Mandates, Trade Structure, and Trade Agreements

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Negotiating mandates

- Before two governments sit down to negotiate a trade agreement, each has already set a confidential mandate.
- The mandate tells negotiators
  - what their government wants to achieve, and
  - which **concessions** they may offer, contingent on the eventual agreement.

  → *contingent concessions*
- Each government chooses its mandate to secure the best terms for itself, knowing the other side does the same.

  → *strategic choice*

Can strategic contingent concessions prevent an efficient trade agreement?

What we show

Can strategic contingent concessions prevent an efficient trade agreement?

- We start with a standard two-country tariff-setting game. ▸ why bilateral?
- Before choosing tariffs, governments commit to contingent concessions, which we model as transfers. This gives the framework of Jackson and Wilkie (2005).
- Even in an *otherwise perfect world* (no political constraints, no costly contracting, welfare is perfectly transferable), the strategic choice of mandates can rule out every efficient agreement.
  - Strict submodularity of aggregate welfare rules out efficiency.
  - Strict supermodularity supports efficiency under additional conditions.
- We link this property to the structure of trade, through specialisation within sectors (substitutable goods) or across sectors (complementary goods).

What we contribute

- **Theory.** We simplify Jackson and Wilkie's (2005) implicit condition for sustaining efficiency in a structured class of games.
  - We link our condition to specialisation within sectors (substitutable goods) or across sectors (complementary goods) in an underlying trading economy.
- **Empirical evidence.** Specialisation across rather than within sectors is associated with a higher probability of subsequently signing a trade agreement.
  - Illustrative evidence consistent with the theoretical mechanism.
- **Beyond tariff setting.** Our results apply to other settings, including Cournot and Bertrand competition and team production.

Where we sit

Endogenous mechanism design / contracting with transfers.

- *Jackson & Wilkie (2005)*: action-contingent side-payments before a game. We give their *implicit* condition a primitive, readable form for a structured class.
- Transfers in networks (Bloch & Jackson, 2007), bargaining with externalities (de Fontenay & Gans, 2014), side payments in political cooperation (Harstad, 2007); modularity methods (Topkis, 1998; Milgrom & Shannon, 1994).

Theory of trade agreements.

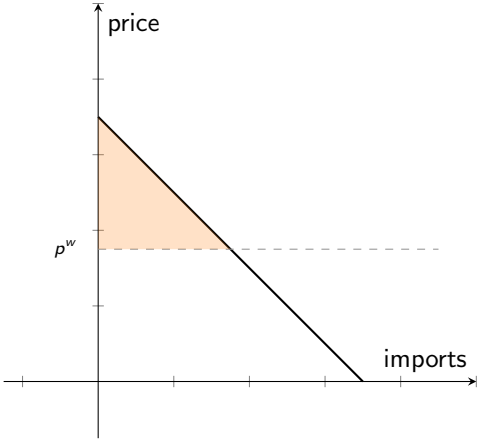
- Why cooperate: terms of trade (Bagwell & Staiger, 1999), political economy (Grossman & Helpman, 1994), commitment (Maggi & Rodríguez-Clare, 1998), uncertainty (Limão & Maggi, 2015).
- Negotiating institutions: protocols (Aghion, Antràs & Helpman, 2007), issue linkage (Conconi & Perroni, 2002; Maggi, 2016), fast-track (Conconi, Facchini & Zanardi, 2012), enforcement (Park, 2011; Buzard, 2017). We isolate a new obstacle: independently chosen mandates, with no political, contracting, or enforcement friction.

Trade structure & agreement formation. Facchini, Silva & Willmann (2013); Lake (2017); Blanchard et al. (2024); empirics à la Baier & Bergstrand (2004). We add the *composition* (within- vs between-sector) margin.

The environment

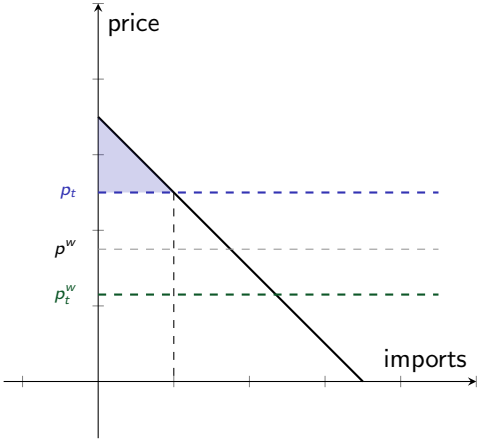
Why tariffs are too high: the terms-of-trade externality

- At the world price p^w, a "large" importer's gains from trade are the surplus under demand.



