

Just Passing Through? A Bayesian Analysis of Import Price Responses to Tariff Shocks

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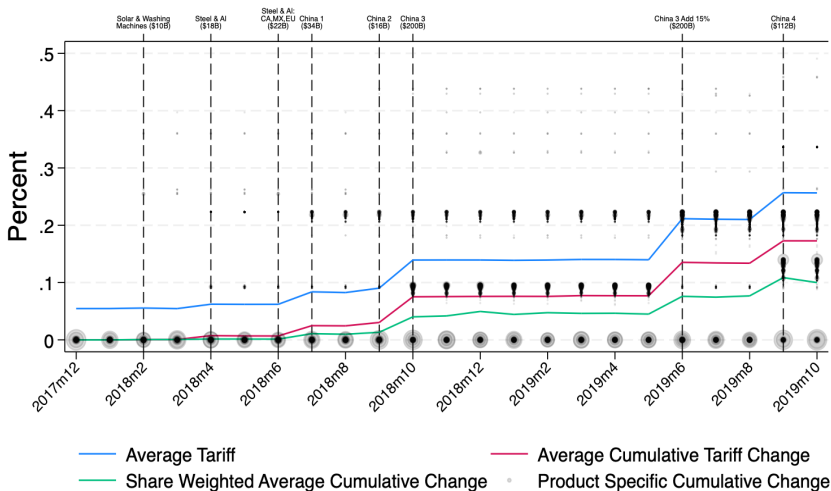
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- Trade-related policy analyses and applications could/should depend on
 - Interconnectedness across industries and markets (discipline by GE/PE structure)
 - Elasticities governing microeconomic channels
 - Heterogeneous micro level responses
 - Consistent metrics and objectives for comparison
- There is a growing disconnect between how policy is applied and evaluated
 - Recent U.S. protectionist policies at the forefront
 - Policy makers versus participants versus evaluators
 - Moving target objective functions
- Economic efficiency metrics do not seem to resonate
- Is the disconnect from
 - Differences in objectives?
 - Misaligned metrics?
- Here we take a less dismissive/more agnostic stance

Background

- Tariff passthrough is my metric
 - Embeds GE channels/elasticities (Farrokhi and Soderbery (2024))
 - Clean metric that guides evaluation
- From Trump 1.0
 - Consensus seems to be passthrough of U.S. tariffs was *universally* complete (Amiti et al. (2019), Amiti et al. (2020), Fajgelbaum et al. (2019), Cavallo et al. (2021))
 - Some nuance
 - Flaaen et al. (2020) find 58% for washing machines
 - Cavallo et al. (2021) suggest meaningful heterogeneity across goods
- Historically, we saw a number of studies focusing on particular industries (e.g., Feenstra (1989) – 52% to 110% for Japanese motorcycles)
- With Trump 2.0 proposals, revisiting the consensus is important
 - There has been a surge of research running with complete passthrough as a key assumption

U.S. Tariffs on Chinese Imports

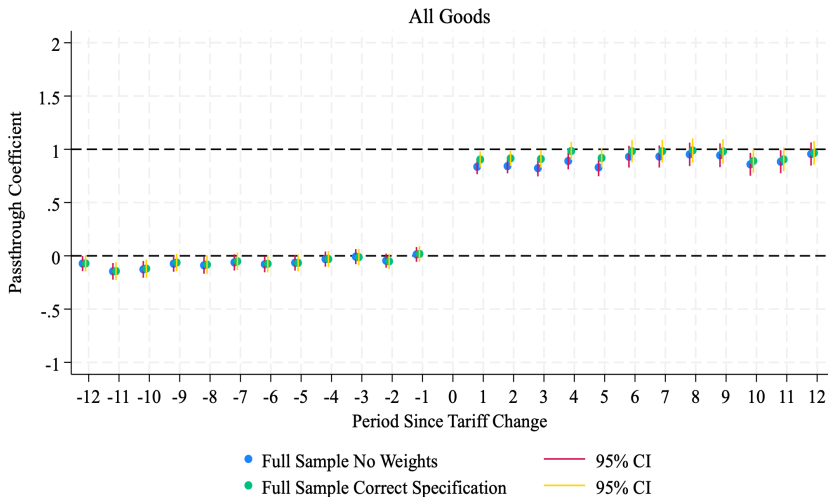


- Trump 1.0 did a lot of normalizing tariffs across goods focusing on China
 - Average increase was 15% by end of sample
 - Sharp (almost) discrete changes
 - Stepwise increases – modal change around 22%, conditional on change
- Larger flow products experienced lower changes on average (10%)
- Seemingly exogenous tariff changes lend to event study and/or diff-diff
- Replicate Amiti et al. (2020)

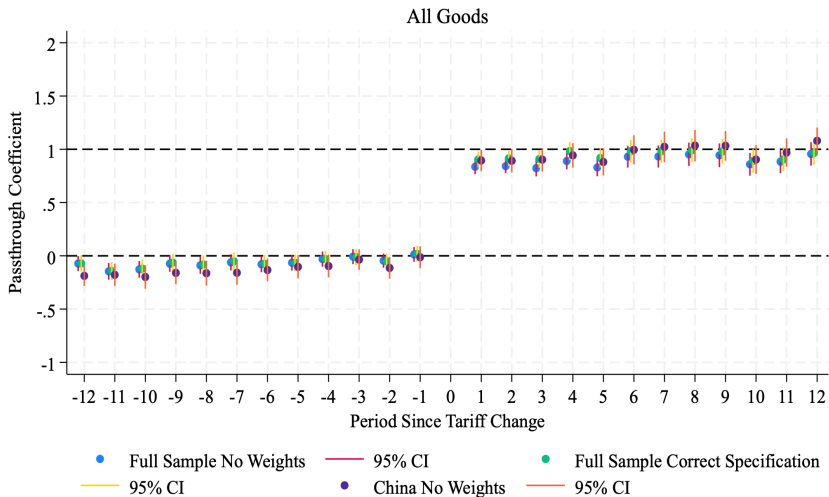
$$\log p_{ijm} = \sum_{s=-\mathfrak{T}}^{\mathfrak{T}} \theta_s \left(\mathbb{1}_{ijs} \times \log \left(\frac{1 + t_{ijs}}{1 + t_{ij0}} \right) \right) + \eta_{ij} + \delta_{jm} + \mu_{im} + u_{ijm}$$

- j : HS10 product, i : source country, t : month, $\mathfrak{T}$: months since tariff change
- Event study relating price p to Trump tariff t change: θ_s is passthrough
- Quick note – Amiti et al. (2020) actually use $\log(1 + t_{ijs} - t_{ij0})$ rather than $\log \left(\frac{1+t_{ijs}}{1+t_{ij0}} \right)$

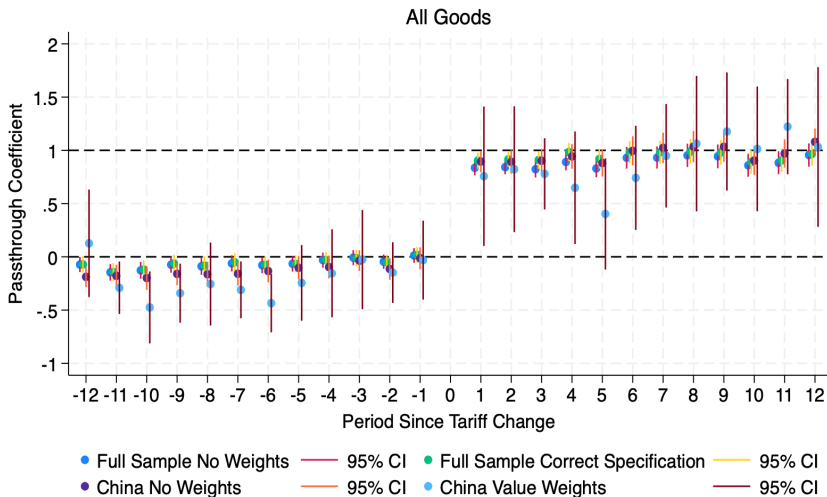
U.S. Tariffs on Chinese Imports



U.S. Tariffs on Chinese Imports



U.S. Tariffs on Chinese Imports



- Without weights, concluding passthrough is universally complete seems quite sensible
 - Further reinforcement when cutting to Chinese only imports
- Adding import value weights muddies the regression
 - Still cannot reject complete passthrough, but my confidence is shaken
- The specification is a bit too nuanced
 - Not much value in the event study (little to no heterogeneity across months)
 - Move back to pooled regressions (nice discussion in Fajgelbaum and Khandelwal (2022))

$$\log p_{ijm} = \theta \log(1 + t_{ijm}) + \eta_{ij} + \delta_{jm} + \mu_{im} + u_{ijm}$$

