Moving parts:

When more restrictive content rules backfire

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Motivation

What is the right rule of origin (ROO)?

- In 1993, US, Canada, and Mexico compromised on a 62.5% content rule for Autos (up from 50% in the earlier US-CA Auto Pact).
- In 2015, “blindsiding” Canada and Mexico, the American and Japanese representatives agreed in a Maui hotel to 45% as the rule for the TPP.
- The USMCA revised Nafta to move the requirement to 75% (USTR ask: 85%), w/ extra rules for materials and labour value
- Lighthizer claimed the ROO would “create strong incentives to invest and manufacture in the United States and North America.”
- The chief Canadian auto lobbyist strongly approved.
- But do stricter ROOs really promote production?

The ROO Laffer Curve

A continuum of parts: setup

- Each part x in the unit continuum is available at home $i = H$ and abroad $i = F$ at different costs, $c_i(x)$.
- Cost of assembled car: $C_{\min} = \int_0^1 \min\{c_H(x), c_F(x)\}dx$
- Cost shifters at home and abroad: $k_H = k$, $k_F = k\delta$.
- δ captures all the factors affecting relative costs of inputs sourced from abroad: transport costs, tariffs on parts, productivity and wages. $\delta > 1 \Rightarrow$ home cost adv.
- Firms differ in their δ because, among other things, they have different networks of supplier locations.

Unconstrained choices

- Weibull distributed costs: $G(c_i) = 1 - \exp(-(c_i/k_i)^\theta)$
- By properties of the Weibull:
  $C_{\min} = (k^{-\theta} + (k\delta)^{-\theta})^{-1/\theta}\Gamma(1 + 1/\theta)$
- Letting $k = 1/\Gamma(1 + 1/\theta)$, $C_{min} = (1 + \delta^{-\theta})^{-1/\theta}$
- The cost-minimizing share of parts sourced at home equals the probability that $c_H < c_F$:

$$\lambda_{\min} = \frac{k^{-\theta}}{k^{-\theta} + (k\delta)^{-\theta}} = (1 + \delta^{-\theta})^{-1} \text{ after normalizing}$$

- Substituting: $C_{min}(\delta) = \lambda_{\min}(\delta)^{1/\theta}$

The input-tariff equivalent of ROO compliance

- Rules of origin: to avoid the MFN tariff, $\tau - 1$, the ROO requires firms to source
  - $\lambda \geq \lambda_R$
  - The rule can also be expressed as a regional cost share, λ_C, but there is a monotonic relationship between λ_R and λ_C.
- To allow for intra-national sales, scale τ by the share exported within region.
- For any λ_R there is a notional tariff, ρ, on foreign inputs that induce local share $\lambda(\rho) = \left[1 + (\rho\delta)^{-\theta}\right]^{-1} = \lambda^R$. Inverting,

