Dynamic Trade Elasticities

Alessandria, Khan, Khederlarian, Ruhl, and Steinberg

ASSA Annual Meetings — January 2024

Intro

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- This paper:
  - How do policy dynamics shape trade dynamics?
  - Key result: large differences in trade response to same tariff changes

The Standard View

- Object of interest: cumulative trade elasticity

$$\varepsilon_h = \frac{\log Y_{t+h} - \log Y_{t-1}}{\log \tau_{t+h} - \log \tau_{t-1}} = \frac{\Delta_h y_t}{\Delta_h \tau_t}, \; h = 0, \ldots, \infty$$

- Canonical quantitative exercise: unanticipated & permanent change in tariffs
- Welfare gains, counterfactual analysis, determined by

1 Short-run trade elasticity
   - Holding constant accumulatable factors—specifically, number of exporting firms
   - Key: tariff change *unanticipated*—otherwise extensive margin changes ahead of time

2 Long-run trade elasticity
   - Overall response once accumulatable factors have fully adjusted
   - Key: *no uncertainty* regarding future tariffs – current tariff = E[PV of future tariff]

3 Path between SR and LR

The Reality is More Complicated

- Wide range of estimates—and estimation methods—in literature
- Our perspective: variation in estimates driven by variation in policy dynamics!
  - Dynamic expectations, anticipation, phase-ins, etc.
- Fix ideas:
  - *Structural elasticity*: ε_h if $\Delta_0 \tau$ is unanticipated & permanent
  - *Measured elasticity*: Observed ε_h given trade and tariffs
- Can we recover structural elasticities from the data?
- We can study how measured trade elasticities vary w/policy

Preview - model exercise

Model experiments illustrate effects of policy dynamics

- Model w/forward-looking export participation decisions
- Study response to anticipated and uncertain reforms w/ given observed reform
- Compare measured vs structural trade elasticity

Findings:

- Anticipation increases SR trade elasticities & reduces LR elasticities
  $\Rightarrow$ Exporters act before policy changes
- Uncertainty lowers LR elasticities
  $\Rightarrow$ exporters care about expected future policy, not only current policy

Preview - empirics

Empirical evidence on how trade elasticity varies with reform type

1. Frequency/Size of tariff changes per variety over time
2. Statutory changes in applied policy regime (e.g. MFN to PTA)
3. Case studies

Findings

- Permanent changes infrequent, most policy changes are transitory
- LR responses to persistent tariff changes larger than to transitory changes
- LR response to policy regime change bigger than within regime tariff changes
- SR response to PTAs high

Related Literature

1. **Trade elasticities**
   - Gallaway et al. (2003), Baier and Bergstrand (2007), Hilberry and Hummels (2013), Yilmazkuday (2019), Anderson and Yotov (2020), Khan and Khederlarian (2021), Boehm et al. (2023)
   - Contribution: Trade elasticities depend on expectations about trade policy

2. **Trade policy uncertainty (TPU)**
   - Ruhl(2011), Handley (2014), Handley and Limão (2017), Pierce and Schott (2016), Alessandria et al (2021), Alessandria et al (2022)
   - Contribution: TPU biases trade elasticities

3. **Dynamic Models of Trade**
   - Baldwin (1986), Baldwin and Krugman (1989), Das et al (2007), Alessandria and Choi (2007), Drozd and Nosal (2012), Fitzgerald et al (2016), Ruhl and Willis (2017), Alessandria et al. (2021), Steinberg (2022)
   - Contribution: Trade response under different tariff processes

Roadmap

1. Model
2. Experiments
3. Empirical Evidence

Overview of the model

- Partial equilibrium version of Alessandria, Choi and Ruhl 2021 (ACR 2021)
  - Slow adjustment due to exporter life-cycle, large gap between SR and LR response
  - Expectations about future trade policy, not current policy, drive export participation

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- Firms
  - Heterogeneous in productivity (z), variable trade cost (ξ)
  - Die with probability $1 - \delta$, replaced by new firm (fixed mass)
  - Pay sunk cost to export next period, smaller fixed cost to continue
  - New exporters start with low export capacity (ξ_H)
  - Longer tenure as exporter $\Rightarrow$ greater chance of attaining low variable trade cost (ξ_L)

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  - Allow for innovations to current tariffs (τ) and expectations about future tariffs ($\mathbb{E}\tau'$)
  - Exporting threshold depends on expected z, ξ and trade policy
- Any dynamic model of trade will deliver similar effects
  Krugman (1980), Melitz (2003), Arkolakis (2010), Alessandria and Choi (2007), Drozd and Nosal (2012) etc.

[See Static Problem] [See Dynamic Problem]

Aggregation, trade elasticities

- Aggregate exports:

$$Y_t = \sum_{\xi \in \{\xi_L, \xi_H\}} \int_z p\left(z, \xi, \tau_t\right) d_t\left(z, \tau_t\right) \varphi_t\left(z, \xi\right) dz.$$

  - Per-firm sales (*pd*) depend on current tariffs
  - Distribution of productivity and export status (φ) depend on past and future tariffs

- Mapping to trade elasticities:
  - SR response to *unanticipated* reform: demand elasticity $= \theta$
  - LR response to *permanent* reform: $> \theta$, increasing in ξ_H/ξ_L and ρ_ξ

[See Calibration] [See Static Problem] [See Dynamic Problem]

Roadmap

1. Model
2. **Experiments**
3. Empirical Evidence

Numerical experiment # 1: permanent reforms

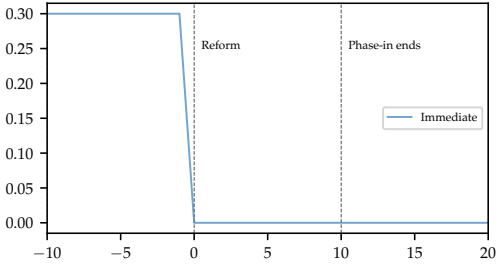
- Start in steady state with $\tau = 30\%$, then go to free trade beginning in period t_R
  1. Unanticipated: $t_A = t_R$
  2. Anticipated: $t_A = t_R - 10$