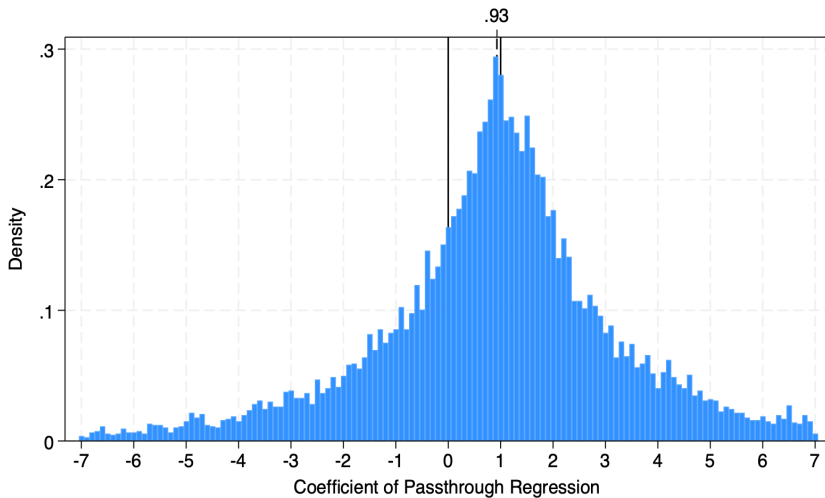
- Progression is best seen as a table

Passthrough Coefficient Estimate							
In Changes: $\ln(p_m) = \theta_m \Delta^0 \ln(1 + t_m)$					In Levels: $\ln(p_m)$		
Replication			China		China		
	Amiti et al. (2020)	Corrected	Baseline	Weighted	Baseline	Weighted	
Months Since Tariff Change	-3	-0.008 (0.036)	-0.012 (0.039)	-0.035 (0.049)	-0.026 (0.238)		
	-2	-0.045 (0.034)	-0.052 (0.036)	-0.114 (0.052)	-0.148 (0.145)		
	-1	0.013 (0.035)	0.019 (0.038)	-0.013 (0.053)	-0.031 (0.189)		
	1	0.836 (0.036)	0.904 (0.039)	0.895 (0.051)	0.757 (0.334)		
	2	0.842 (0.034)	0.915 (0.036)	0.892 (0.056)	0.823 (0.301)		
	3	0.823 (0.039)	0.909 (0.042)	0.903 (0.056)	0.779 (0.171)		
	4	0.890 (0.04)	0.984 (0.044)	0.943 (0.059)	0.649 (0.270)		
	5	0.830 (0.042)	0.919 (0.046)	0.881 (0.065)	0.403 (0.266)		
	6	0.930 (0.052)	0.982 (0.054)	0.996 (0.070)	0.742 (0.249)		
	7	0.932 (0.053)	0.983 (0.055)	1.024 (0.073)	0.949 (0.248)		
	$\ln(1 + t_m)$					1.080 (0.031)	0.890 (0.032)
	N	4814959	4814959	402712	402712	402712	402712
	R^2	0.977	0.977	0.969	0.991	0.969	0.991
	Weights	N/A	N/A	N/A	Share	N/A	Share

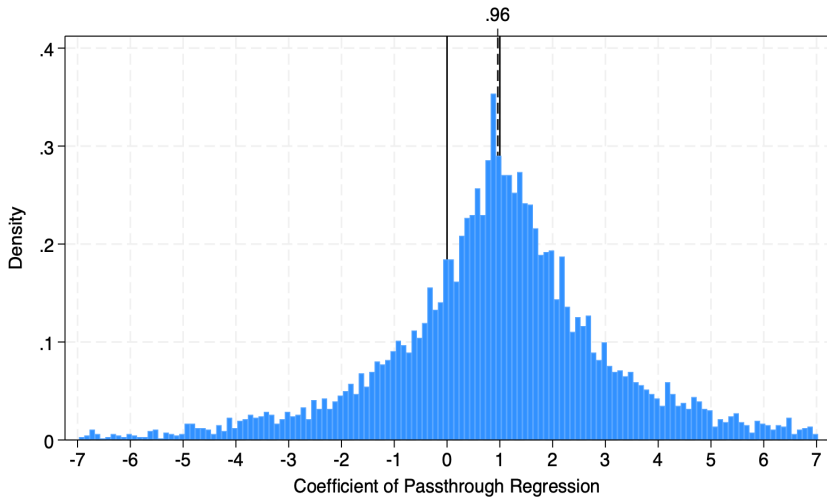
- We find these patterns suggestive of passthrough heterogeneity across products
 - Especially when we compare across weighted and unweighted specifications
 - More precise econometric test – F-tests reject homogeneity across all goods
- Related and historical results are also suggestive
 - Flaaen et al. (2020) find incomplete passthrough for washing machines of 58%, and evidence that passthrough rises above 100% when taking into account complementary goods and policies
 - Cavallo et al. (2021) examine retailer responses, and find passthrough is roughly complete on average, but point out "meaningful" heterogeneity across goods
 - Feenstra (1989) finds passthrough of tariffs to U.S. imports of cars, trucks and motorcycles from Japan depended on the type of vehicle and ranged from 52% to 110%

- The extreme econometric version of heterogeneity is good by good OLS
- Practical estimation challenges
 - Trump 1.0 was widespread – 15,581 HS10 goods facing at most 3 tariff changes, with many presenting a single sharp change
 - Of the 15,581 HS10 goods, 7% do not have enough data for estimation and 16% cannot identify a coefficient due to insufficient tariff variation
- Start with OLS by HS10, then common coefficient at HS8

U.S. Tariffs on Chinese Imports



U.S. Tariffs on Chinese Imports



- Some precision gains from moving to common coefficient aggregates (HS8), but a lot of noise
- Neither deliver a mean estimate statistically significantly different from 1
- Heterogeneity is hard to ignore
 - If we were to restrict our attention to estimates between zero and one, the mean passthrough rate is 0.55
- Takeaways
 - Concluding complete passthrough universally based on noise is a stretch
 - Hard to put much stock in good by good OLS due to the sheer lack of statistical power
 - A lot of goods fall outside of the theoretically palatable unit interval
 - Unit interval has been called into question recently (e.g., Costinot et al. (2019) and Farrokhi and Soderbery (2024))
 - Others have explored heterogeneity by arbitrarily aggregating data (Amiti et al. (2020) group by BEC, find some differences, but conclude complete passthrough)
 - Focal point at complete passthrough
 - Potential industry level determinants

- We seek to explore the existence and nature of passthrough heterogeneity at the good level
- Our approach is Bayesian in nature, which allows us to discipline, but not entirely dismiss, underlying passthrough tendencies
- Our preferred model will:
 - Provide a posterior probability of complete passthrough (conditioned on the prior's structure) for each good
 - Simultaneously classify the rate of passthrough as (a) incomplete, (b) complete or (c) more-than-complete for each good (i.e., regimes)
 - Link regime probabilities with good characteristics to identify overall tendencies (estimation not imposition)
 - Investigate welfare sensitivity to the assumption of complete passthrough
- Generically, we examine models that follow:

$$y_{gm} = \gamma_g + x_{gm}\theta_g + \mathbf{s}_{gm}\boldsymbol{\delta} + \epsilon_{gm}$$

$$\epsilon_{gm}|\mathbf{x}, \mathbf{S} \stackrel{ind}{\sim} \mathcal{N}(0, \sigma_g^2)$$

$$g = 1, 2, \dots, G, \quad m = 1, 2, \dots, M_g$$

Progression of Models

M1 benchmark – fully pooled model with no good-level heterogeneity. The specification in **M1** thus contains a single global intercept parameter, pass through coefficient and error variance parameter. Parameter restrictions defining **M1** are given as follows:

$$\mathbf{M1} : \quad \gamma_g = \gamma, \quad \theta_g = \theta, \quad \sigma_g^2 = \sigma^2$$

M2 generalizes **M1** and represents what may be considered the workhorse of the literature. This model includes good-specific intercepts / “fixed effects” while also allowing error variance parameters to vary across goods. Parameter/prior restrictions in **M2** can be stated as follows:

$$\mathbf{M2} : \quad \{\gamma_g\}_{g=1}^G, \quad \theta_g = \theta, \quad \{\sigma_g^2\}_{g=1}^G, \quad \gamma_g | \gamma_0, v_\gamma \stackrel{iid}{\sim} \mathcal{N}(\gamma_0, v_\gamma)$$

M3 generalizes **M1** and **M2** to explore good-specific passthrough rates. It is identical to **M2** but frees the restriction that $\theta_g = \theta$:

$$\mathbf{M3} : \quad \{\gamma_g\}_{g=1}^G \quad \{\theta_g\}_{g=1}^G \quad \{\sigma_g^2\}_{g=1}^G \quad \gamma_g | \gamma_0, v_\gamma \stackrel{iid}{\sim} \mathcal{N}(\gamma_0, v_\gamma) \quad \theta_g | \theta_0, v_\theta \stackrel{iid}{\sim} \mathcal{N}(\theta_0, v_\theta)$$