$$\rho = \left[\lambda_R / (1 - \lambda_R)\right]^{1/\theta} \delta^{-1}$$

ROO compliance imposes a cost penalty

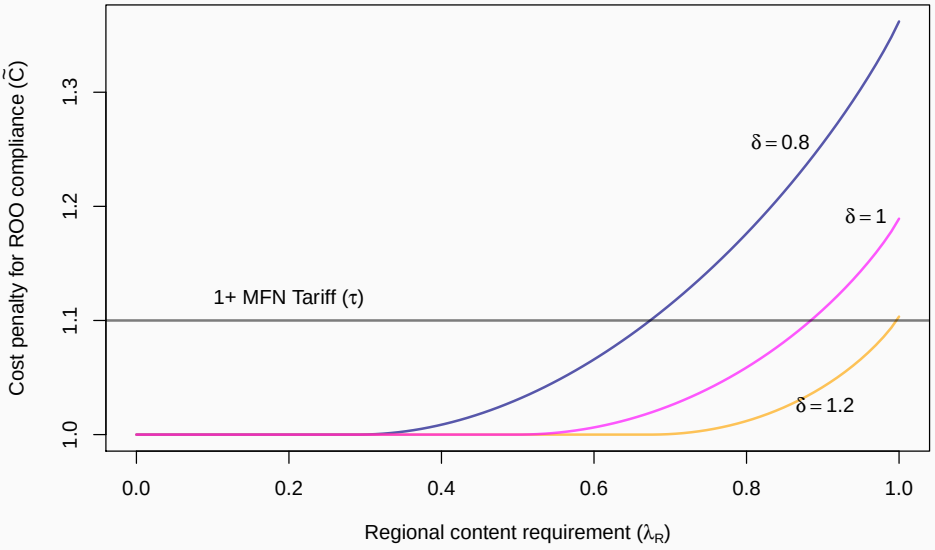
- Compliance distorts sourcing away from the optimal as if there were a tariff ρ on foreign inputs—but the firm doesn't actually pay a tariff.
- Complying exactly with a ROO of λ_R implies a car cost for firm δ of

$$C(\lambda_R, \delta) = \lambda_R^{\frac{1+\theta}{\theta}} + (1 - \lambda_R)^{\frac{1+\theta}{\theta}} \delta$$

- The cost penalty of compliance is

$$\tilde{C}(\lambda_R, \delta) = \begin{cases} \frac{C(\lambda_R, \delta)}{C_{\min}(\delta)} > 1 & \text{for } \lambda_R > \lambda_{\min}(\delta) \\ 1 & \text{for } \lambda_R \leq \lambda_{\min}(\delta) \end{cases}$$

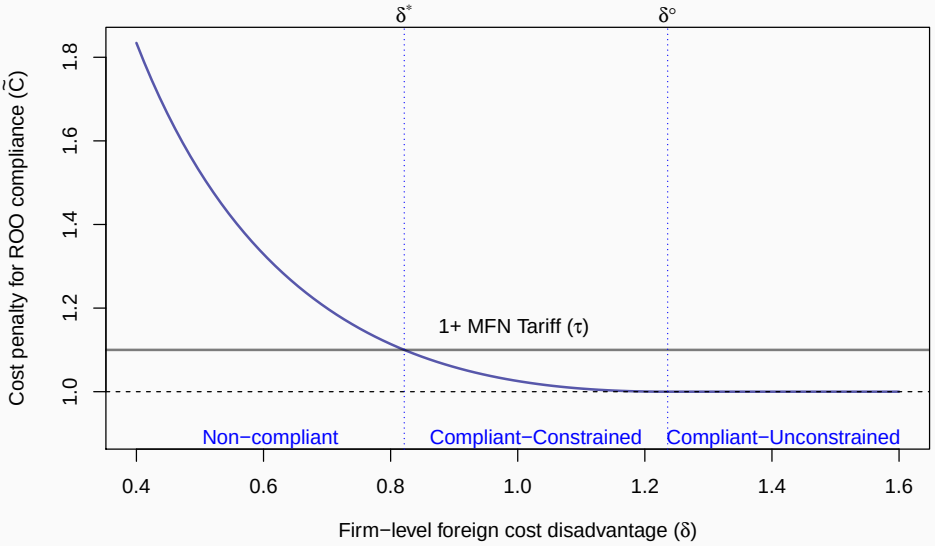
ROO compliance increases costs, heterogeneously