  A. Immediate: free trade from t_R onward

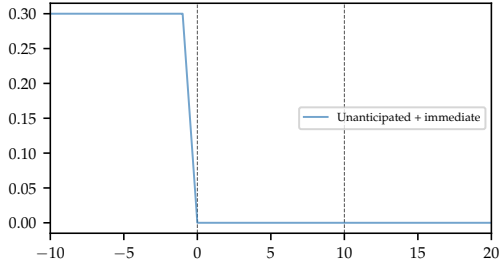
  B. Phased-in: τ falls to 0 over 10 periods
- Combine 1–2 with A–B (e.g. unanticipated + phased-in)
- Announcement in t_A unanticipated in all cases; rational expectations from then onward

Permanent reforms: policy and trade dynamics

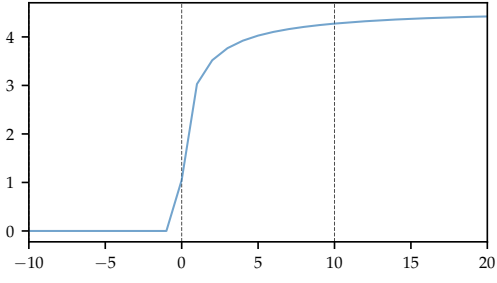
Tariff



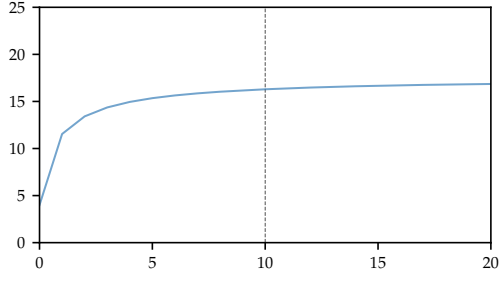
Present Value of tariff



Log exports (initial SS, change rel $t = -11$)



Measured trade elasticity



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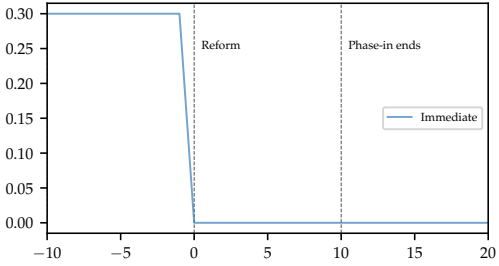

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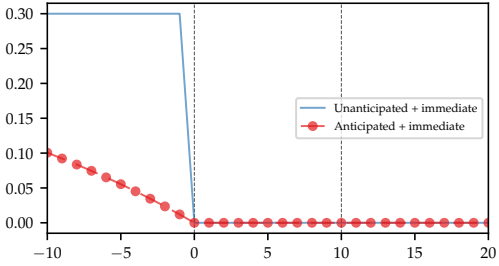

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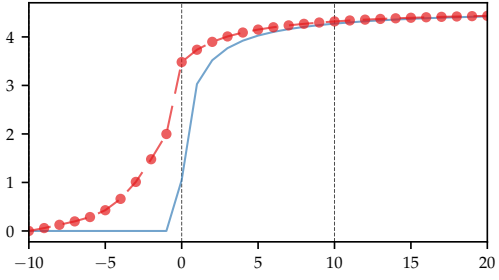

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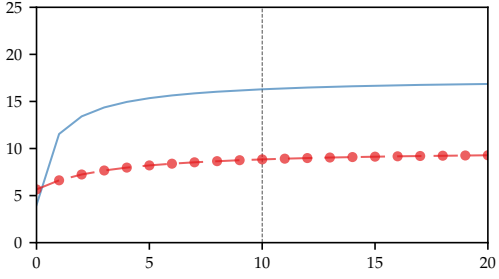

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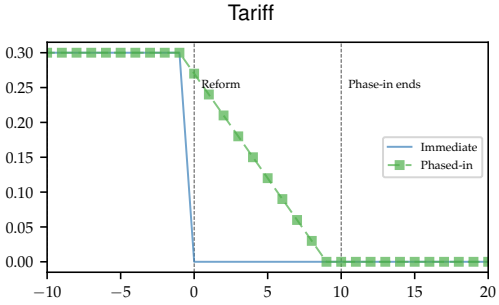

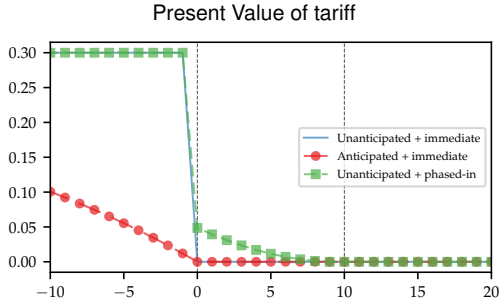

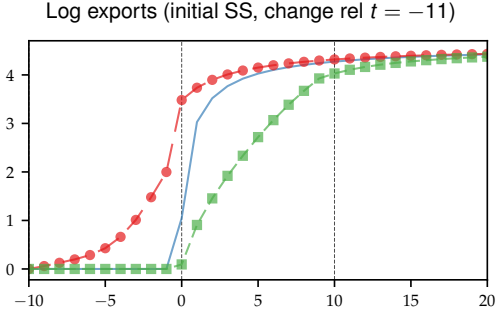

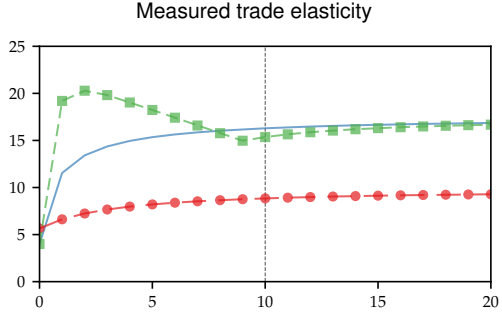

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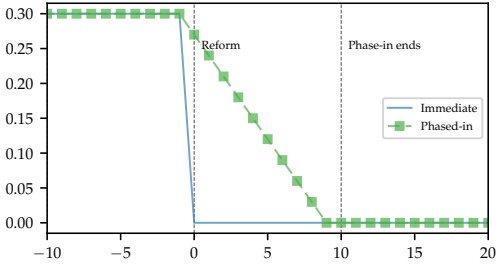

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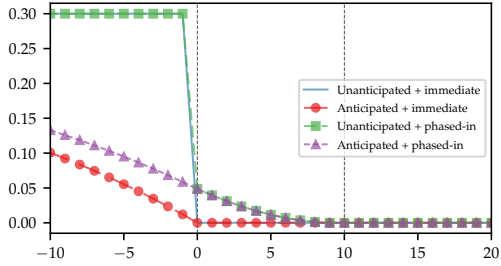

