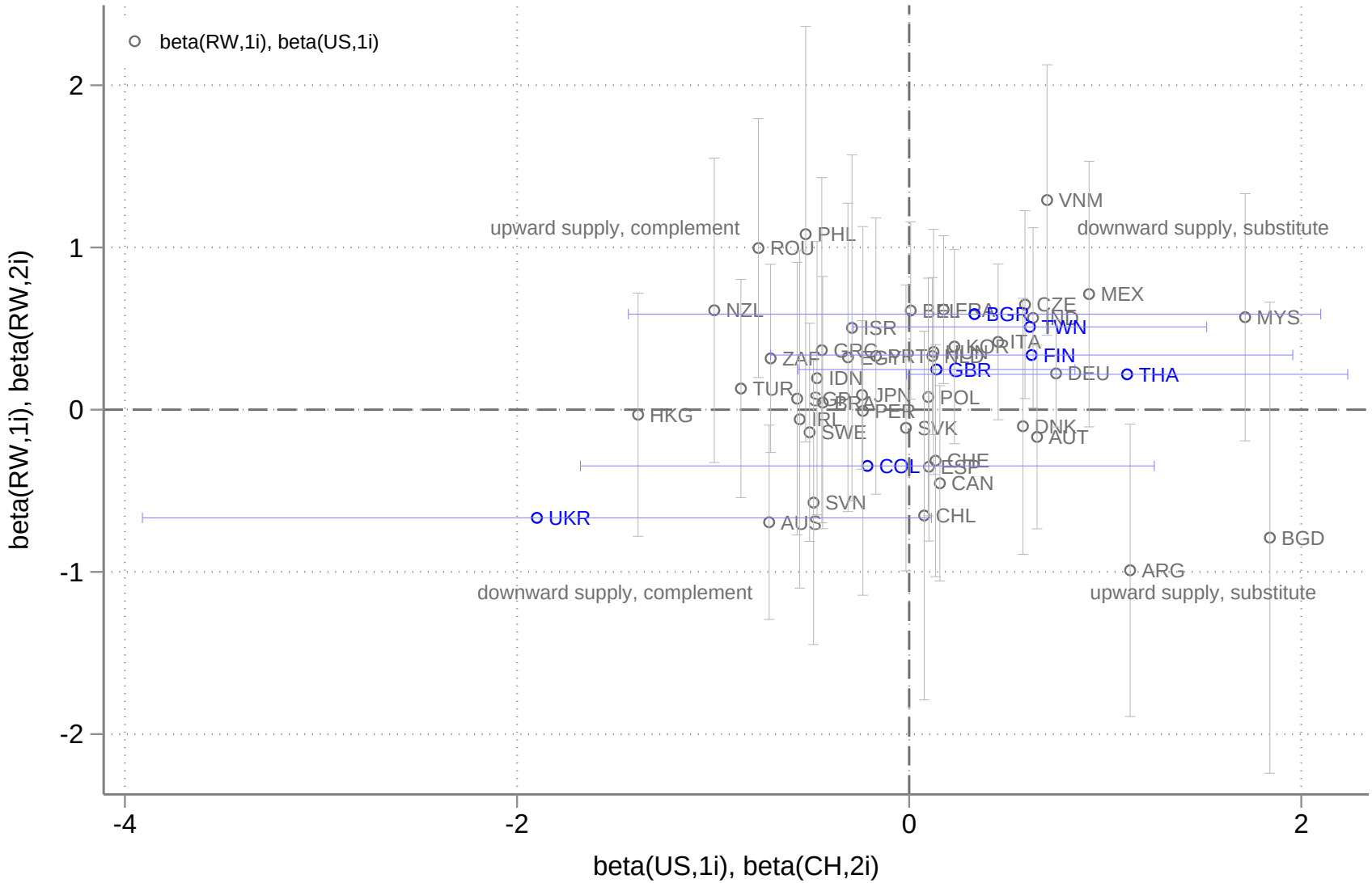
Supply and Demand Forces

Takeaway 4: Supply and Demand Forces Driving Response



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Supply