- Deviance Information Criteria (DIC) – lower numbers suggest better fit against parameterization

Table: DIC and Fit of Competing Models

	DIC	$\ln p(y \Gamma_M = E(\Gamma_M \mathbf{y}, M), M)$
M1	331,100	-165,500
M2	76,093	-36,297
M3	63,136	-29,213

- **M1** is dreadful
 - Poor model fit, astronomic DIC
 - Wholly implausible estimates – Posterior mean: $E(\theta|\mathbf{y}, \mathbf{M1}) = -2.47$, St. Dev. $\text{Std}(\theta|\mathbf{y}, \mathbf{M1}) = .11$,
 - Need controls for good level heterogeneity
- **M2** is comparable to the workhorse fixed effects model(s) earlier
 - Vast improvement in fit
 - Sensible estimates – Posterior mean: $E(\theta|\mathbf{y}, \mathbf{M1}) = 1.03$, St. Dev. $\text{Std}(\theta|\mathbf{y}, \mathbf{M1}) = .15$,
 - Good and time fixed effects are important
 - Centered on complete passthrough, but significant mass above and below
- **M3** adds passthrough heterogeneity to **M2**
 - Comparable to good by good OLS with discipline
 - Fit further improves
 - Some degree of discipline – $\theta_g|\theta_0, v_\theta \sim \mathcal{N}(\theta_0, v_0)$
 - Estimates shrink toward θ_0 , without imposing θ_0
 - Sensible estimates – Posterior mean: $\theta_0 = 1.07$ (0.11)
 - Lowest estimate $E(\theta_g|\mathbf{y}) = .39$, highest estimate $E(\theta_g|\mathbf{y}) = 2.08$
 - Cross good heterogeneity is strongly supported

Preferred Model

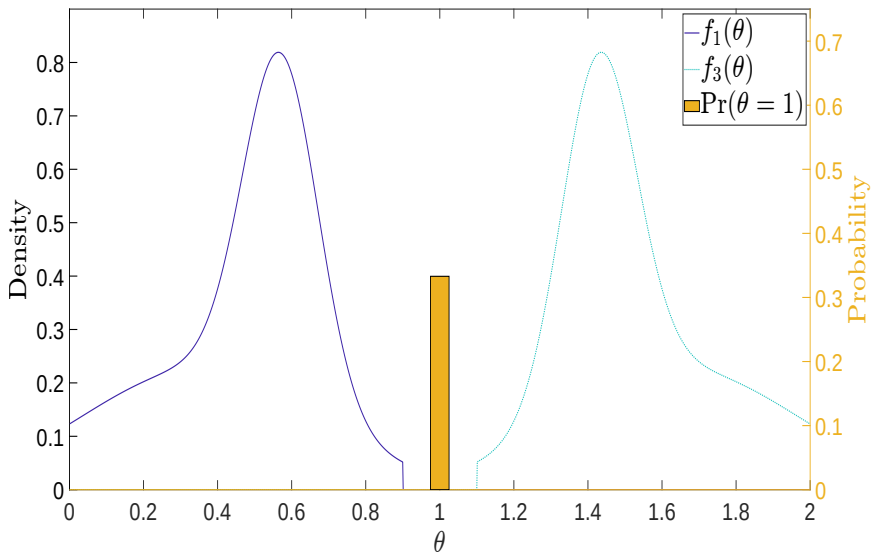
- We want to strike a balance between econometric flexibility/robustness and theoretical/conceptual discipline
 - Allow for passthrough heterogeneity, and further discipline to regimes
 - Economic controls (industry specific and to explain more than complete)

M4 similar to **M3** in that it permits intercepts, slopes and variance parameters to differ across goods. It differs from **M3** in the structure of the prior over the passthrough rates θ_g

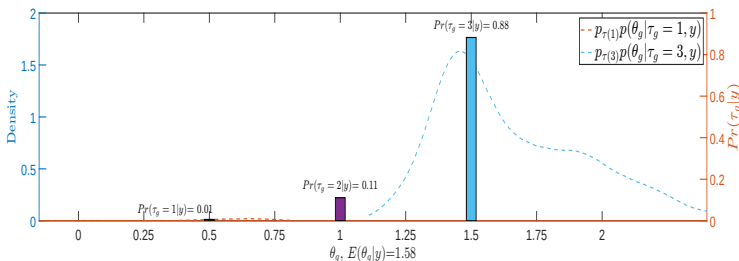
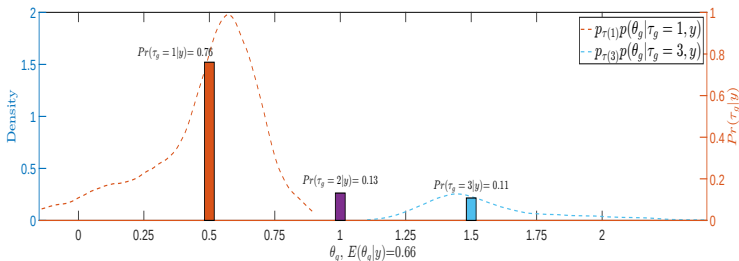
$$\theta_g | \mathbf{z}_g \sim p_1(\mathbf{z}_g) f_1(\theta_g) + p_2(\mathbf{z}_g) \mathbb{1}(\theta_g = 1) + [1 - p_1(\mathbf{z}_g) - p_2(\mathbf{z}_g)] f_3(\theta_g)$$

where $\mathbf{z}_g$ is a $1 \times k_z$ vector of good characteristics, and we can represent passthrough regimes through an indicator τ_g :

$$\theta_g | \tau_g \sim \begin{cases} f_1(\theta_g) & \text{if } \tau_g = 1 \\ \mathbb{1}(\theta_g = 1) & \text{if } \tau_g = 2 \\ f_3(\theta_g) & \text{if } \tau_g = 3 \end{cases} \quad \Pr(\tau_g = j | \mathbf{z}_g) = \begin{cases} p_1(\mathbf{z}_g) & \text{if } j = 1 \\ p_2(\mathbf{z}_g) & \text{if } j = 2 \\ 1 - p_1(\mathbf{z}_g) - p_2(\mathbf{z}_g) & \text{if } j = 3 \end{cases}$$

Statistical Prior: **M4**

Posterior Passthrough Distributions for Two Goods



Notes: Top – Candy bars (2.29(1.00)) , Bottom – Trailer wheels (3.24(0.30))

- M4 presents the lowest DIC (63,065)
- Heterogeneity of passthrough estimates is substantial both within and across Regimes
- Regimes are determined by covariates z s:
 - Exhaustive set of industries based on BEC: Agriculture, Capital, Consumer, Input
 - Countervailing duty (CVD) cases to try to explain more than complete passthrough

Posterior Regime Probabilities: Controls					
	Input	Capital	Consumer	Agriculture	CVD
R1	0.14	0.24	0.49	0.80	0.07
R2	0.46	0.48	0.35	0.14	0.23
R3	0.40	0.28	0.16	0.06	0.70

- Agricultural and consumer goods gravitate toward incomplete passthrough, input and capital goods toward complete and more than complete, CVD goods toward more than complete
- Patterns are stark when applied to the data

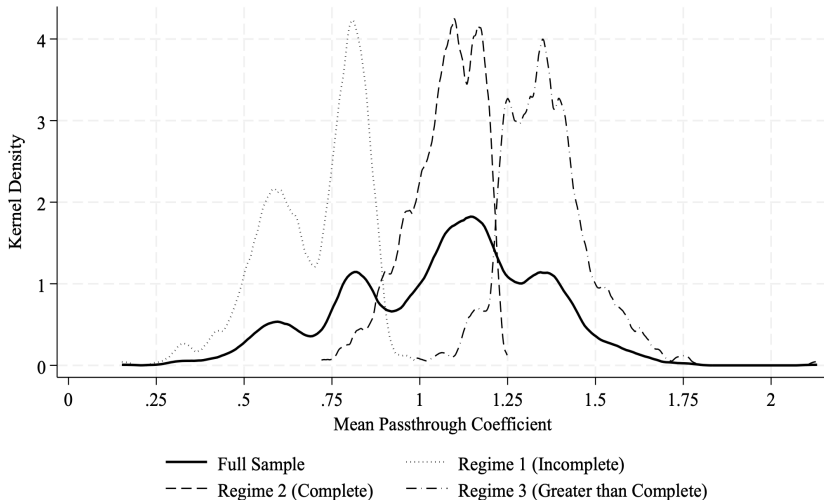
- Can statistically sort goods into Regimes in the data
 - Let R1 be incomplete, R2 complete, R3 more-than-complete based on highest posterior probability