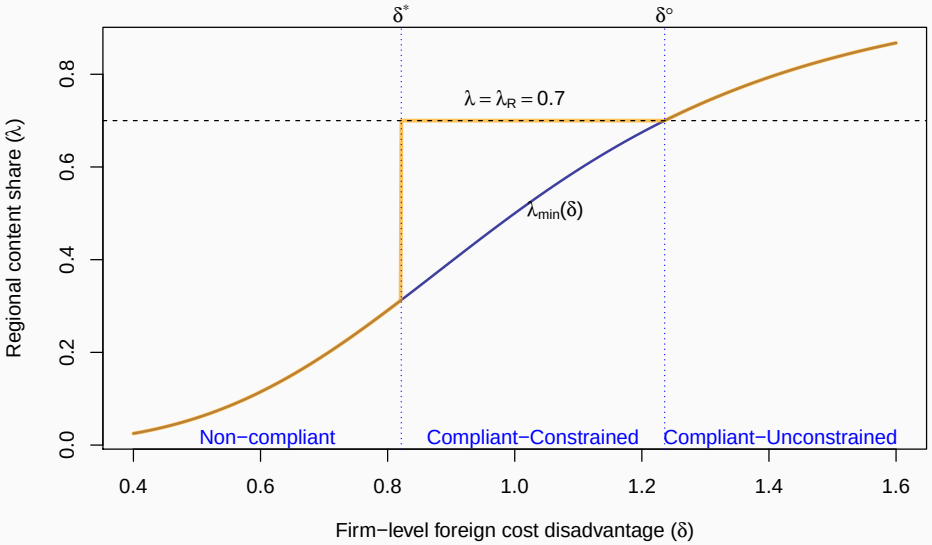
Three types of firms

1. The non-compliant: δ is so low they would rather pay τ and keep $\lambda = \lambda_{\min}(\delta) < \lambda_R$.
2. The compliant-constrained ($\lambda_{\min}(\delta) < \lambda_R$): δ is high enough that complying (raising λ to λ_R) is less costly than paying the MFN tariff.
3. The compliant-unconstrained: δ is so high they *choose* $\lambda = \lambda_{\min}(\delta) > \lambda_R$.

How costs affect the decision to comply ($\lambda_R = 0.7$)



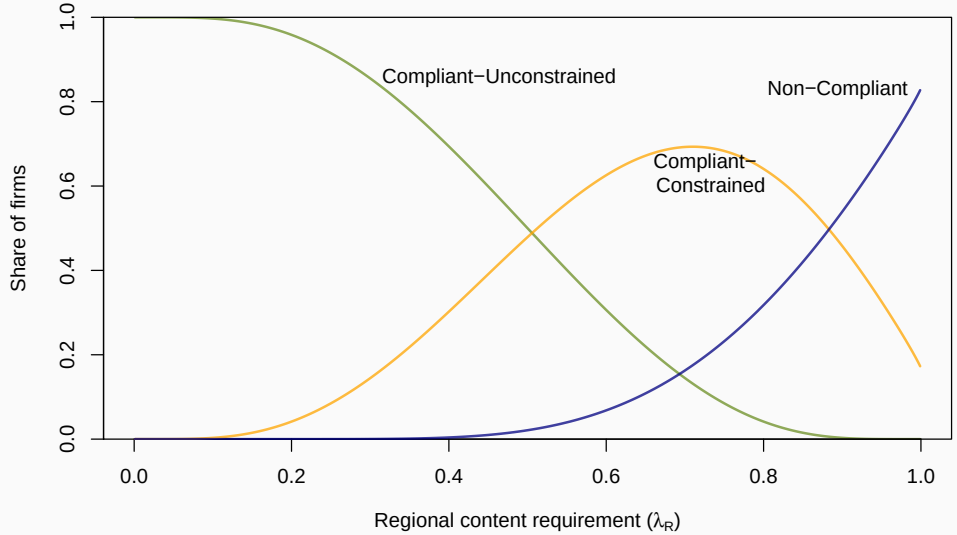
How costs affect the chosen regional share ($\lambda_R = 0.7$)



Shares in each regime

- δ^* is the critical value for which $\tilde{C}(\lambda_R, \delta^*) = \tau$
- $\delta^\circ > \delta^*$ is the critical value for which $\lambda_{\min}(\delta^\circ) = \lambda_R$.
  Inverting: $\delta^\circ = \left(\lambda_R^{-1} - 1\right)^{-1/\theta}$
- The CDF of δ is $F = \mathcal{LN}(\mu, \sigma)$
- Non-compliant share $=$ Prob$(\delta < \delta^*) = F(\delta^*)$.
- Compliant-constrained share
  $=$ Prob$(\delta^* < \delta < \delta^\circ) = F(\delta^\circ) - F(\delta^*)$.
- Compliant-unconstrained share
  $=$ Prob$(\delta^\circ < \delta) = 1 - F(\delta^\circ)$.