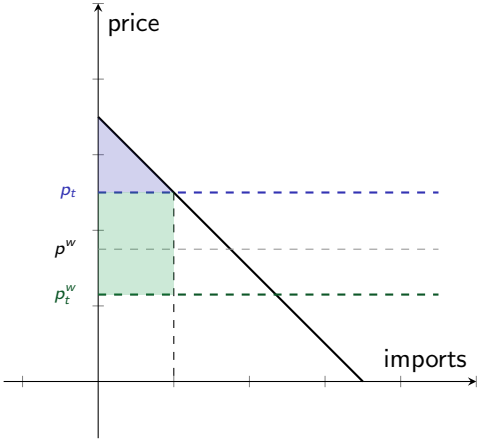
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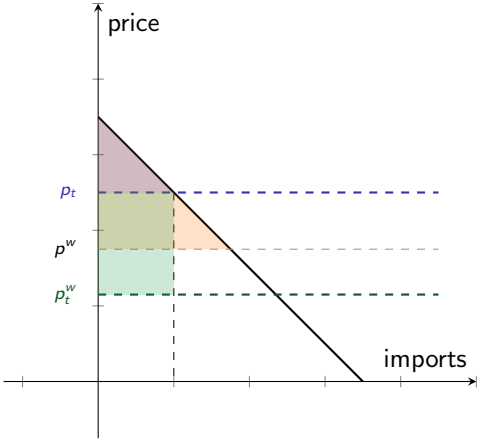
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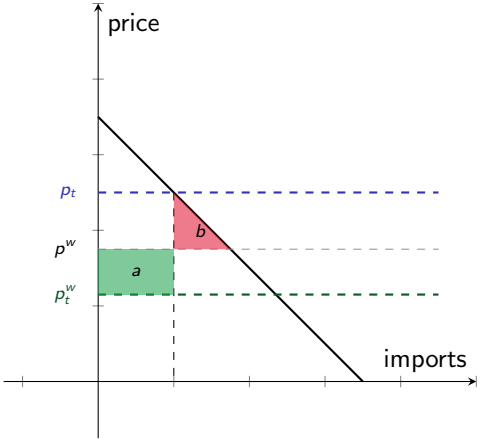
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- New surplus + revenue vs the old: the gap is the *net* effect.



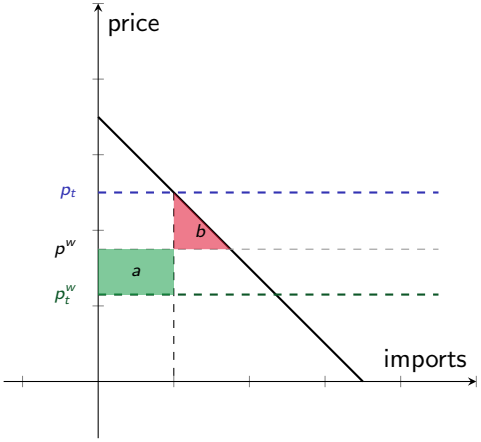
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- It splits into a terms-of-trade **gain** *a* (foreigners pay via the lower world price) minus a deadweight **loss** *b*.



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- New surplus + revenue vs the old: the gap is the *net* effect.
- It splits into a terms-of-trade **gain** a (foreigners pay via the lower world price) minus a deadweight **loss** b.
- Small tariff $\Rightarrow a > b$: optimal tariff positive; it lowers the partner's price, so tariffs are too high and cuts help both.



Net $= a - b > 0$ for a small tariff.

The tariff-setting environment

- Two governments choose tariffs t_1, t_2. Government i receives welfare $G_i(t_1, t_2)$, where G_i is continuous.
- Aggregate welfare is $G = G_1 + G_2$. Efficient tariffs t^{eff} maximise G.
- We impose the familiar features of a terms-of-trade environment.
  - Each government's welfare falls when its partner raises its tariff.
  - A Nash equilibrium exists, and Nash tariffs exceed efficient tariffs in both countries.
  - Aggregate welfare is strictly jointly concave.
- We first study these welfare functions directly. Later, a trade model explains how their properties depend on the goods countries trade.