Table: Characteristics of Passthrough Regimes

	Sample		Passthrough Estimates				Trade Averages		
	Goods	Fraction	Mean	$\Pr[R1 y]$	$\Pr[R2 y]$	$\Pr[R3 y]$	Value(\$M)	2017 Tariff	Δ Tariff
R1	494	25.4%	0.701	0.614	0.280	0.106	2.834	0.119	0.070
R2	832	42.7%	1.070	0.183	0.499	0.318	2.456	0.101	0.110
R3	621	31.9%	1.357	0.063	0.284	0.653	2.073	0.098	0.114

- Mean of means for the full sample is 1.068
 - Significant differences in means conditional on regime
- Did not control directly for trade flows and tariff changes, but patterns help explain the earlier impacts of weighting regressions by value

Posterior Passthrough Distributions for Two Goods



Composition of Passthrough: Industries and Partitions

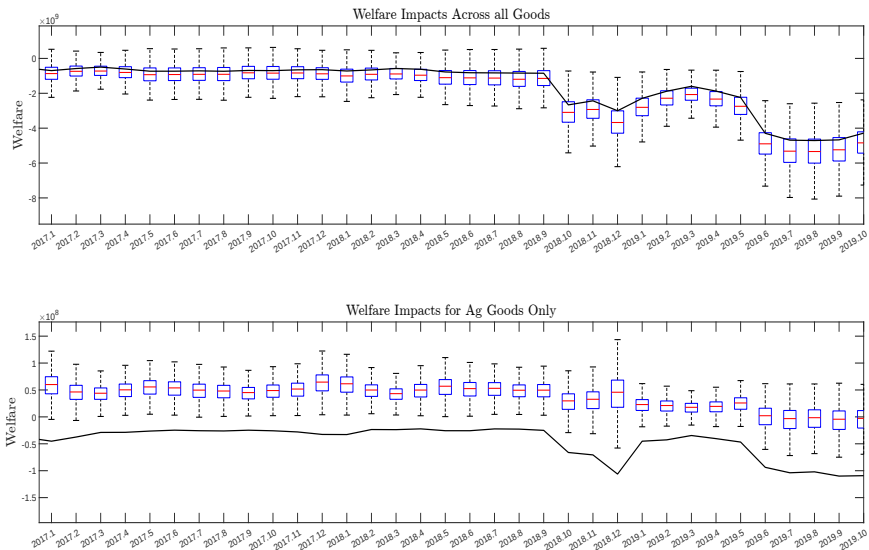
Regime	Count	Proportion of Products in Industry				CVD
		Ag	Capital	Consumer	Inputs	Fraction
Regime 1	494	0.370	0.006	0.620	0.004	0.012
Regime 2	832	0.000	0.205	0.059	0.736	0.001
Regime 3	621	0.001	0.027	0.031	0.941	0.680
Industry	Count	Proportion of Products in Regime			CVD	
		Regime 1	Regime 2	Regime 3	Fraction	
Agricultural	184	0.992	0.000	0.005	0.027	
Capital	191	0.016	0.896	0.088	0.031	
Consumer	374	0.818	0.131	0.052	0.045	
Inputs	1,198	0.002	0.511	0.487	0.335	

- Accounting for heterogeneous passthrough is important insofar as it alters evaluation
- Partial equilibrium welfare analysis (Feenstra (1995))

$$\Omega_g(\theta) \equiv \frac{\partial W_g}{\partial t_g} = \underbrace{t_g x_g p_g^* \frac{\partial \log(x_g)}{\partial \log(p_g)} \theta_g}_{\text{Efficiency Losses}} + \underbrace{p_g^* x_g (1 - \theta_g)}_{\text{Terms of Trade Gains}}$$

- θ_g good specific passthrough rate
- x_g , p_g and p_g^* : imported quantities, delivered (tariff inclusive) prices and shipped prices
- Punt on import demand elasticity (not what the paper is about), let $\frac{\partial \log(x_g)}{\partial \log(p_g)} = -3$
- Efficiency losses rise and terms of trade effects fall with passthrough
- Compare our **M4** estimates to universally complete passthrough

Calculation and Comparisons of Welfare



Conclusion

- We uncover significant heterogeneity in tariff passthrough across U.S. imports from China
 - Our estimates have strong implications for unilateral aggregate welfare calculations
- But, efficiency and aggregate welfare arguments are no longer resonating with policy makers
 - Anecdotally, the strongest proponents for protection are input producers, while the biggest dissent is coming from farmers
 - Following our estimates of welfare, we would suggest the opposite
- The disconnect between policy makers and evaluators is stark
 - A lot of rhetoric is implicitly around U.S. terms of trade gains (market power)
 - Policies have been countered by pointing to complete passthrough, but there is a lot of heterogeneity in passthrough we have ignored
- Bridging the gap(s) require consistent metrics and objectives founded in data

Interwar Laffer Curves: Not So Funny

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Introduction

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 - Interconnectedness across industries and markets (disciplined by GE/PE structure)
 - Elasticities governing microeconomic channels
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 - Consistent metrics and objectives for comparison
- There is a growing disconnect between how policy is applied and evaluated
 - Recent U.S. protectionist policies at the forefront
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 - Moving target objective functions
- Economic efficiency metrics do not seem to resonate
- Is the disconnect from
 - Differences in objectives?
 - Misaligned metrics?
- Let's follow rhetoric for a bit

“I am a Tariff Man. When people or countries come in to raid the great wealth of our Nation, I want them to pay for the privilege of doing so.”

“I am a Tariff Man standing on a tariff platform.”

“I am a Tariff Man. When people or countries come in to raid the great wealth of our Nation, I want them to pay for the privilege of doing so. It will always be the best way to max out our economic power. We are right now taking in \$billions in Tariffs. MAKE AMERICA RICH AGAIN”

— Trump, December 2018

“I am a Tariff Man standing on a tariff platform.”

— McKinley 1896

“In raising revenue, duties should be so levied upon foreign products as to preserve the home market, so far as possible, to our own producers; to revive and increase manufactures; to relieve and encourage agriculture; to increase our domestic and foreign commerce; to aid and develop mining and building; and to render to labor in every field of useful occupation the liberal wages and adequate rewards to which skill and industry are justly entitled.”

— McKinley, 1897 Congress

“The period of exclusiveness is past... Commercial wars are unprofitable. A policy of good will and friendly trade relations will prevent reprisals. Reciprocity treaties are in harmony with the spirit of the times, measures of retaliation are not. If perchance some of our tariffs are no longer needed, for revenue or to encourage and protect our industries at home, why should they not be employed to extend and promote our markets abroad?”

— McKinley, 1901 Buffalo

“This tariff law is like all other tariff legislation, whether framed primarily upon a protective or a revenue basis. It contains many compromises between sectional interests and between different industries. No tariff bill has ever been enacted or ever will be enacted under the present system that will be perfect. A large portion of the items are always adjusted with good judgment, but it is bound to contain some inequalities and inequitable compromises. There are items upon which duties will prove too high and others upon which duties will prove to be too low. Certainly no President, with his other duties, can pretend to make that exhaustive determination of the complex facts which surround each of those 3,300 items, and which has required the attention of hundreds of men in Congress for nearly a year and a third. That responsibility must rest upon the Congress in a legislative rate revision.”

— Hoover, 1929 Smoot-Hawley Bill

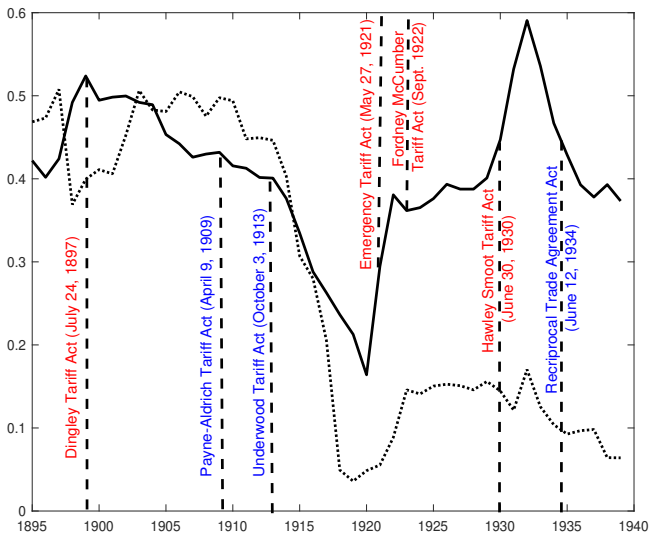
Motivation

- Modern US policy is developing parallels with historic policy
 - Hoover through Smoot-Hawley reforms was deepening analysis to the industry (often firm) level with eyes on revenue motives
 - Trump is harder to pin down, but has pointed to revenue motives and seems to be driven more by country level policies
- Develop metrics that are:
 - Lightweight
 - Able to move along aggregations
 - Decomposable along dimensions of tradeoffs
- Brings us to international trade Laffer curves
 - Relatively simple conceptually – there exist two duties that deliver the same tariff revenue
 - Aggregation and decompositions that maintain the simplicity are where we come in
- Take an elasticity based approach

Interwar period: 1927-1935

- Other than the growing parallels, this period in history is fantastic
 - Wildly transparent documentation of trade policy motivation
 - Interesting, but not buried supply chains/vertical integration
 - A wealth of policy levers
 - Huge shocks to production, consumption, trade, and policy
- For this particular question three features stand out:
 - Foreign duties were an important source of government revenue
 - Policy shocks were huge and motivated in public
 - Data are abundant (after sweat)

U.S. Aggregate Tariff and Customs Revenue Share



Sen Sackett: Why should they all not be free if what you are saying is a fact, that the domestic production is not a practical and economic thing?