Shares of firms by regime ($\mu = 0, \sigma = 0.2$)

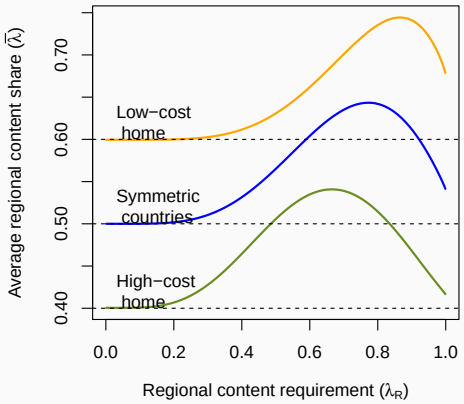


Regional content rules and chosen shares

- The average regional content share depends on the composition of firms across regimes

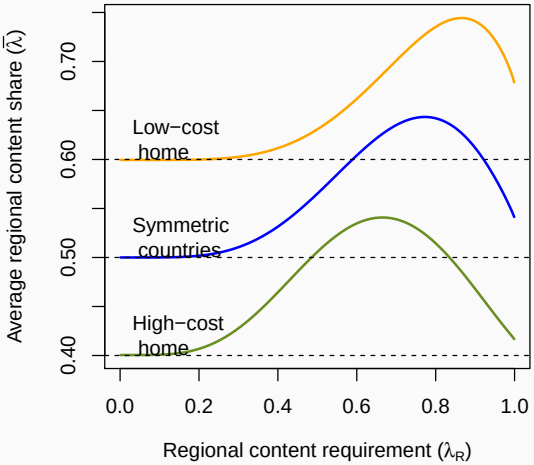
$$\bar{\lambda}(\lambda_R) = \underbrace{\int_0^{\delta^*} \lambda_{\min}(\delta) dF(\delta)}_{\text{Non-compliant}} + \underbrace{\lambda_R[F(\delta^\circ) - F(\delta^*)]}_{\text{Compliant-constrained}} + \underbrace{\int_{\delta^\circ}^{\infty} \lambda_{\min}(\delta) dF(\delta)}_{\text{Compliant-Unconstrained}}$$

The ROO Laffer Curve

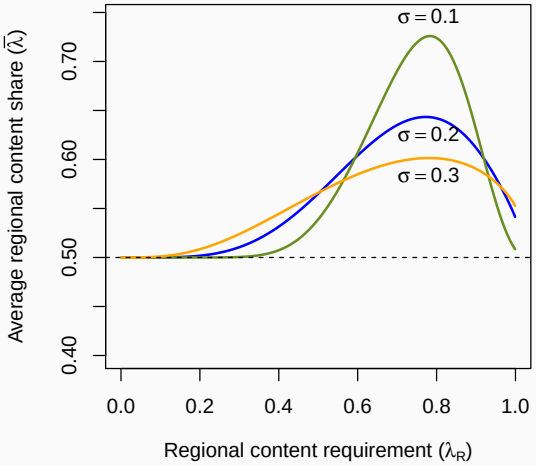


- Blue curve starts at 0.5 since mean $\log \delta = 0$
- Ends above 0.5 because of 17% always-compliant firms.
- Low-cost home ($\mu = 0.12$) has higher share of always-compliers and Laffer curve peaks later.