The game

Simultaneously Decide Side-Payment Schedules ⟶ Decide Tariffs

- **Stage 1.** Governments simultaneously commit to mandates $S_i(t_1, t_2) \geq 0$, specifying the transfer each will make at every tariff outcome.
- **Stage 2.** Given the mandates, governments choose tariffs simultaneously and make the promised transfers.

$$TG_i(t) = G_i(t) + S_j(t) - S_i(t).$$

- Transfers cancel in aggregate, so efficient tariffs still maximise G.
- Tariffs lie on a finite grid that can be made arbitrarily fine. Every continuation game therefore has a Nash equilibrium, possibly in mixed strategies.

▸ Reciprocity ▸ Nash existence

The game

Jackson and Wilkie (2005)

Simultaneously Decide Side-Payment Schedules → Decide Tariffs

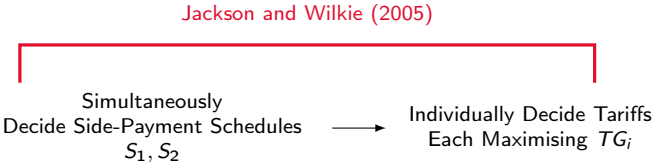
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Reciprocity Nash existence

Jackson and Wilkie's characterisation

Consider an action profile t and a division u of its aggregate payoff, $u_1 + u_2 = G(t)$.

Minimal supporting schedule $S_j^{t,u}$: the smallest non-negative payments by j that cap its payoff at u_j when i plays t_i; zero payments otherwise.

Jackson and Wilkie (2005, Theorem 3). (t, u) is sustainable in SPE **if and only if**, for each player i,

$$u_i \geq u_i^{ms}(t,u) = \sup_{S_i'} \min_{\mu \in NE(S_i', S_j^{t,u})} U_i(\mu).$$

- S_i' is any alternative side-payment schedule; μ is a (possibly mixed) continuation Nash equilibrium.
- $U_i(\mu)$ is i's expected payoff under μ: its underlying payoff, plus transfers received, minus transfers paid.

Interpretation: Each player must receive at least what it can guarantee by changing its schedule, even under its *worst continuation equilibrium*.

Our question

The characterisation is exact, but implicit: can we determine when efficiency is sustainable *directly from the economic environment*?

A tractable bound: the pure solo claim

Consider a unilateral deviation where player i targets a single action profile. It can:

- Offset j's concessions.
- Pay j just enough to induce its desired action.
- Commit to its own target action.

This gives the pure solo claim:

$$\underline{TG}_i = \max_{t_i} \left[\underbrace{\max_{t_j} G(t_i; t_j)}_{\text{best aggregate payoff}} - \underbrace{\max_{t'_j} G_j(t_i; t'_j)}_{j\text{'s best underlying payoff}} \right].$$

Lemma 1

For every (t, u), $u_i^{ms}(t, u) \geq \underline{TG}_i$.
Any sustainable outcome must give each player at least its pure solo claim.

If $\underline{TG}_1 + \underline{TG}_2 > G(t^{\text{eff}})$, no efficient agreement is sustainable.

▸ Why this is a valid bound

Main results

Impossibility

Definition: strict submodularity

For $t_1 > t_1'$, $t_2 > t_2'$: $\underbrace{G(t_1', t_2') - G(t_1, t_2')}_{\text{gain from cutting } t_1,\ t_2 \text{ low}} < \underbrace{G(t_1', t_2) - G(t_1, t_2)}_{\text{gain from cutting } t_1,\ t_2 \text{ high}}$

(smooth: $\partial^2 G / \partial t_1 \partial t_2 < 0$): tariff cuts are substitutes, worth more when the partner's tariff stays high.

Proposition 1

Strictly submodular $\Rightarrow$ $\underline{TG}_1 + \underline{TG}_2 > G(t^{\text{eff}})$: no efficient agreement; the outcome is the Nash t^*.

Why. Evaluate each claim at i's own Nash tariff: $\underline{TG}_i \geq G(t_i^*; t_j^{\text{eff}}) - G_j(t^*)$. Both demand this at once; submodularity (comparing t^{eff} with the higher t^*) makes the claims overshoot the surplus. (needs only a pure Nash + excessive tariffs)

Impossibility, built up

Each country keeps its Nash tariff t_i^* and concedes t_j^{eff} to its partner, who then needs only $G_j(t^*)$:

$$\underline{TG_1} \geq G(t_1^*; t_2^{\text{eff}}) - G_2(t^*)$$



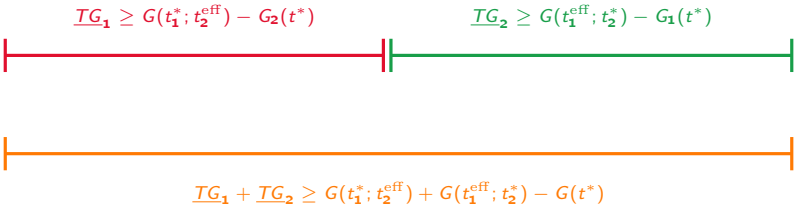
Impossibility, built up

Country 2 makes the symmetric demand:



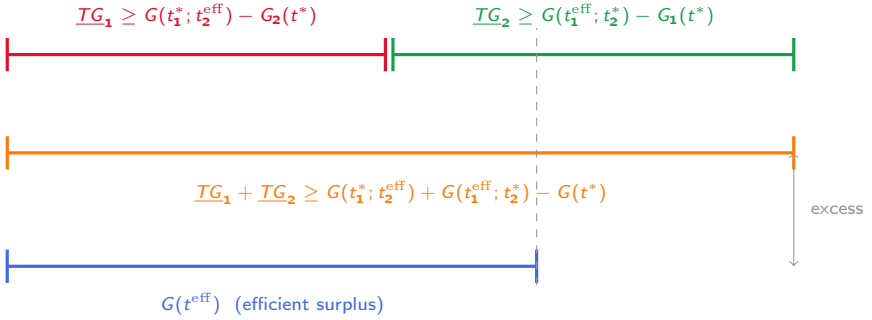
Impossibility, built up

Add them up:



Impossibility, built up

By strict submodularity, $G(t_1^*; t_2^{\text{eff}}) + G(t_1^{\text{eff}}; t_2^*) > G(t^{\text{eff}}) + G(t^*)$, so the claims overshoot $G(t^{\text{eff}})$:



Under supermodularity the sum falls *short* instead: strict slack, and t^{eff} can be supported.

Possibility

Definition: strict supermodularity

For $t_1 > t_1'$, $t_2 > t_2'$: $\underbrace{G(t_1', t_2') - G(t_1, t_2')}_{\text{gain from cutting } t_1,\ t_2 \text{ low}} > \underbrace{G(t_1', t_2) - G(t_1, t_2)}_{\text{gain from cutting } t_1,\ t_2 \text{ high}}$

(smooth: $\partial^2 G / \partial t_1 \partial t_2 > 0$): tariff cuts are complements, worth more when the partner also cuts.

Proposition 2

Strictly supermodular (+ three conditions) $\Rightarrow \underline{TG}_1 + \underline{TG}_2 < G(t^{\text{eff}})$ (strict slack) and t^{eff} is supportable on a fine grid.

Possibility asks more: the extra conditions control the *full* modified solo payoff, not just the lower bound (next).

▸ proof sketch

The asymmetry, and the three conditions

Impossibility is cheap.

A lower bound on the claims suffices; needs only submodularity, a pure Nash, excessive tariffs.

Possibility is harder.

Must control the full u^{ms}, including mixed deviations → three extra conditions.

1. *Diminishing harm* (G_i convex in the partner's tariff): stops a government profiting by making its tariff unpredictable instead of committing. [the substantive one]
2. *Stable individual modularity* (each G_i's cross-partial keeps one sign): keeps each best reply monotone. [near-automatic locally]
3. *Sufficiently fine grid*: the discretisation error is smaller than the slack.

The economics

One line

Feasibility turns on whether a tariff cut by one country makes a cut by the other more or less valuable in generating aggregate surplus: the *cross-partial* of G.

The same thing, as a comparison of the *pie*

No best replies needed. Compare aggregate surplus at four corners:

$$\underbrace{G(\text{cut},\text{cut}) + G(\text{high},\text{high})}_{\text{diagonal}} \gtrless \underbrace{G(\text{cut},\text{high}) + G(\text{high},\text{cut})}_{\text{split}}.$$

$>$ supermodular (cutting *together* beats splitting) vs. $<$ submodular. This is exactly the inequality that decides whether the two solo claims fit.

- A second-order property: *not* the first-order observation that more complementary economies gain more from trade (that concerns the *level* of the gains, not whether the deal is *reachable*).

The takeaway

Free transfers, complete information, no frictions. Efficiency should be trivial.
It is not, and **one** property says when.

Submodular: cuts are substitutes

Each side can claim too much alone.

No efficient agreement (needs almost nothing).

Trade: two-way trade *within* sectors.

Supermodular: cuts are complements

Concessions pay off only jointly.

Efficiency supportable (plus mild conditions).