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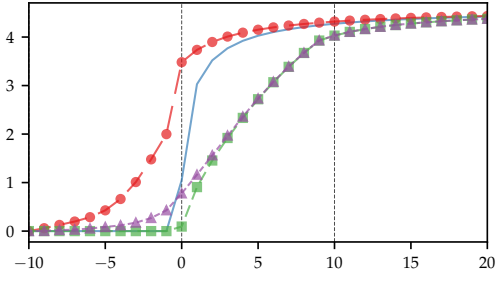

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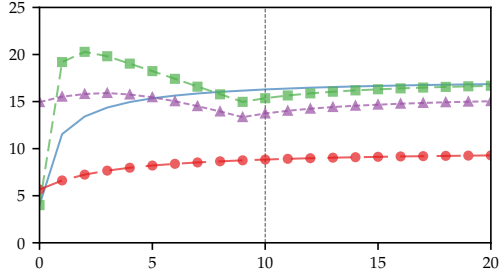

Numerical experiment # 2: uncertain/stochastic reforms

1. (Uncertain) Similar to permanent reforms, except there is a 50% chance per period until t_U that reform will be reversed (but this never happens)

A. Permanent uncertainty: $t_U = \infty$

B. Temporary uncertainty: $t_U = t_R + 20$

2. (Stochastic) Markov process with two states: high tariffs (30%) and low tariffs (0%)

- Start in high-tariff for many periods, then switch to low-tariff for many periods
- Vary transition probability $\rho \in (0, 1)$

Uncertain reforms: policy and trade dynamics

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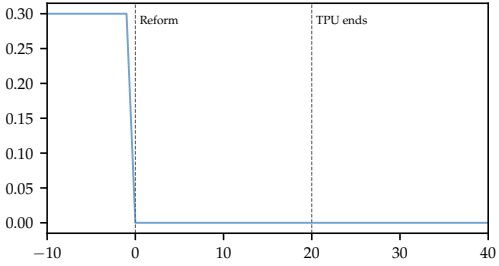

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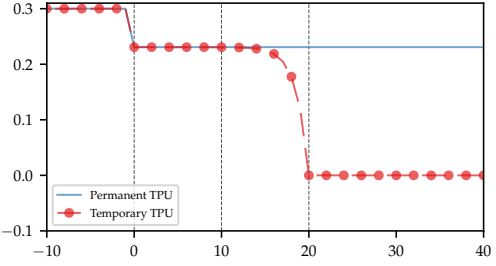

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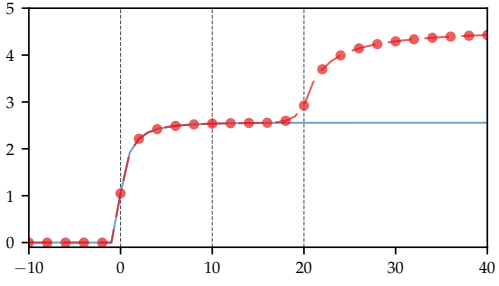
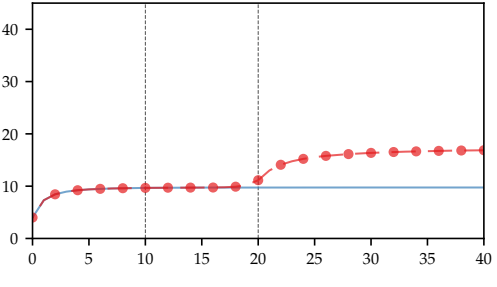
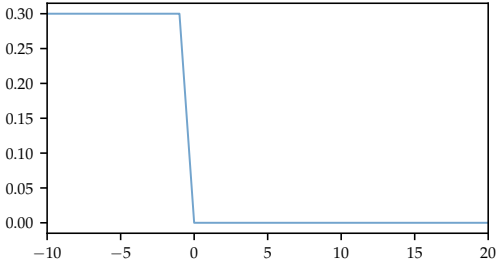


Measured trade elasticity



Stochastic reforms: policy and trade dynamics

Tariff



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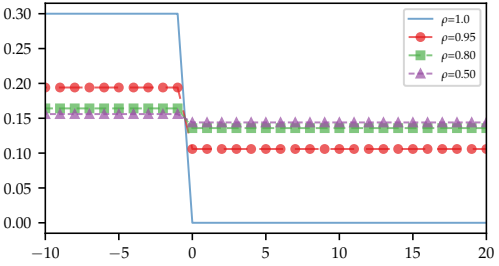
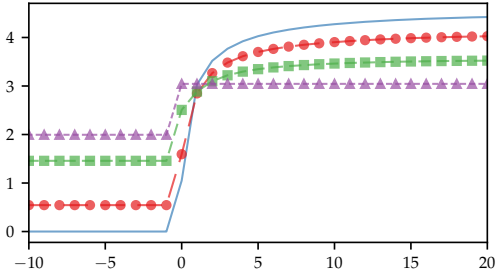
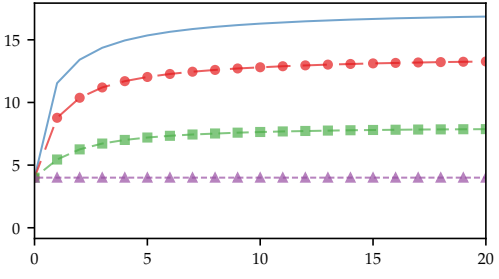


Log exports (initial SS w/ ρ = 1)



Measured trade elasticity (relative to t_R)



Takeaways

1. Anticipation

- Increases SR elasticity, decreases LR elasticity
- Channel: exporters begin entering earlier, exports already high at t_R
- Phase-ins further increase SR elasticity, generate non-monotonic dynamics

2. Uncertainty

- Reduces LR elasticity [See rel. to time t_A]
- Two channels: suppressing post-reform trade and boosting pre-reform trade
- Resolution of uncertainty resolves LR elasticity bias, but also lengthens transition

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3. **Empirical Evidence**

Data

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  - Large reforms – NNTR to MFN, GATT rounds, first PTAs, GSPs, etc.
- Good defined as 5-digit SITC level rev. 2
  - 1974–1988 U.S. imports at 8-digit TS-USA level: Concordance by Feenstra (1996)
  - 1989–2017 U.S. imports at 8-digit HTS level: Concordance using UNCTAD
- 44 years (t), 163 countries (j), 2,032 goods (g), 2,279,579 observations (jgt)
- Policy at variety level (jg): applied tariff (=duties/FOB imports)
  - Potentially different from scheduled tariffs due to aggregation, measurement error, etc.
  - In addition, same jgt can have transactions at different tariffs - satisfy rules of origin, GSP requirements, etc.