The ROO Laffer Curve 2

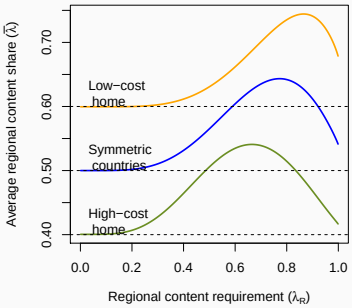


(a) δ means (μ) differ

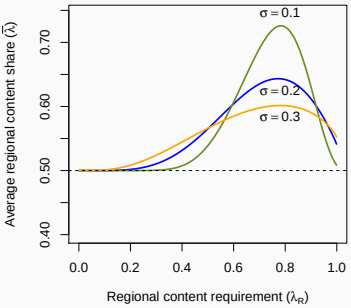


(b) δ dispersions (σ) differ

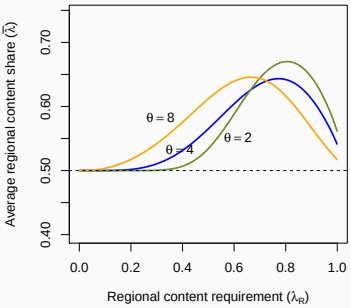
The ROO Laffer Curve 3



(a) δ means (μ) differ



(b) δ dispersions (σ) differ



(c) θ differences

Bottom line: while parameters affect shape, the ROO Laffer curve does not depend on specific settings.

Transition to empirics

- The ROO Laffer curve comes from 2 features of the model
  - Parts differ in their low-cost location (comp. adv. within firms)
  - Heterogeneous home vs foreign cost advantages (δ) give each firm a different compliance rule (comp. adv. between firms)
- Going from the continuum to our empirical focus on two critical parts ($+$ final assembly), the key ideas are that
  - Two parts is enough to retain the convex cost response to ROOs.
  - The ideal source for engines and transmissions differs.
  - The costs and benefits of sourcing outside the region depend on the firm and vehicle
  - Higher λ_R may induce relocation of final assembly.

Notable features of the sourcing of engines and transmissions

Insights from detailed sourcing data

- IHS Markit Powertrain data tell us where the engine and transmission come from for every car.
- A few interesting numbers about cars made in Nafta & EU
  - **2**: modal number of suppliers of engines to each car model (same for transmissions)
  - **99%**: Fraction of vehicle “specs” with a single supplier of engines (same for transmissions)
  - **97%**: Fraction of NAFTA engines made in-house (70% for transmissions, 80% and 53% for EU-made cars) for both in EU)
  - **172km**: median distance travelled by engines to assembler
  - **682km**: median distance travelled by transmissions

Main sources of super-core parts in North America

	Final assembly location of each					
	Engine			Transmission		
Origin	USA	MEX	CAN	USA	MEX	CAN
USA	62.52	27.16	69.46	63.78	28.04	51.20
MEX	16.57	53.63	10.14	16.48	33.93	11.93
CAN	9.12	0.00	13.45	0.00	0.00	8.80
JPN	0.61	0.83	0.00	12.27	14.95	24.30
DEU	3.28	1.17	0.00	5.48	6.92	0.64
ESP	0.88	1.03	5.70	0.00	4.15	0.00
AUT	2.91	3.33	0.00	0.31	0.05	0.00
BRA	0.00	5.63	0.00	0.08	0.73	0.00
ROW	4.11	7.23	1.25	1.60	11.23	3.14

Notes: Shares from each top sourcing country. Each column adds to 100%.

Discrete choice model and estimates

Cost equation

- c_i^E: cost of engine manufactured in i
- c_k^T: cost of transmission manufactured in k
- c_ℓ^V costs of vehicle assembly (+ other inputs) in country ℓ
- The final manufacturing cost of vehicle is $c_\ell^V + c_i^E + c_k^T$.
- To that must add tariffs and transport costs:

$$C_{n\ell ik} = \left[c_\ell^V + (1 + t_{i\ell}^E)\tau_{i\ell}^E c_i^E + (1 + t_{i\ell}^T)\tau_{k\ell}^T c_k^T\right] \tau_{\ell n}^V (1 + t_{\ell n}^V)$$

- Problem: $t_{\ell n}^V$ may depend on sourcing locations of E and T

Nested discrete choice

Upper level choice: the dealership network in country n is the chooser, selecting a single assembly plant in country ℓ for each vehicle specification.