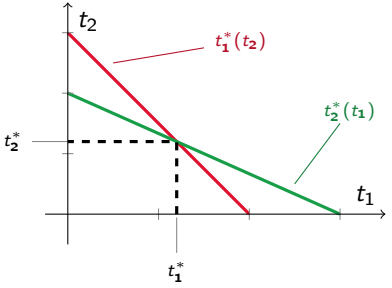
Trade: specialisation *across* sectors.

The obstacle is the *structure* of what is being negotiated, not any friction in negotiating it.

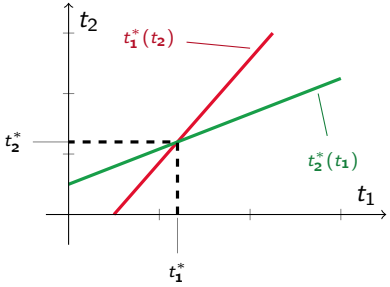
Interpreting the sign: best replies in the symmetric case

In the symmetric case, the sign of the cross-partial shows up in the slope of the *best replies in the underlying tariff game* (before any mandate).

In general, the relevant object is *aggregate* modularity, so individual best-reply slopes need not coincide. But in the symmetric case, this picture is exact.



Downward best replies
substitutes ⇒ submodular ⇒ only Nash tariffs are sustainable



Upward best replies
complements ⇒ supermodular ⇒ efficient tariffs can be sustainable

Trade structure

The mechanism: world-price adjustment

Suppose country 1 imports good A and exports good B, while country 2 does the reverse.

When country 1 cuts its tariff on A:

$$t_1 \downarrow \Rightarrow \; D_1(A) \uparrow \Rightarrow \; \frac{p_A^w}{p_B^w} \uparrow .$$

Thus, B becomes relatively cheaper in country 2, which imposes a tariff on B.

Within a sector (substitutes).
Country 2 shifts demand *towards* imported B, partly offsetting its tariff distortion.
The higher t_2, the more distortion there is to offset. Hence, the gain from cutting t_1 is larger when t_2 is high: towards submodularity.

Across sectors (complements).
Country 2 instead reduces demand for imported B, reinforcing its tariff distortion.
The higher t_2, the more severe this effect. Hence, the gain from cutting t_1 is larger when t_2 is low: towards supermodularity.

Trade structure: substitutes and complements

The idea: Goods within sectors serve similar purposes; goods across sectors satisfy different needs.

- **Within sectors: substitutes** ($\sigma_k > 1$).
  Different varieties of the same good compete: if one car becomes more expensive, consumers can buy another.
- **Across sectors: complements** ($\sigma_0 < 1$).
  Consumers want a mix of different goods. Cheaper cars do not replace food or clothing.

Our model:

- Two-country endowment economy with nested-CES preferences and a linear numeraire (for transfers).
- Endowments determine trade direction; each government sets one uniform tariff on its imports.
- Governments maximise national welfare; free trade is efficient: $t^{\text{eff}} = (0, 0)$.

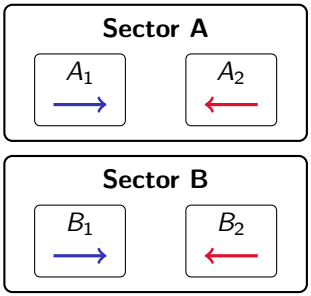
Does the location of trade within or across sectors change the prospects for agreement?

▸ CES details

The smallest version: two sectors, two varieties each

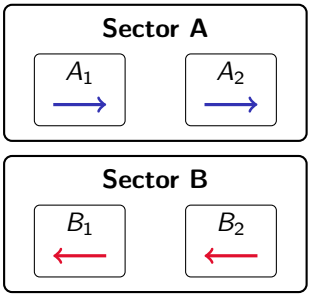
$\longrightarrow$ Country 1 exports $\longleftarrow$ Country 1 imports

Within-sector specialisation



Within $\Rightarrow$ submodular

Across-sector specialisation



Across $\Rightarrow$ supermodular

Same overall trade direction; different location of specialisation.

The sign of the cross-partial: a variance decomposition

For sector k, let $\bar{m}_k =$ share of the sector's goods country 1 imports (by expenditure), $\theta_k =$ sector weight.