Estimating trade dynamics: 3 Specifications

1. *"h on h"* differences

$$\Delta_h y_{jgt} = \beta_h^{hh} \Delta_h \tau_{jgt} + \delta_{jt} + \delta_{gt} + u_{jgt}$$

where $\Delta_h x_t \equiv x_{t+h} - x_{t-1}$

- Effects of multilateral policy changes (e.g. to MFN rates) absorbed by *gt* fixed effects
- Captures cumulative tariff changes between $t-1$ and $t+h$

2. *"h on 1"* local projections

Boehm et al. (2023)

- Like *"h on h"*, but instrument $\Delta_h \tau_{jgt}$ with $\Delta_0 \tau_{jgt}$
- Average autocorrelation of tariff changes control for subsequent changes

Estimating trade dynamics: 3 Specifications

3. Error correction model (*"ECM"*)

Gallaway et al. (2003); Alessandria and Choi (2021); Khan and Khederlarian (2021)

$$\Delta_0 y_{jgt} = \beta_0^{ecm} \Delta_0 \tau_{jgt} + \gamma(y_{jg,t-1} - \beta_\infty^{ecm} \tau_{jg,t-1}) + \delta_{gt} + \delta_{jt} + \delta_{jg} + u_{jgt}$$

- Identifies SR (β_0^{ecm}) and LR (β_∞^{ecm}), along with adjustment speed (γ)
- β_∞^{ecm} equivalent to cross-sectional elasticity when $\Delta_0 y_{jgt} = \Delta_0 \tau_{jgt} = 0$
- δ_{jg} captures level (not trend) of trade - can rewrite ECM in levels

[Performance in Experiments] [Robustness][Average Elasticities]

Three “Proofs of Concept” in the Data

- Goal: Consider differential trade responses to different tariff changes (not to recover structural elasticity, yet)

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1. How often/how large has a variety undergone tariff changes?
2. Tariff changes from across/within statutory regimes.
3. Case studies: NTR liberalizations China (1980) and Vietnam (2001)

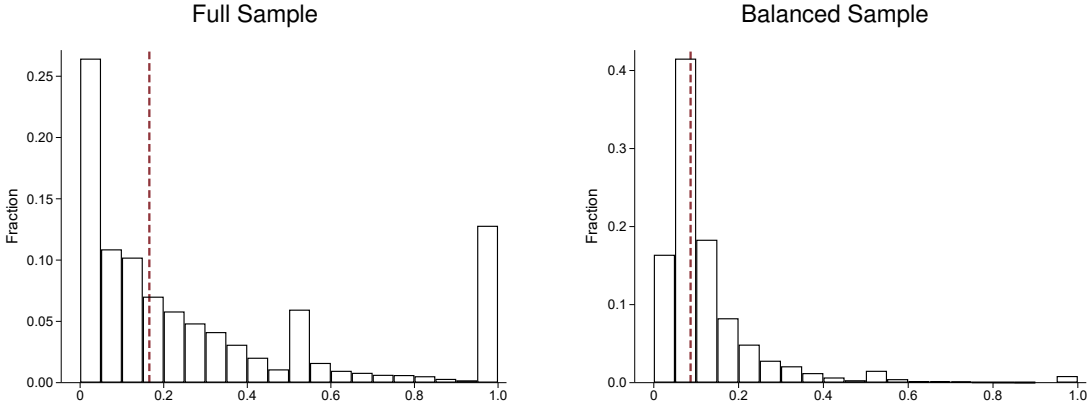
Proof of Concept #1: Variety-level Concentration of Tariff Changes

- Trade policy generally applied at variety level: country-good pair
- For each variety, calculate **HH concentration index** of rel. tariff changes:

$$HH_{jg} = \sum_{t} \left(\frac{|\Delta_0 \tau_{jgt}|}{\sum_s |\Delta_0 \tau_{jg,s}|} \right)^2$$

- If $HH_{jg} \to 1$ one major tariff change, closest to canonical reform
- If $HH_{jg} \to 0$ many, similar-sized tariff changes
- Captures both intensive and extensive margin of tariff changes
- Robust to using only relative tariffs (scaled by MFN rate), scaling by fraction of non-zero trade flows, balancing sample, HS 6-digit goods, more restrictive FEs

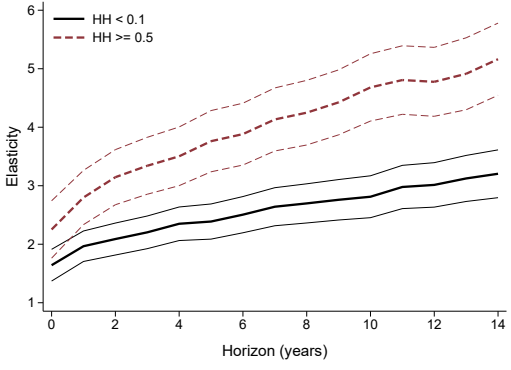
Distribution concentration of tariff changes



- Most varieties experience many, small, tariff changes
- Few varieties with high concentration, less than 15% (5%) in full (balanced) sample

Trade dynamics by concentration group

"h on h"