Mr Lloyd: Theoretically you are correct, Senator

Sen Sackett: Not theoretically, but I want to know the practical reason.

Mr Lloyd: There is no industry in the United States...

Sen Sackett: You have not answered yet why they should not be free, instead of having 60%

Mr Lloyd: I have no reason in the world—

Sen Sackett (interposing): You are perfectly willing to make it free?

Mr Lloyd: I think from the revenue standpoint they should not be free.

Sen Sackett: From the revenue standpoint?

Mr Lloyd: In my original suggestion, I suggested 50% under the Payne-Aldrich Act.

Sen Sackett: If they were made free, would they compete with some other glove and drive it out of this country?

Mr Lloyd: No sir; there is nothing in competition with it in this country...

Sen Sackett: Do you know about what the revenue the Government gets from these gloves?

Mr Lloyd: Yes, we have the figures. For the year 1927 it was \$4,683,565...

Sen Sackett: That is the price the ladies pay toward the support of the Government; if you made them free, would just let the ladies off that much.

Mr Lloyd: Understand, I am not advocating putting them on the free list.

Sen Sackett: I just want to get you clear.

Mr Lloyd: Yes, sir. For three years we worked under the Payne-Aldrich law, with the duty on those gloves, and permitted them to go into the sales of those years. And in looking at it from the revenue standpoint I think the US Government is entitled to the revenue.

(b) Gloves (1935)

Data Excerpts

Knit goods—					
Hose and half hose—					
Valued at not more than \$1.75 per dozen pairs.....	(Dor. pr.	14,485			
	Pound.... 36¢ lb. + 35%.....	14,500	23,289	13,371.15	57.41
Valued at more than \$1.75 per dozen pairs.....	(Dor. pr.	364,718			
	Pound.... 45¢ lb. + 50%.....	609,611	2,448,152	1,538,900.95	62.96
Embroidered.....	Dor. pr. 75%.....	14,773	110,629	82,971.75	
Gloves and mittens—					
Valued at not more than \$1.75 per dozen pair.....	(Dor. pr.	119,787			
	Pound.... 36¢ lb. + 35%.....	115,528	192,997	109,139.03	56.55
Valued at more than \$1.75 per dozen pair.....	(Dor. pr.	42,656			
	Pound.... 45¢ lb. + 50%.....	56,444	146,410	98,604.80	67.35
Embroidered.....	Dor. pr. 75%.....	3,724	10,969	8,228.75	

(a) Glove Duties (1927)

Avenues for Richness

- Import markets
 - Importer market power (potentially upward sloping export supply curves)
 - Product heterogeneity (potentially different import demand elasticities)
 - Incorporate product specific policy tools (specific duties are disruptive)
- Domestic production
 - Interplay between domestic and foreign industries
 - Vertical integration

Model Schematic

				Per capita measures																						
				Value Added				C			I			Exports by Destination												
GDP	Y	N _r	N _{j,r}	y _j	wh	rk	j _r	C ₁	...	C _R	I ₁	...	I _R	C _{R+1}	...	C _{R+N}	I _{R+1}	...	I _{R+N}							
Agriculture	Y _A	N _A	N _{a,1}	a	w _A h _A	r _A k _A	a ₁	a _{1,1}	...	a _{1,R}				a _{1,R+1}	...	a _{1,R+N}										
			:				:	:	:	:				:	:	:	:	:	:	:						
			N _{a,R}				a _R	a _{R,1}	...	a _{R,R}				a _{R,R+1}	...	a _{R,R+N}										
Manufactures	Y _M	N _M	N _{m,1}	m	w _M h _M	r _M k _M	m ₁	d _{1,1}	...	d _{1,R}	i _{1,1}	...	i _{1,R}	d _{1,R+1}	...	d _{1,R+N}	i _{R+1,1}	...	i _{R+1,R+N}							
			:				:	:	:	:	:	:	:	:	:	:	:	:	:	:						
			N _{m,R}				m _R	d _{R,1}	...	d _{R,R}	i _{R,1}	...	i _{R,R}	d _{R,R+1}	...	d _{R,R+N}	i _{R+N,1}	...	i _{R+N,R+N}							
Services	Y _S	N _S	N _{s,1}	s	w _A h _A	r _A k _A	s ₁	s ₁																		
			:				:	:	:	:										:	:	:	:	:	:	:
			N _{s,R}				s _R			s _R																
Imports by source								a _{R+1,1}	...	a _{R+1,R}																
								:	:	:																
								a _{R+N,1}	...	a _{R+N,R}																
								d _{R+1,1}	...	d _{R+1,R}	i _{R+1,1}	...	i _{R+1,R}													
								:	:	:	:	:	:													
								d _{R+N,1}	...	d _{R+N,R}	i _{R+N,1}	...	i _{R+N,R}													

Data Coverage

Year	Output						International Trade			Income
	Manufacturing	Mining	Distribution	Agriculture		I/O	Imports	Exports	Tariffs	Slaughter
	Census	Census	Census	ATICS	ICPSR35206		FCNUS-T4	FCNUS-T5	FCNUS-T9	
1919	3000x11	2000x11		1348x6		40X40	9157x16	20497x16	4037x11	
1920				1348x6	3000x500		9157x16	20497x16	4110x12	
1921	3000x11			1348x6			9157x16	20497x16	3739x12	
1922				1348x6			8027x17	20208x16	7345x12	
1923	3000x11			1348x6			8472x16	19092x18	7527x12	
1924				1348x6			7418x17	17246x17	7348x12	
1925	3000x11			1348x6	3000x500		7129x19	16809x18	7942x12	
1926				1348x6			7427x18	16642x18	7877x12	
1927	3312x11			1348x6			7410x18	16669x18	6157x12	
1928				1348x6			7359x18	17798x18	6072x12	
1929	3312x11	2000x11	2000x11	1348x6		40X40	7254x18	18015x18	6290x12	48x20
1930				1348x6	3000x500		20200x18	18498x18	10542x12	48x20
1931	2375x11			1348x6			19985x18	19086x18	6790x12	48x20
1932				1348x6			6067x18	18569x18	5943x12	48x20
1933	2375x11			1348x6			5864x18	18151x19	5631x12	48x20
1934				1348x6			13499x18	18904x19	7000x12	48x20
1935	2996x11			1348x6	3000x500		13621x18	19130x19	7000x12	48x20
1936				1348x6			12000x19	20000x19	7000x12	
1937	3000x11			1348x6			12000x19	20000x19	7000x12	
1938				1348x6			12000x19	20000x19	7000x12	
1939	3000x11	2000x11	2000x11	1348x6		40X40	12000x19	20000x19	7000x12	
Totals										
Sectors	174	20	20	22	66	40	1000	1000	2000	4
Locations	49	49	49	49	49	1	120	120	120	49
Observations	356070	66000	44000	169848	6000000	4800	3841452	7089085	1668163	6720

Legend: Numerical entry indicates Rows by Columns of the raw data, collected or estimated. Color coding is as follows:

	Data unavailable	Raw data collected
	Data available but inconsistent with study requirements	Raw data collected and processed
	Data available but not collected	

Deepening the Trade Side – Imports

- CES over Armington imported varieties j of goods g Cobb-Douglas nested

$$U = c_0 + \xi_X \sum_{g \in G} \phi_g \log \left(\left(\sum_{j \in J_g} (b_{jg})^{\frac{1}{\sigma_g}} (x_{jg})^{\frac{\sigma_g - 1}{\sigma_g}} \right)^{\frac{\sigma_g}{\sigma_g - 1}} \right) + \xi_D \log(D)$$

- Where b_{jg} are demand shifters for imported quantities x_{jg} with elasticity of substitution σ_g
- The import price index is $\mathcal{P}_g = \left(\sum_j b_{jg} (p_{jg})^{1 - \sigma_g} \right)^{\frac{1}{1 - \sigma_g}}$, yields demand

$$x_{jg} = \xi_X \phi_g b_{jg} (p_{jg})^{-\sigma_g} (\mathcal{P}_g)^{\sigma_g - 1} E_g \quad (1)$$