Proposition 3 (at free trade)

$$\frac{\partial^2 G}{\partial t_1 \partial t_2} = \frac{\gamma_1 \gamma_2}{\gamma_1 + \gamma_2} \Big[\underbrace{(1-\sigma_k) \textstyle\sum_k \theta_k \, \bar{m}_k (1-\bar{m}_k)}_{\textbf{within-sector variation, } <0} + \underbrace{(1-\sigma_0) \, \mathrm{Var}^{\theta}(\bar{m}_k)}_{\textbf{between-sector variation, } >0} \Big]$$

- **Within** $\bar{m}_k(1-\bar{m}_k)$: a sector traded *both ways* (import some varieties, export others). $\sigma_k > 1 \Rightarrow$ submodular.
- **Between** $\mathrm{Var}^{\theta}(\bar{m}_k)$: import *some* sectors, export *others*. $\sigma_0 < 1 \Rightarrow$ supermodular.

Both are variation in *trade direction*: within sectors vs. between sectors.

Empirical evidence

Measuring the location of trade overlap

We use HS2 chapters as sectors and HS6 products as varieties.
For each country pair, let:

- q_k be the share of sector k's bilateral trade imported by country 1;
- θ_k be sector k's share of bilateral trade.

Within sectors

$$W = \sum_k \theta_k q_k (1 - q_k)$$

High when imports and exports overlap within sectors.

Between sectors

$$B = \sum_k \theta_k (q_k - \mu)^2$$

High when trade direction differs across sectors.

Here $\mu = \sum_k \theta_k q_k$, and

$$W + B = \mu(1 - \mu) \equiv H.$$

Prediction: $\beta_W < 0$, $\beta_B > 0$.

▸ Measurement details

Data and empirical design

- **Trade:** UN Comtrade (HS6), averaged over years $t-7$ to $t-5$, before an agreement.
- **Agreements:** DESTA; first FTA or customs-union signature.
- **Sample:** 34,830 pair-years, 5,587 country pairs, 521 first signatures.

We estimate:

$$\mathrm{PTA}_{ij,t} = \beta_W \bar{W}_{ij,t} + \beta_B \bar{B}_{ij,t} + X'_{ij,t}\gamma + F_{ij,t} + \varepsilon_{ij,t}.$$

- ⋆ **Controls:** geography, historical ties, economic size and bilateral trade, number of traded products.
- ⋆ **Fixed effects:** country and year; alternatively country×year. Standard errors clustered by country pair.

Descriptive evidence of the predicted relationship, not a causal test.

▸ Fixed effects

Results: the composition of trade matters

	(1) Country & year FE	(2) Country×year FE
Within-sector $\bar{W}$	-0.0675^{**}	-0.0377
	(0.0271)	(0.0237)
Between-sector $\bar{B}$	0.0332^{***}	0.0283^{***}
	(0.0101)	(0.0088)
Difference $\delta = \beta_B - \beta_W$	0.1007^{***}	0.0659^{***}
	(0.0290)	(0.0254)

- Between-sector variation is positively associated with signing in both specifications.
- The relative composition effect, $\delta > 0$, remains significant even with country×year fixed effects.

A one-SD shift from within- to between-sector variation, holding H fixed: $+0.39$ percentage points.

Mean annual signing probability: 1.49%.

▸ Magnitudes and robustness

Beyond trade

The mechanism is not about trade

skip examples

The classification is a property of *pre-committed contingent transfers*. Three settings we work out explicitly (among others):

	cross-partial	modularity	efficient outcome
Cournot	$-2b < 0$	sub	not sustainable
Bertrand (diff.)	$2d > 0$	super	sustainable
Team production	$F_{12} > 0$	super	sustainable

Tractability: no nested guarantee problems to solve, just read the sign of a cross-partial.

Beyond trade: Cournot and Bertrand

Cournot (quantities). $G_i = (a - b(q_1 + q_2) - c_i)q_i$; rival's output lowers i's payoff; Nash output excessive.

$$\frac{\partial^2 G}{\partial q_1 \partial q_2} = -2b < 0 \quad (\textit{submodular}) \Rightarrow \text{joint-profit cut not sustainable.}$$

Bertrand (differentiated prices). $D_i = a_i - bp_i + dp_j$, $b > d > 0$; $G_i = (p_i - c_i)D_i$; Nash prices too low.

$$\frac{\partial^2 G}{\partial p_1 \partial p_2} = 2d > 0 \quad (\textit{supermodular}) \Rightarrow \text{efficient prices sustainable.}$$

- To match our tariff set-up, work in the *reduction from a cap*, $x_i = \bar{p}_i - p_i$, which plays the role of the tariff t_i: a negative externality with excessive actions.