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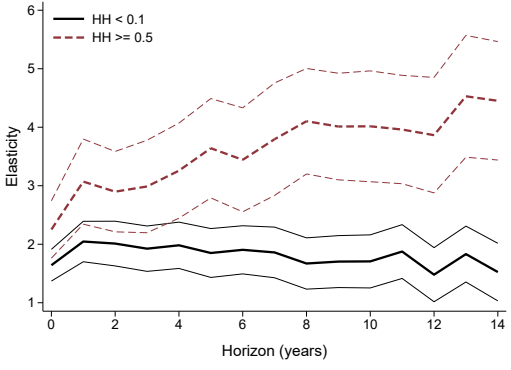
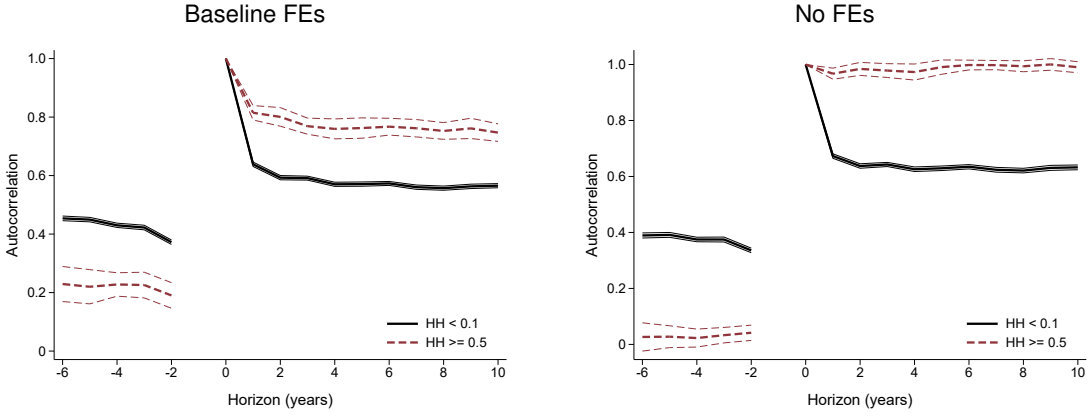


"ECM"

HH range	(0, 0.1)	[0.5, 1]
SR	2.09	2.44
LR	3.77	6.95

Autocorrelation tariff changes by concentration group

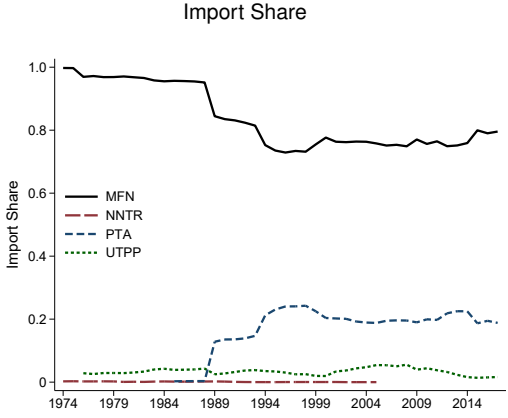


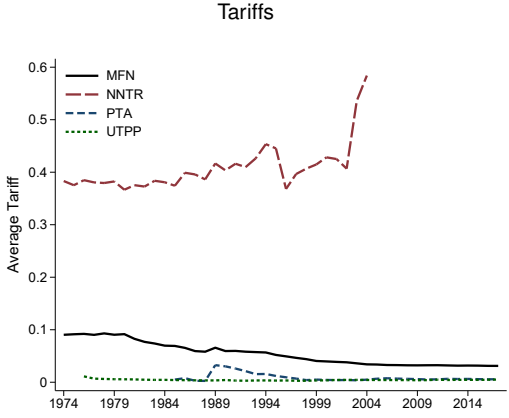
- Varieties w/$HH \leq 0.1$: $\approx$ 50% reversion after change, preceded by correlated changes
- Varieties w/$HH > 0.5$: permanent changes, not preceded by significant changes

Proof of Concept #2: Statutory Tariff Regime Changes

- Applied tariffs are determined at variety, rate of provision and country subcode level:
  - Rate of Provision: The rate a tariff or duty is set according to the provision allowed by a trade agreement
  - Country Subcode: Indicators used to identify special trade agreements
- Use rate of provision and (2) country sub-code from customs-declaration of imports, to classify *jgt* into one of the four regimes:
  1. MFN rate of provision 10 or 61 or subcodes C, K, and L (non-discriminatory special programs)
  2. NNTR rate of provision 62
  3. Preferential Trade Agreement (PTA) rate of provision 18, 19 or 64 and country with PTA or subcodes referring to bilateral/multilateral PTA's (e.g. NAFTA)
  4. Unilateral Trade Preference Program (UTPP) rates of provision 18, 19 or 64 and country with PTA or subcodes referring to special U.S. programs (e.g. GSP, CBERA, AGOA)
- Define *jgt* as belonging to a state if at least 50% of its value is traded in that state.
- Unclassified *jgt*'s represent around 2 percent of imports [See]

Imports and Tariffs by Regime





Transition Probabilities

Fraction (%) *jgt* at *s* in $t-1$ that transition to *s* at over total *jgt* at *s* in *t*.

$t-1/t$	MFN	NNTR	PTA	UTPP
MFN	97.10	0.15	0.51	2.24
NNTR	4.83	94.92	0.00	0.25
PTA	15.45	0.00	77.49	7.06
UTPP	17.83	0.04	0.18	81.95

- Consider only transitions between consecutive years, with $|\tau_{jgt} - \tau_{jg,t-1}| > 0.001$
- Similar if no restriction, 5-year changes

Tariff Changes Across and Within Regimes

		Observations		Mean	Median	Std. Dev.	Coeff. Var.
From	To	# *jgt*'s	%	(p.p.)	(p.p.)	(p.p.)	
MFN	MFN	1,614,131	80.61	−0.19	0.00	17.04	89.82
MFN	NNTR	1,028	0.05	29.37	27.99	21.30	0.73
MFN	PTA	14,901	0.74	−3.20	−1.77	5.03	1.57
MFN	UTPP	45,990	2.30	−4.33	−3.18	12.26	2.83
NNTR	MFN	3,849	0.19	−30.37	−29.70	24.54	0.81
NNTR	NNTR	14,247	0.71	0.00	0.00	12.83	2,746.61
NNTR	UTPP	453	0.02	−33.71	−34.90	17.08	0.51
PTA	MFN	11,643	0.58	2.48	1.10	5.10	2.05
PTA	PTA	78,404	3.92	−0.12	0.00	1.53	13.15
PTA	UTPP	1	0.00	0.00	0.00		
UTPP	MFN	47,353	2.36	2.98	2.14	6.51	2.19
UTPP	NNTR	47	0.00	32.55	35.00	20.13	0.62
UTPP	PTA	2,837	0.14	0.09	0.00	3.34	36.54
UTPP	UTPP	167,426	8.36	−0.03	0.00	1.03	38.61

- Tariff changes largest in across-regime transitions, very few
- Large coefficient of variation in within-regime changes