- Important to keep prices straight: p_{jg} is the delivered price such that

$$p_{jg} = (1 + \tau_{jg}) p_{jg}^*$$

Duties

- Specific duties are commonplace in this period, such that

$$\tau_{jg} \equiv \tau_g^a + \frac{\tau_g^s}{p_{jg}^*}$$

- Where τ_g^a and τ_g^s are the ad-valorem and specific duty rates
- Notice the ad-valorem equivalent (τ_{jg}) is importer by product specific
- Export supply closes the import market – generic and potentially upward sloping depending on the inverse export supply elasticity ω_g

$$p_{jg}^* = \eta_{jg}(x_{jg})^{\omega_g}$$

- Equilibrium is where import demand equals export supply

- Equilibrium import quantity:

$$x_{jg} = \left((1 + \tau_{jg})^{-\sigma_g} \mathcal{P}_g^{\sigma_g-1} \xi_X \phi_g b_{jg} E_g \eta_{jg}^{-\sigma_g} \right)^{\frac{1}{1+\sigma_g\omega_g}}$$

- Equilibrium shipped price:

$$p_{jg}^* = \left((1 + \tau_{jg})^{-\sigma_g\omega_g} (\mathcal{P}_g^{\sigma_g-1} \xi_X \phi_g b_{jg} E_g)^{\omega_g} \eta_{jg} \right)^{\frac{1}{1+\sigma_g\omega_g}}$$

- Equilibrium value:

$$p_{jg}^* x_{jg} = \left((1 + \tau_{jg})^{-\sigma_g(\omega_g+1)} (\mathcal{P}_g^{\sigma_g-1} \xi_X \phi_g b_{jg} E_g)^{\omega_g+1} \eta_{jg}^{1-\sigma_g} \right)^{\frac{1}{1+\sigma_g\omega_g}}$$

- Demand Shifter (price index, taste shock and expenditure):

$$\Lambda_{jg} \equiv \xi_X \phi_g b_{jg} \mathcal{P}_g^{\sigma_g-1} E_g$$

- Supply Shifter (shock): η_{jg}

Revenue

- Tariff Revenue variety by variety

$$R_{jg} = \tau_{jg} p_{jg}^* x_{jg} = \tau_{jg} \left((1 + \tau_{jg})^{-\sigma_g(\omega_g+1)} \Lambda_{jg}^{\omega_g+1} \eta_{jg}^{1-\sigma_g} \right)^{\frac{1}{1+\sigma_g\omega_g}}$$

- This is the variety specific Laffer Curve, which we can decompose into Demand, Export and GE effects:

$$R_{jg} = \underbrace{\frac{\tau_{jg}}{(1 + \tau_{jg})^{\sigma_g}}}_{\text{Demand effect}} \underbrace{\left[(1 + \tau_{jg})^{\sigma_g(\omega_g+1)} \right]^{\frac{1}{1+\sigma_g\omega_g}}}_{\text{Export effect}} \underbrace{\left[\Lambda_{jg}^{\omega_g+1} \eta_{jg}^{1-\sigma_g} \right]^{\frac{1}{1+\sigma_g\omega_g}}}_{\text{Shocks and GE effect}}$$

Revenue

- To further isolate the impact of tariffs on revenues, we normalize variety specific Laffer curves by their shifters

$$\tilde{R}_{jg} = \underbrace{\frac{\tau_{jg}}{(1 + \tau_{jg})^{\sigma_g}}}_{\text{Demand effect}} \left[\underbrace{(1 + \tau_{jg})^{-\sigma_g \omega_g}}_{\text{Passthrough effect}} \underbrace{(1 + \tau_{jg})^{\sigma_g \omega_g \sigma_g}}_{\text{Supply effect}} \right]^{\frac{1}{1 + \sigma_g \omega_g}}$$

- Assuming the variety is atomistic, the change in revenue with the AVE is

$$\frac{\partial R_{jg}}{\partial \tau_{jg}} = R_{jg} \left(1 - \frac{\sigma_g(\omega_g + 1)}{1 + \sigma_g \omega_g} \frac{\tau_{jg}}{1 + \tau_{jg}} \right)$$

- The sign of this derivative is determined by:

$$\frac{\partial R_{jg}}{\partial \tau_{jg}} \gtrless 0 \iff \tau_{jg} \lessgtr \frac{1 + \sigma_g \omega_g}{\sigma_g - 1}$$

- ? was particularly interested in maximizing tariff revenue

Data

- What we have
 - We observe (after much sweat) the universe of good level U.S. imports by country from 1927-1935 along with product level duty rates and collections
- What we need
 - Import demand and export supply elasticity and shifters
- Imported goods are separable, focus on Cotton Knit or Crocheted Gloves (product 3090) from the discussion earlier to anchor things
 - I want to implement a heteroskedastic estimator (have a time series, hard to think of product by product IVs that separately identify supply and demand – ?)
 - One immediate challenge is AVEs are country specific under specific duties – Greenland et al. (2023)

- First, convert the model into logs of product specific market shares and shipped prices

$$D: \ln(s_{jgt}^*) = -(\sigma_g - 1)(\ln(p_{jgt}^*) - \ln(\mathcal{P}_{gt})) - \sigma_g \ln(1 + \tau_{jgt}) + \ln(b_{jgt})$$

$$S: \ln(s_{jgt}^*) = \frac{1+\omega_g}{\omega_g} \ln(p_{jgt}^*) - \ln(E_{gt}) - \frac{1}{\omega_g} \ln(\eta_{jgt})$$

- Next we first- and reference-difference (denoted Δ^k) then multiply modified supply and demand error terms together
 - AVE falls out from the reference differencing if duties are only ad valorem
 - Here, AVE is potentially j specific (τ_{jg})

$$\begin{aligned} \Delta^k \ln(p_{jgt}^*)^2 &= \frac{\omega_g}{(1+\omega_g)(\sigma_g-1)} \Delta^k \ln(s_{jgt}^*)^2 + \frac{\omega_g(\sigma_g-2)-1}{(1+\omega_g)(\sigma_g-1)} \Delta^k \ln(s_{jgt}^*) \Delta^k \ln(p_{jgt}^*) \\ &\quad + \frac{\sigma_g \omega_g}{(1+\omega_g)(\sigma_g-1)} \Delta^k \ln(s_{jgt}^*) \Delta^k \ln(1 + \tau_{jgt}) \\ &\quad + \frac{\sigma_g}{\sigma_g-1} \Delta^k \ln(p_{jgt}^*) \Delta^k \ln(1 + \tau_{jgt}) + \frac{1}{(1+\omega_g)(\sigma_g-1)} \Delta^k \epsilon_{jgt} \end{aligned}$$

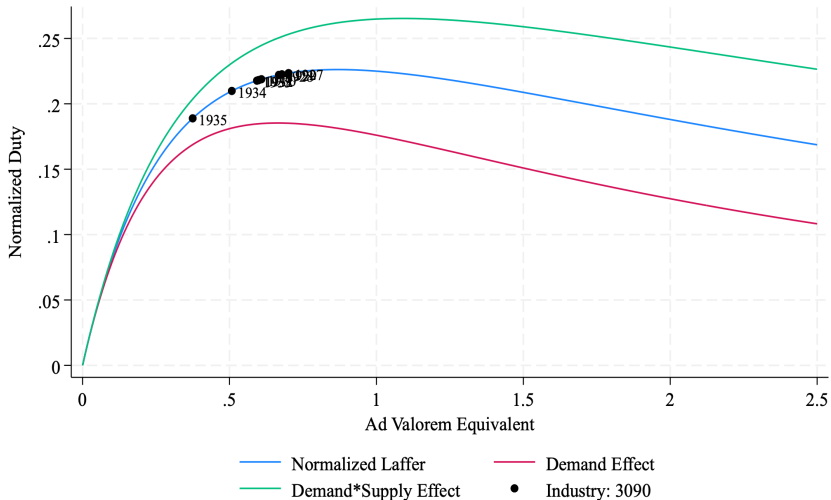
- Estimate nonlinearly following Grant and Soderbery (2024)

Cotton Knit or Crocheted Gloves

Year	Sources	Imports (\$M)	Q (M pair)	Duties (\$M)	AVE	Specific	Ad-Val	σ	ω	AVE*
1927	11	6.54	2.19	4.59	0.70	0.22	0.63	2.51	0.12	0.87
1928	12	8.23	2.49	5.50	0.67	0.54	0.50	2.51	0.12	0.87
1929	9	5.81	1.98	3.94	0.68	0.44	0.53	2.51	0.12	0.87
1930	10	5.76	1.76	3.50	0.61	0.15	0.56	2.51	0.12	0.87
1931	10	6.85	2.54	4.10	0.60	0.00	0.60	2.51	0.12	0.87
1932	7	4.35	2.28	2.61	0.60	0.00	0.60	2.51	0.12	0.87
1933	7	5.32	2.82	3.15	0.59	0.00	0.59	2.51	0.12	0.87
1934	11	5.21	2.31	2.63	0.50	0.18	0.45	2.51	0.12	0.87
1935	13	6.39	2.41	2.36	0.37	0.06	0.45	2.51	0.12	0.87