Beyond trade: team production

Two agents choose costly efforts a_i; output $F(a_1, a_2)$ shared in fixed shares λ_i ($\lambda_1 + \lambda_2 = 1$):

$$G_i(a_1, a_2) = \lambda_i F(a_1, a_2) - C_i(a_i).$$

- Each agent keeps only a *share* of the return to its effort $\Rightarrow$ effort *under*-provided at Nash. Working in the shortfall $x_i = \bar{a}_i - a_i$ (which plays the role of t_i) gives the same negative-externality, excessive-action form.
- Efforts complementary: $F_{12} > 0 \Rightarrow \partial^2 G / \partial a_1 \partial a_2 > 0$, supermodular.

So

Efficient effort is sustainable, under the *same* three conditions as Prop 2: diminishing harm = marginal product non-decreasing in own effort; stable modularity = F_{12} one-signed; plus a fine grid.

Conclusion

- Agreements are negotiated through mandates: commitments chosen in advance, in each side's interest.
- Even with free transfers and no frictions, that strategic choice can place *every* efficient agreement out of reach.
- Whether it does is organised around one second-order property: the modularity of aggregate surplus.
- In trade it becomes observable: the *composition* of trade, not its volume, bears on whether efficient liberalisation is reachable.
- And it is not special to trade: a primitive way to read when JW-style contingent commitments sustain efficiency.

Thank you.

Backup slides

Setup

Why bilateral? | Reciprocity | Nash existence

Theory

Jackson–Wilkie | Pure solo bound | Possibility proof sketch

Trade

Nested CES

Evidence

HS measurement | Fixed effects | Magnitudes and robustness

Why bilateral?

- **The negotiating institution.** We focus on two parties negotiating a preferential trade agreement.
  - In DESTA, around 60% of preferential agreements are purely bilateral.
  - A further 20% involve an existing trade bloc, typically bargaining with a common position, and another party.
- **The mechanism.** Two parties are enough for strategic mandate choice to obstruct efficiency, even when both can gain and compensation is freely available.
- **Scope.** Multilateral negotiations also involve third-country effects and most-favoured-nation treatment. Extending the results to more than two parties requires a separate analysis.

Source: DESTA, as discussed in the paper, Section 3, footnote 3.

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Backup: why $\underline{TG}_i$ is a valid lower bound

Fix a target profile and $\varepsilon > 0$. Country i deviates to a schedule with three parts:

- ⋆ **(a) return** the partner's concessions ⇒ its mandate confers no advantage;
- ⋆ **(b) pay** the partner $q(t_j)$ = just enough (its outside option $+\varepsilon$ at the target) to accept;
- ⋆ **(c) commit** to its own target by posting a large payment M at every *other* own tariff.

- ☐ (c) with M above the range of G_i makes t_i' *strictly dominant*: a *unique* continuation.
- ☐ (b) flattens the partner's payoff, and the ε tilts it uniquely to the target: unique best reply.
- ☐ So the min over continuations is pinned down: i guarantees $\max_{t_i} G(t_i; t_j) - \max_{t_j'} G_j(t_i; t_j')$.

Maximising over t_i gives $u_i^{ms} \geq \underline{TG}_i$, with *no* assumptions on G.

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Backup: Jackson–Wilkie, formally

Partner holds its minimal supporting schedule $S_j^{t,u}$ (caps i at u_i on the target row, pays nothing elsewhere). Then

$$u_i^{ms}(t,u) = \sup_{S_i'} \min_{\mu \in NE(S_i', S_j^{t,u})} U_i\big(\mu, (S_i', S_j^{t,u})\big).$$

(t,u) is an SPE outcome $\iff$ $u_i \geq u_i^{ms}$ for both. Our contribution: for this class, u^{ms} is controlled by the modularity of G: impossibility via the lower bound $\underline{TG}_i$; possibility via a hybrid claim that handles mixed continuations.

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Why an efficient agreement can be sustained

1. **Construct a division.** Under strict supermodularity, efficient welfare exceeds the sum of the two continuous pure solo claims by some $\delta > 0$. Give each government its claim plus $\delta/2$.

2. **Check a change of mandate.** A new mandate may induce random tariffs. Transfers cancel, so the deviator receives total welfare minus its partner's payoff. Compare the off-target draws with their mean:
   - **Joint concavity** puts a ceiling on total welfare: randomising cannot raise expected welfare above the best attainable at the mean tariff.
   - **Diminishing harm** puts a floor under the partner's payoff: for any fixed admissible response, its welfare is convex in the deviator's tariff, so randomising cannot hurt it more than the mean tariff does.