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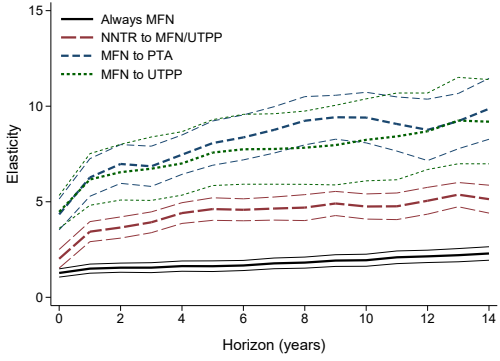
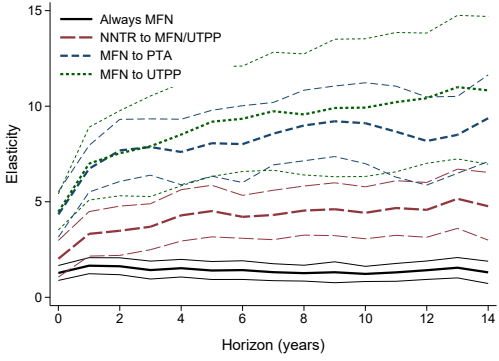
Trade dynamics from transitions across/within statutory regimes

"h on h"



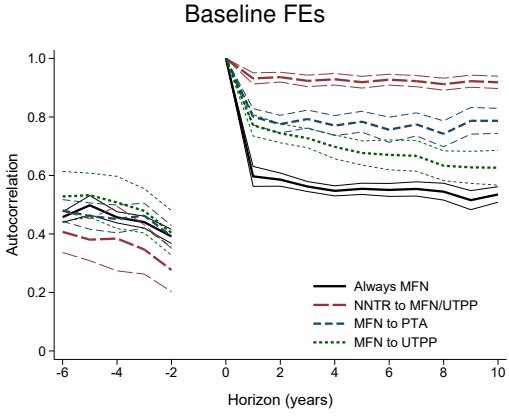
"h on 1"

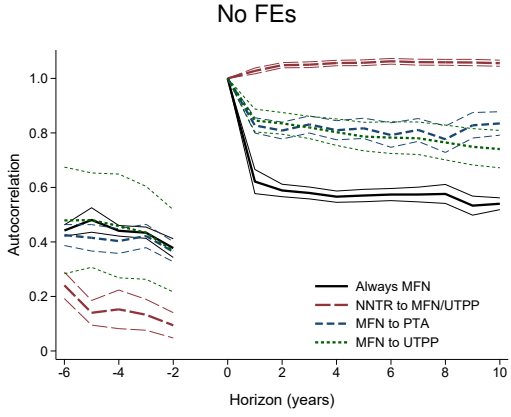


"ECM"

	NNTR to PTA	MFN to PTA	MFN to UTPP	Always MFN
SR	2.64	2.75	3.31	1.62
LR	5.38	5.41	6.35	3.03

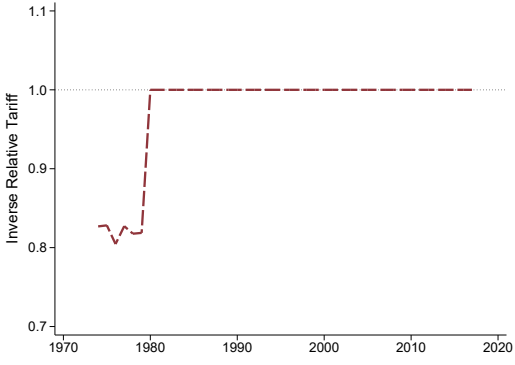
Autocorrelation tariff changes from transitions across/within statutory regimes





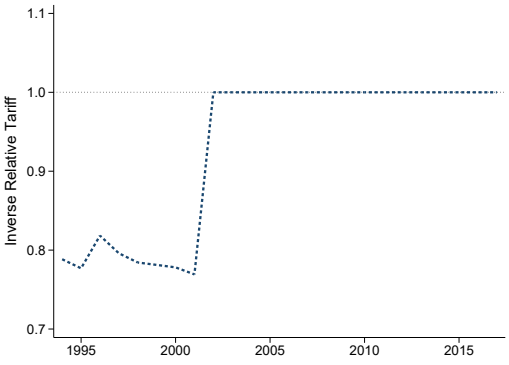
Proof of Concept #3: Case Studies

China



- NNTR access in 1971
- Conditional NTR access in 1980
- PNTR upon joining WTO in 2001

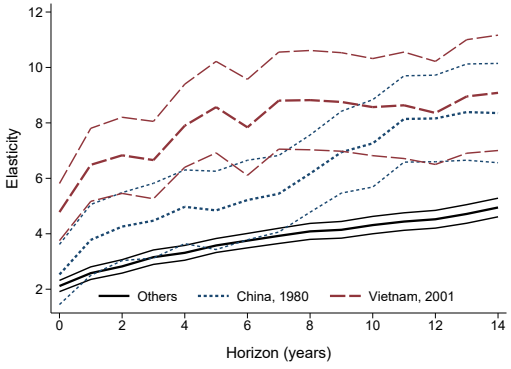
Vietnam



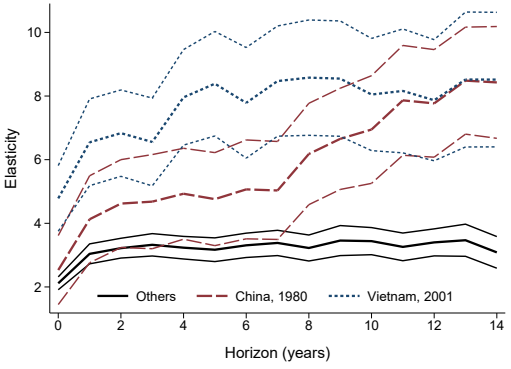
- NNTR access in 1994
- Conditional NTR access in 2001
- PNTR in 2006

Trade dynamics from China, 1980 & Vietnam, 2001

"h on h"



"h on 1"



"ECM"

Country	China	Vietnam	Other
SR	2.6	4.7	2.2
LR	8.3	8.5	4.2

Summary & Conclusions

- Estimates of trade dynamics depend on nature of reform
  - Anticipation/phase-ins induce exporters to react in advance of policy changes. This increases (decreases) short-run (long-run) response
  - Transitory, uncertain reforms have little impact on PV of future tariffs. This reduces long-run response.
- Most policy changes in the data are gradual & transitory.