- Recall duties from the Sackett-Lloyd discussion were \$4.68M in 1927 and they were debating a 60% ad-valorem rate for 1931
- This product is elastically supplied (low ω) and relatively inelastically demanded (low σ)
- Combined, passthrough is moderately incomplete (high revenue maximizing AVE)
- This information is compactly summarized by Laffer curves

Laffer Curves: Gloves



Marginal Cost of Public Funds

- Gloves exhibit duties and rates on the upward sloping portion of the Laffer curve approaching the maximum
 - Supports the idea that duties are being used as a revenue generation tool, as the discussion suggests
 - Discussions do not need to gravitate toward the maximum (?’s focus) – the applied AVE is around 25% below AVE*, yet yields nearly the same revenue
 - The full Laffer curve provides a rich sense of the policy tradeoffs
- The Marginal Cost of Public Funds (MCF) is a potential metric for position evaluation
 - Brings in efficiency tradeoffs: $MCF \equiv \frac{\Delta \text{Efficiency}}{\Delta \text{Revenue}}$
 - Interpreted as the importer surplus loss associated with a dollar increase in tariff revenue

$$MCF_{jgt} = \frac{1+\tau_{jgt}}{\sigma_g-1} \frac{1}{\tau_{jgt}^* - \tau_{jgt}} \quad (2)$$

Cotton Knit or Crocheted Gloves

Year	Sources	Imports (\$M)	Q (M pair)	Duties (\$M)	AVE	Specific	Ad-Val	σ	ω	AVE*	MCF
1927	11	6.54	2.19	4.59	0.70	0.22	0.63	2.51	0.12	0.87	6.76
1928	12	8.23	2.49	5.50	0.67	0.54	0.50	2.51	0.12	0.87	5.54
1929	9	5.81	1.98	3.94	0.68	0.44	0.53	2.51	0.12	0.87	5.87
1930	10	5.76	1.76	3.50	0.61	0.15	0.56	2.51	0.12	0.87	4.12
1931	10	6.85	2.54	4.10	0.60	0.00	0.60	2.51	0.12	0.87	3.95
1932	7	4.35	2.28	2.61	0.60	0.00	0.60	2.51	0.12	0.87	3.95
1933	7	5.32	2.82	3.15	0.59	0.00	0.59	2.51	0.12	0.87	3.85
1934	11	5.21	2.31	2.63	0.50	0.18	0.45	2.51	0.12	0.87	2.74
1935	13	6.39	2.41	2.36	0.37	0.06	0.45	2.51	0.12	0.87	1.82

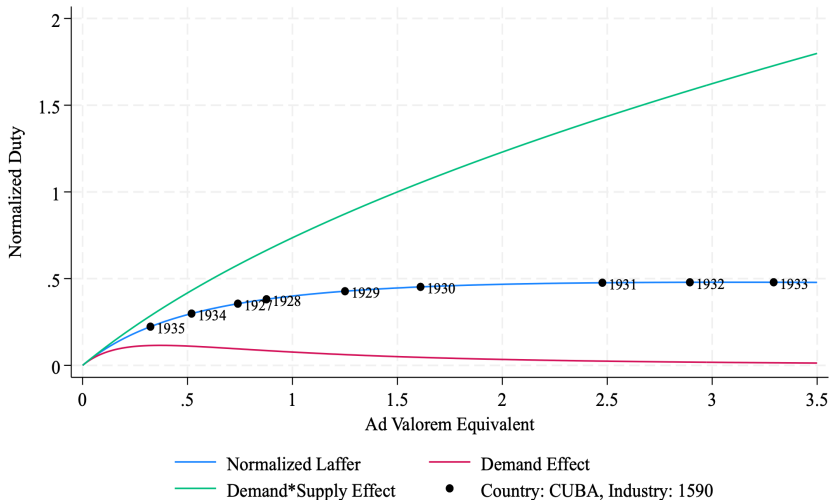
- Reciprocal trade act cut into AVEs considerably, leading to big decreases in the MCF
- One more pet example to walk through aggregation
 - Sugar (good 1590)

Cane Sugar

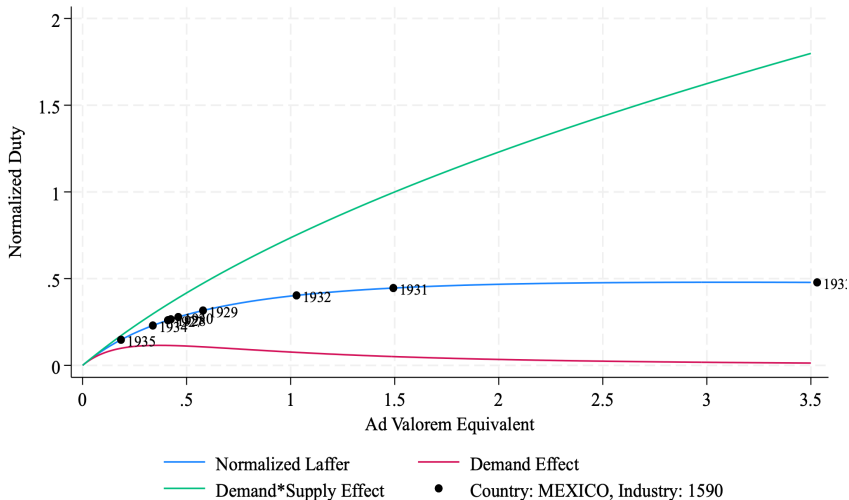
Year	Sources	Trade Statistics			Trade Policies			Elasticities		
		Imports (\$M)	Q (M lbs)	Duties (\$M)	AVE	Specific	Ad-Val	$\hat{\sigma}$	$\hat{\omega}$	AVE*
1927	26	258.16	8431.41	177.38	0.69	0.02	0.00	3.70	1.71	2.72
1928	21	207.03	7737.00	163.86	0.79	0.02	0.00	3.70	1.71	2.72
1929	20	209.28	9776.78	232.19	1.11	0.02	0.00	3.70	1.71	2.72
1930	18	129.54	6989.32	161.28	1.25	0.02	0.00	3.70	1.71	2.72
1931	15	112.63	6347.66	208.09	1.85	0.03	0.00	3.70	1.71	2.72
1932	13	96.70	5941.44	172.94	1.79	0.03	0.00	3.70	1.71	2.72
1933	15	107.64	5748.25	236.29	2.20	0.04	0.00	3.70	1.71	2.72
1934	15	117.61	5994.38	47.18	0.40	0.01	0.00	3.70	1.71	2.72
1935	13	133.48	5908.29	38.50	0.29	0.01	0.00	3.70	1.71	2.72

- Sugar is wild in this period
- Elasticity estimates support anecdotal assertions – This product is inelastically supplied (high ω) and neither elastically nor inelastically demanded (average σ)
 - Combined, passthrough is highly incomplete (astronomical revenue maximizing AVE around 272%)
- Concentrated among a few very large exporters Cuba (75%) Philippine Islands (15%) Mexico (5%)