and Demand Forces

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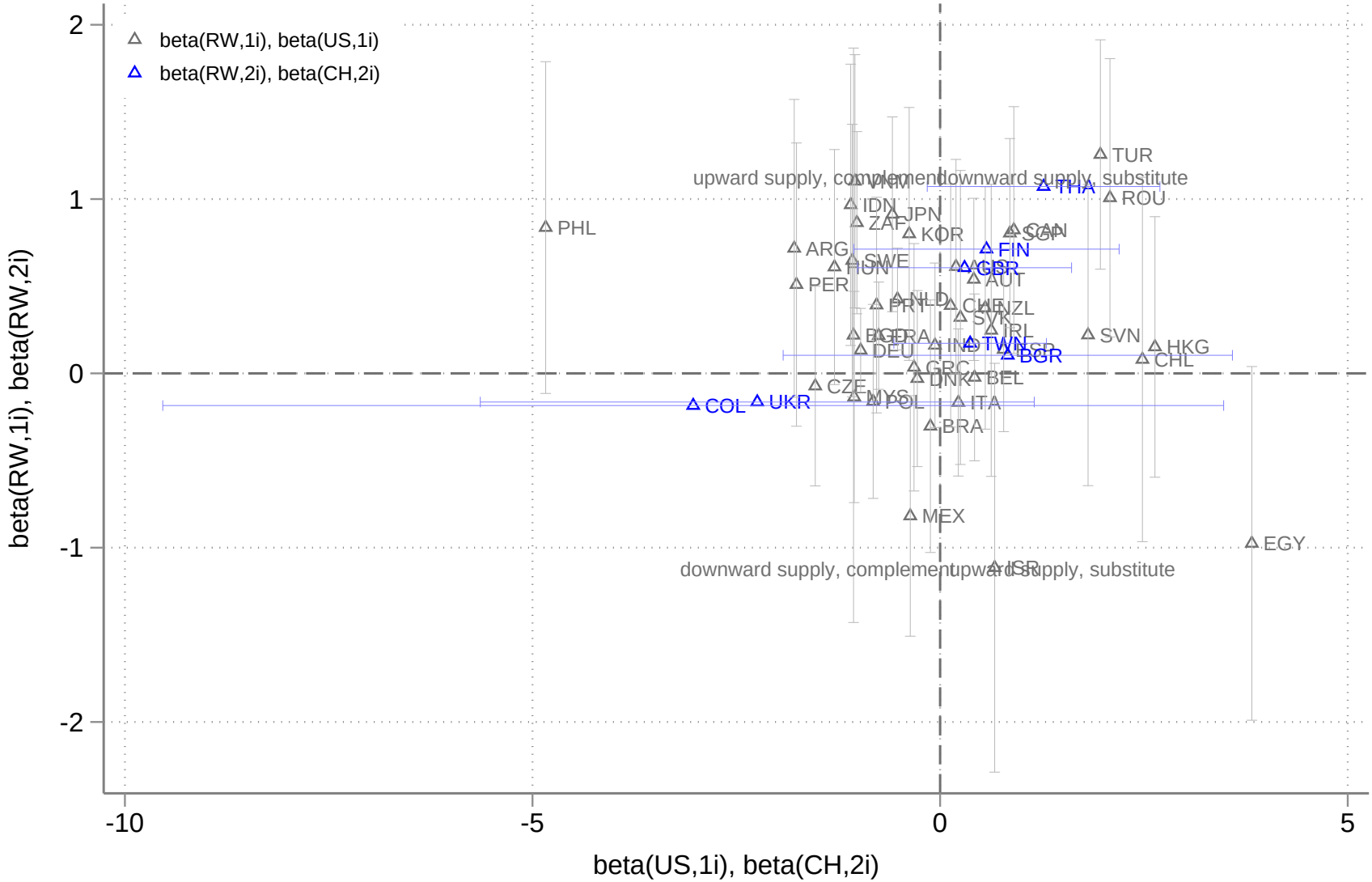

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