  $\Rightarrow$ Potentially large role anticipation & uncertainty.
- Conventional estimates do not correspond to inputs needed for quantitative work.
- Structural SR (LR) elasticities are likely lower (higher) than we think
- Next: Match U.S. tariff processes and trade responses in model to provide estimate of underlying structural trade elasticity

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Alessandria, George and Horag Choi, "The Dynamics of the U.S. Trade Balance and Real Exchange Rate: The J Curve and Trade Costs?," *Journal of International Economics*, 2021.

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Gallaway, Michael P., Christine A. McDaniel, and Sandra A. Rivera, "Short-run and Long-run Industry level Estimates of U.S. Armington Elasticities," *The North American Journal of Economics and Finance*, 2003, *14(1)*, 49–68.

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Appendix

Production, demand, static optimization

- Production technology (z = productivity; ℓ = labor):

$$y_t = z_t \ell_t$$

- Export demand curve (p_t = price; τ = tariff):

$$d_t(p_t, \tau_t) = (p_t \tau_t)^{-\theta}$$

- Resource constraint (ξ = variable trade cost):

$$y_t \geq \xi d_t(p_t, \tau_t)$$

- Given z, ξ, choose p, ℓ to max flow profits

$$\pi(z_t, \xi_t, \tau_t) = \max_{p,\, \ell} p d_t(p_t \tau_t) - w_t \ell_t \quad \textbf{s.t.} \quad z_t \ell_t \geq d_t(p_t, \tau_t) \xi_t$$

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Exporter life cycle, dynamic optimization

- Variable trade cost (ξ) captures current export status
  - ∞: non-exporter
  - $\overline{\xi}$: low-capacity exporter
  - $\underline{\xi}$: high-capacity exporter
- Costs of exporting in $t+1$ depend on current export status in t
  - New exporters: pay f_0, start with low export capacity ($\overline{\xi}$)
  - Continuing exporters: pay f_1, switch to higher/lower export capacity with prob. $1-\rho_\xi$
- Given z, ξ, s, choose whether to export at $t+1$ to max PV of profits:

$$V(z,\xi,s) = \pi_{gt}(z,\xi,s) + \max\left\{ \underbrace{-f(\xi) + \frac{\delta(z)}{1+r}\mathbb{E}_{z',\xi',s'} V(z',\xi',s')}_{\text{export}}, \underbrace{\frac{\delta(z)}{1+r}\mathbb{E}_{z',\xi',s'} V(z',\infty,s')}_{\text{don't export}} \right\}$$

- Decision yields threshold $\overline{z}(\xi', s')$

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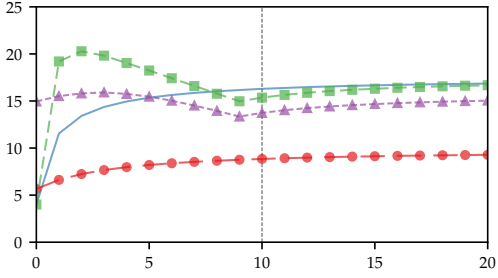
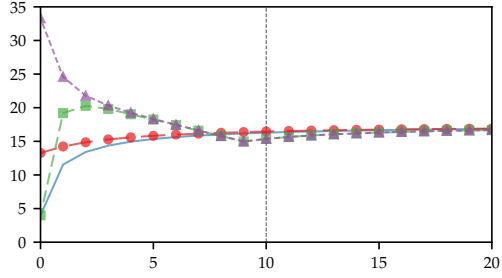
Permanent reforms: measuring elasticities from change in policy vs. change in information

Measured trade elasticity (from t_R)



Measured trade elasticity (from t_A)



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Calibration

- Taken from ACR (2021)
  - Productivity process: $\log z_t = \rho_z \log z_{t-1} + \sigma_z \epsilon_t$, $\rho_z = 0.65$, $\sigma_z = 1.32$
  - Demand elasticity: $\theta = 4$
  - Interest rate: $r = 4\%$
  - Wage (w), low variable trade cost (ξ_L) normalized to 1
- Calibrated to match export participation facts from ACR (2021)
  - Sunk cost f_0: Export participation rate = 22.3%
  - Continuation cost f_1: Export exit rate = 17.0%
  - High variable trade cost ξ_H: avg. entrant sales/avg. incumbent sales = 0.5

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Estimated trade elasticities in simulated reforms

		Actual (t_R/t_A)		*"ECM"*		*"h on h"*		*"h on 1"*	
		SR	LR	SR	LR	SR	LR	SR	LR
(a) Permanent									
Anticipated	Phased-in								
✗	✗	4.0/4.0	17.1/17.1	4.0	17.1	4.0	15.5	4.0	17.0
✓	✗	5.7/13.3	9.5/17.1	4.4	17.1	5.6	15.3	5.7	9.4
✗	✓	4.0/4.0	17.1/17.1	14.9	17.1	14.7	16.4	14.7	16.6
✓	✓	14.9/33.3	15.4/17.1	12.9	17.1	13.2	16.1	13.2	15.6
(b) Uncertain									
Permanent TPU		4.0	9.7	4.0	9.7	4.0	9.3	4.0	9.7
Temporary TPU		4.0	17.1	4.0	17.1	4.0	10.3	4.0	15.5
(c) Stochastic									
$\rho = 0.95$		4.0	13.4	4.0	13.4	4.0	12.3	4.0	13.4
$\rho = 0.80$		4.0	7.9	4.0	7.9	4.0	7.4	4.0	7.9
$\rho = 0.50$		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

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Temporary reforms: details

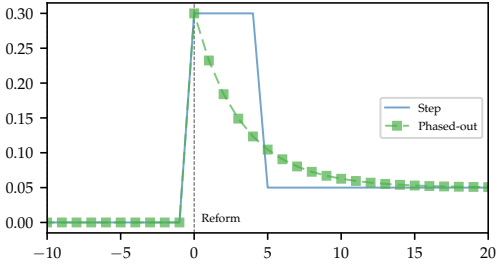
- Start in free-trade steady state, τ rises to 30% in period t_R, then falls back down after several periods
  1. Unanticipated: $t_A = t_R$
  2. Anticipated $t_A = t_R - 10$