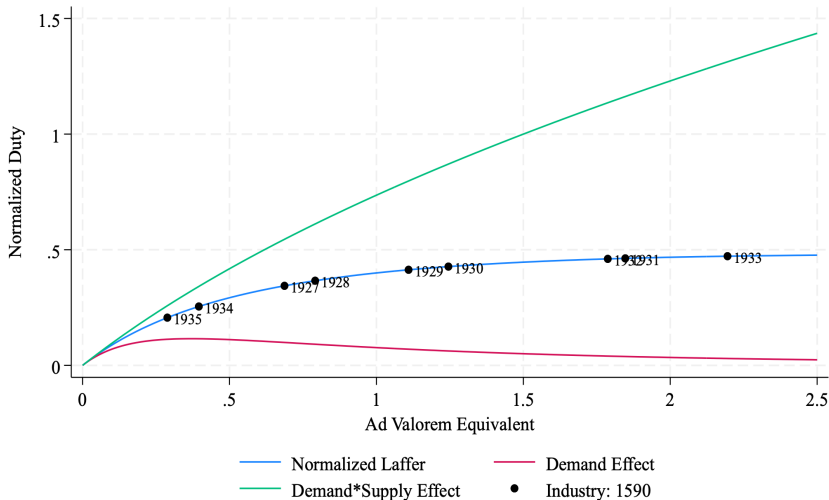
Laffer Curves: Cuban Sugar



Laffer Curves: Mexican Sugar



Laffer Curves: Sugar



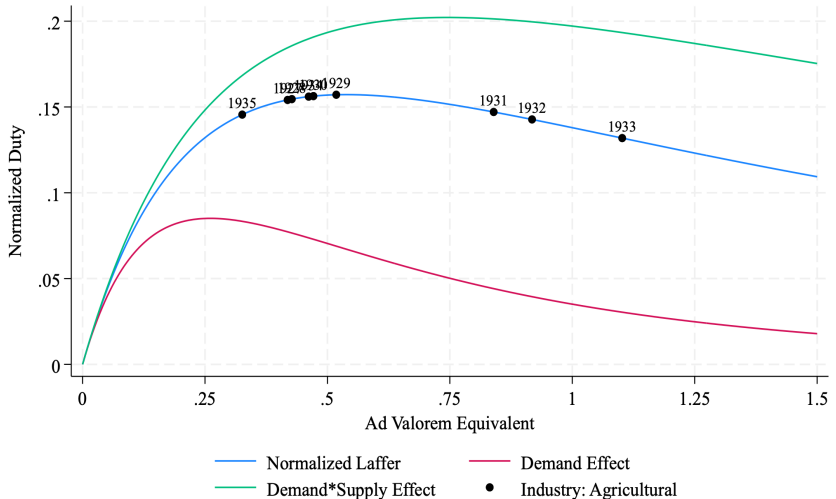
- The rapid flattening of the Laffer curves for sugar stand out
 - The US could have achieved similar revenue levels with considerably lower AVEs post Smoot-Hawley
- Won't bore you with the math of aggregation (clunky due to product heterogeneity), but these curves aggregate smoothly
- Consider aggregation to broad sectoral levels, then the US as a whole
 - Use median elasticity estimates for dutiable imports

Agricultural Goods

Sector	Year	Trade Statistics				Median Elasticities			
		Products	Imports (\$M)	Duties (\$M)	AVE	$\hat{\sigma}$	$\hat{\omega}$	AVE*	MCF
Agri	1927	245	745.02	311.90	0.419	4.868	0.235	0.555	2.70
	1928	255	677.52	289.51	0.427	4.846	0.233	0.554	2.94
	1929	252	714.68	370.23	0.518	4.828	0.225	0.545	14.82
	1930	293	591.72	278.95	0.471	4.794	0.204	0.521	7.81
	1931	269	400.53	336.23	0.839	4.794	0.204	0.521	.
	1932	271	270.29	248.07	0.918	4.828	0.210	0.526	.
	1933	268	328.99	362.52	1.102	4.849	0.217	0.533	.
	1934	300	388.19	179.28	0.462	4.846	0.235	0.556	4.02
	1935	320	698.24	226.85	0.325	4.841	0.217	0.533	1.65

- Smoot-Hawley (as publicized) targeted Ag goods disproportionately
 - In the aggregate, these duties exceeded the Laffer curve peak
- Reset with the Reciprocal Trade Act in 1934
- Immediate with Laffer curves

Laffer Curves: Agriculture

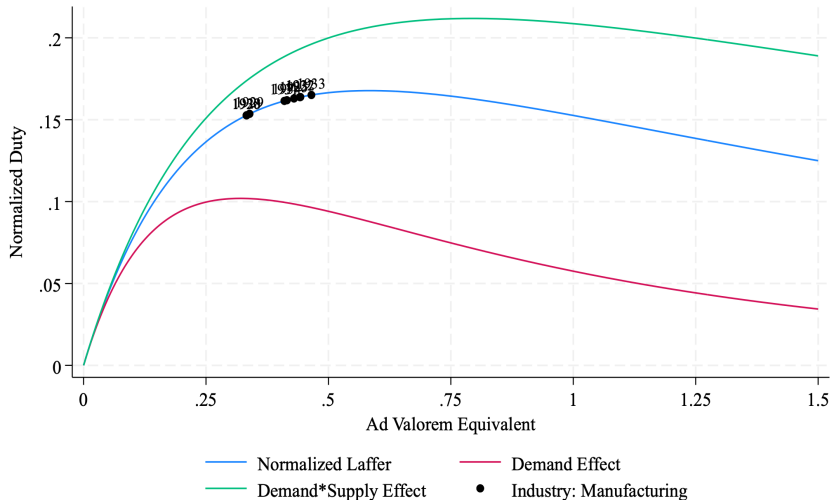


Manufacturing Goods

Sector	Year	Trade Statistics				Median Elasticities			
		Products	Imports (\$M)	Duties (\$M)	AVE	$\hat{\sigma}$	$\hat{\omega}$	AVE*	MCF
Manuf	1927	107	363.17	160.44	0.442	4.074	0.289	0.709	1.76
	1928	108	358.70	119.50	0.333	3.812	0.197	0.622	1.64
	1929	115	381.99	129.47	0.339	4.074	0.289	0.709	1.18
	1930	124	215.07	71.53	0.333	4.482	0.140	0.468	2.83
	1931	117	151.96	62.31	0.410	4.639	0.187	0.513	3.77
	1932	119	82.25	36.42	0.443	4.084	0.187	0.571	3.64
	1933	124	111.05	51.66	0.465	4.084	0.181	0.563	4.84
	1934	199	182.79	75.81	0.415	3.895	0.187	0.597	2.69
	1935	202	225.47	92.88	0.412	3.934	0.140	0.529	4.11

- Less pronounced variation in AVEs, but dramatic decreases in imports, duties collected, and average unit values
- Consistently, AVEs fall in the increasing portion of the Laffer curves
 - Relatively low MCF pre-Smoot-Hawley

Laffer Curves: Manufacturing

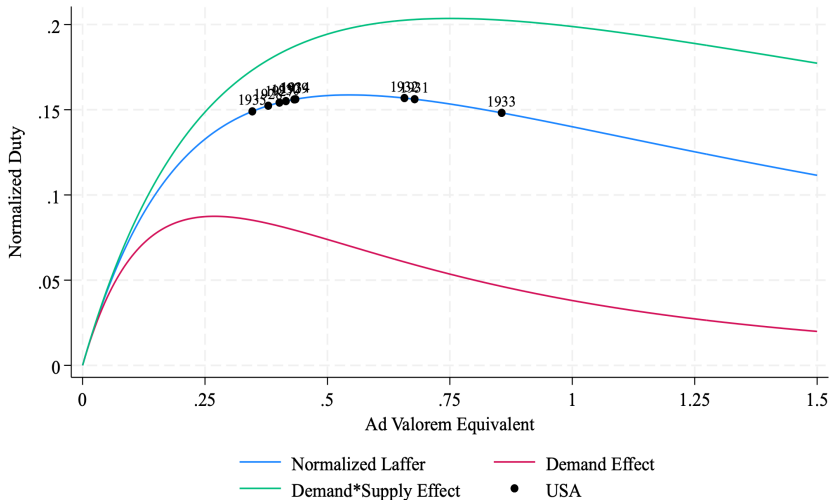


US Aggregates

Sector	Year	Trade Statistics				Median Elasticities			
		Products	Imports (\$M)	Duties (\$M)	AVE	$\hat{\sigma}$	$\hat{\omega}$	AVE*	MCF
USA	1927	449	1300.83	522.96	0.402	4.794	0.233	0.558	2.37
	1928	468	1224.13	464.14	0.379	4.644	0.212	0.545	2.28
	1929	474	1300.91	562.28	0.432	4.265	0.233	0.611	2.45
	1930	533	941.25	390.77	0.415	4.794	0.200	0.516	3.71
	1931	501	628.98	426.49	0.678	4.846	0.210	0.525	.
	1932	519	466.49	306.60	0.657	4.828	0.210	0.526	.
	1933	522	528.05	451.92	0.856	4.868	0.212	0.526	.
	1934	692	710.32	306.98	0.432	4.657	0.230	0.566	2.93
	1935	716	1085.07	370.09	0.341	4.747	0.212	0.536	1.84

- Agricultural goods account for about 60% of dutiable imports
- Manufacturing goods account for about 20% of dutiable imports
- Resource based goods account for about 20% of dutiable imports

Laffer Curves: US



Conclusion

- Economic efficiency and aggregate welfare arguments are no longer resonating with policy makers
- The disconnect between policy makers and evaluators is stark
 - A lot of rhetoric is implicitly around U.S. terms of trade gains (market power)
 - Learning from historical policies with comparable motivation is valuable
- Bridging the gap(s) require consistent metrics and objectives founded in data
- Laffer curves provide a unique window into the revenue motives for duties
- Potential next steps
 - Incorporate the deeper trade model into a GE model
 - The immediate effect is more richness in the treatment of price indexes (now we are holding fixed along the curve)
 - Keep slogging away at data – would be neat to incorporate domestic and export markets in the model and elasticity estimation
 - With domestic markets, adding vertical integration seems like a natural/beneficial enhancement

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