Lower level choices: This stage considers the vehicle assembly plant, in a given location, ℓ, to be the chooser, selecting the source countries, i and k, for engines and transmissions.

Logit probabilities

$$\mathbb{P}^E_{i\ell} = \frac{\exp[\mathrm{FE}^E_i - \delta^E \ln D_{i\ell} - \theta^E \ln(1 + t^E_{i\ell})]}{\Phi^E_\ell} \tag{1}$$

$$\mathbb{P}^T_{k\ell} = \frac{\exp[\mathrm{FE}^T_k - \delta^T \ln D_{k\ell} - \theta^T \ln(1 + t^T_{k\ell})]}{\Phi^T_\ell} \tag{2}$$

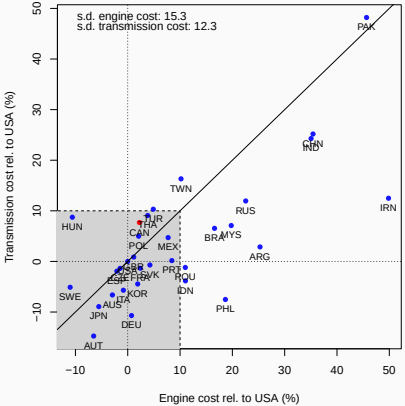
$$\mathbb{P}^V_{\ell n} = \frac{\exp[\mathrm{FE}^V_\ell - \delta^V \ln D_{\ell n} - \theta^V \ln(1 + t^V_{\ell n})]}{\Phi^V_n} \tag{3}$$

The Φ terms are formed as sums of the numerators across all the sourcing options for the vehicle or part. The *FE* capture each country's costs. D represents distance, and t tariffs.

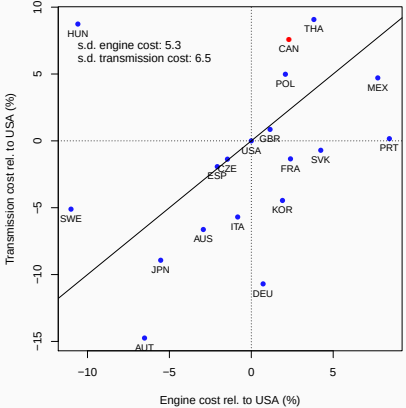
Summary of estimation results

- Sourcing is strongly biased towards plants within trade agreements: NAFTA sources preferred by a factor of 2.3 (engines), 2.45 (transmissions), and 2.5 (vehicles). Strong EU effects, also.
- As the regressions control for plant-to-plant distance and tariffs, the ROOs are likely to be important.
- National border effects are large and heterogeneous for emerging markets.
- Tariff elasticities: 7.4 (engines), 7.2 (transmissions), 6.7 (vehicles).
- We employ these θ estimates to back out the implied production cost differences.

Estimated cost differences in transmissions and engines



(a) All E & T making countries



(b) Zoom on grey area

% cost diff., calculated as $100 \times (\exp(-\hat{\alpha}_i/\hat{\theta}) - 1)$, based on origin FEs (2000–2018 period).

ROO Counterfactuals planned

- Stricter content rules induce the firm to evaluate 3 alternatives:
  1. Just comply: source trans. from USA instead of JPN.
  2. Pay the MFN, retaining current assembly location, e.g. Canadian Toyotas pay 2.5% US tariff
  3. Relocate assembly to the new optimal location, e.g. source Toyotas for American market from Japan.
- Our Logit coefficients allow us to compute the expected costs of each alternative and probability of relocation of production.
- Taking into account the optimal responses, we can evaluate the impact of stricter ROOs on assembly and parts production within the region.
- The impact will be negative on the wrong side of the Laffer curve.