  A. Immediate reversal: $\tau = 30\%$ for 5 periods then 5% thereafter

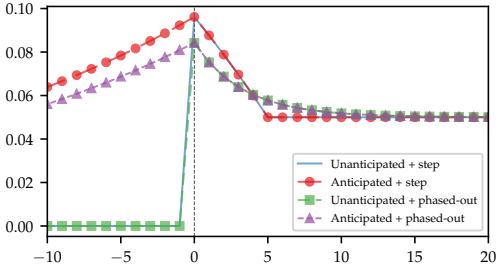
  B. Phased-out: τ falls gradually starting in $t_R + 1$
- Tariffs fall to 5% (not zero) so that LR elasticity well-defined

Temporary reforms: policy and trade dynamics

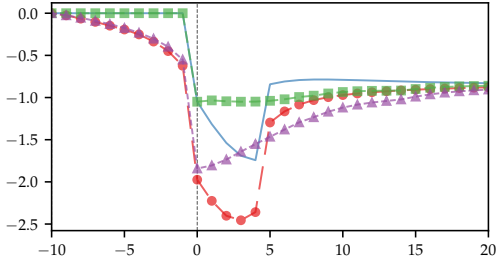
Tariff



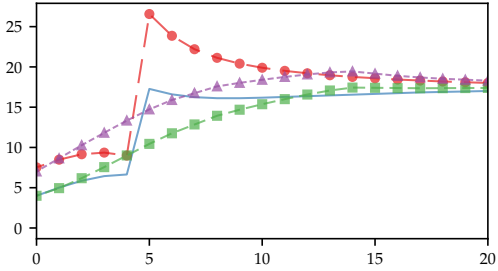
Present Value of tariff



Log exports (initial SS = 0)

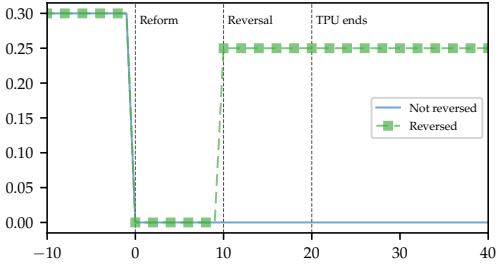


Measured trade elasticity

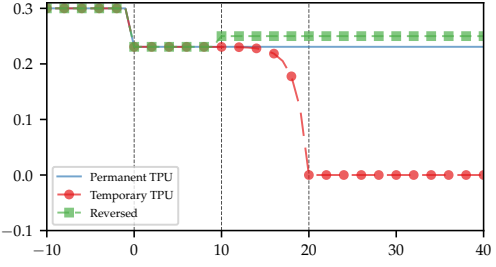


Uncertain reforms w/ reversal: policy and trade dynamics

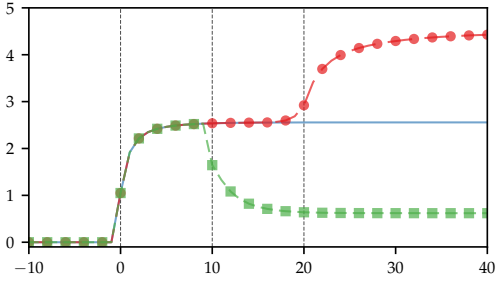
Tariff



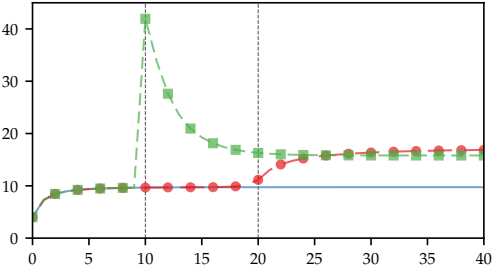
Present Value of tariff



Log exports (initial SS = 0)

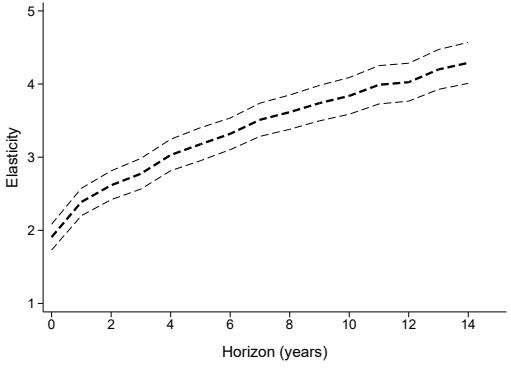


Measured trade elasticity

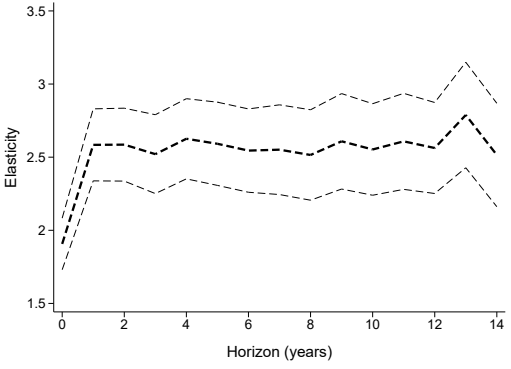


Average Trade Elasticities

"h on h"



"h on 1"



	"ECM"
SR	2.62
LR	5.49

- On average, SR trade elasticity of around 2 and LR of 4-6

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Robustness

- Alternative fixed effects, incl. sector-country-Time FEs
- Balancing sample
- Using HS 6-digit U.S. imports
- Controlling for lagged tariff and trade changes

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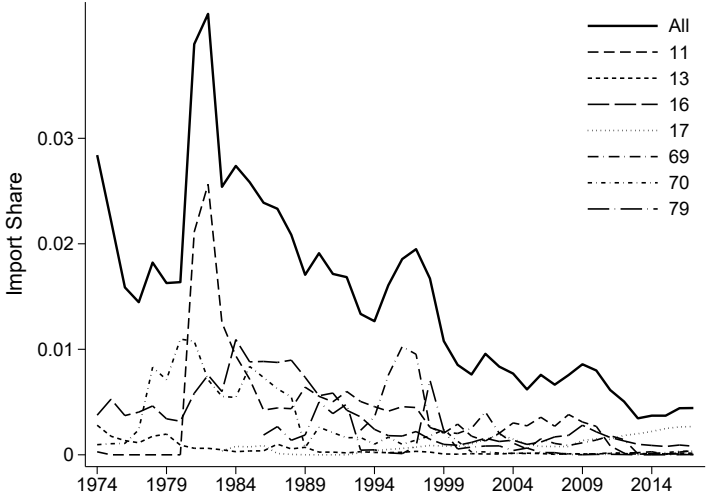
Import Share Unclassified Observations (Statutory Regimes)



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