3. **Use the slack.** At this division the continuous deviation bound equals the pure solo claim. On a sufficiently fine grid it rises by less than $\delta/2$. Each government's proposed payoff therefore exceeds what it can secure by rewriting its mandate.

The Jackson–Wilkie condition holds for both governments at the efficient tariffs.

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Backup: nested-CES utility and price index

Numeraire x_i (linear); differentiated consumption $c_{i,k,l}$:

$$U_i = x_i + \gamma_i \log V(c_i), \quad V = \left[\sum_k \alpha_k Q_{i,k}^{\frac{\sigma_0 - 1}{\sigma_0}}\right]^{\frac{\sigma_0}{\sigma_0 - 1}}, \quad Q_{i,k} = \left[\sum_l \beta_{kl} c_{i,k,l}^{\frac{\sigma_k - 1}{\sigma_k}}\right]^{\frac{\sigma_k}{\sigma_k - 1}}.$$

Price indices (sector, then overall):

$$R_{i,k} = \left[\sum_l \beta_{kl}^{\sigma_k} p_{i,k,l}^{1-\sigma_k}\right]^{\frac{1}{1-\sigma_k}}, \qquad P_i = \left[\sum_k \alpha_k^{\sigma_0} R_{i,k}^{1-\sigma_0}\right]^{\frac{1}{1-\sigma_0}}.$$

- Quasi-linearity $\Rightarrow$ differentiated spending fixed at γ_i; numeraire absorbs income effects.
- Importer faces $p_{i,k,l} = e^{t_i} p_{k,l}^w$ on imports $\Rightarrow G_i = Y_i - \gamma_i + \gamma_i \log \gamma_i - \gamma_i \log P_i$.
- Side-payments = transfers of the numeraire.

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Backup: why these fixed effects

- **Country + year FE** absorb each country's overall propensity to sign and global waves of PTAs.
- **Country×year FE** absorb anything time-varying at the country level (a country's total PTA activity in a given year). Identification: *which partners* a country signs with, given its own activity.
- **Why *not* country-pair FE?** $\bar{W}, \bar{B}$ are slow-moving, nearly time-invariant at the pair level, and the outcome is a *first* signature. Pair FE would absorb precisely the cross-pair variation in trade structure that identifies β_W, β_B: the effect we want to measure.

The theory is about the *pair's* trade structure. Country×year FE isolate the bilateral channel without soaking up the pair-level variation.

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Backup: Nash existence

- Sufficient: each G_i (quasi-)concave in its own tariff (Debreu–Glicksberg–Fan). *Not* Topkis, since we allow individual payoffs of different modularity.
- Possibility side: joint concavity + diminishing harm $\Rightarrow$ each G_i strictly concave in its own tariff $\Rightarrow$ existence is *implied*.
- Impossibility side: existence is an independent, mild posit; submodularity is silent on it.
- GE model and all examples satisfy everything at once, so no conflict.

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Backup: is reciprocity ruled out?

A natural worry: mandates are set simultaneously and in advance, so can the parties respond to each other at all?

- They can. Because a concession can depend on the *whole* tariff profile, a government can commit to cut its own tariff *only if* its partner does.
- Tariff reciprocity is therefore available, not assumed away.

The efficient deal fails *despite* reciprocity being available, not because it is absent.

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Measurement: from HS6 products to HS2 sectors

For HS6 product g, let q_g denote the share of its bilateral trade imported by country 1, and ω_g its share of total bilateral trade.

Aggregating to HS2 sector k:

$$\theta_k = \sum_{g \in k} \omega_g, \qquad q_k = \frac{\sum_{g \in k} \omega_g q_g}{\theta_k}.$$

Model	Data	Meaning
$\sum_k \theta_k \bar{m}_k (1 - \bar{m}_k)$	$W = \sum_k \theta_k q_k (1 - q_k)$	Within-sector
$\mathrm{Var}^{\theta}(\bar{m}_k)$	$B = \sum_k \theta_k (q_k - \mu)^2$	Between-sector

- **Within:** exports cars, imports car parts within the vehicles chapter.
- **Between:** exports vehicles, imports cereals.

HS2 chapters proxy for sectors; HS6 products proxy for varieties; bilateral trade-value shares proxy for model shares.

Magnitudes and robustness

Economic magnitudes (mean annual signing probability = 1.49%):

- ⋆ 1-SD increase in $\bar{W}$: -0.25pp (17% of the mean).
- ⋆ 1-SD increase in $\bar{B}$: $+0.24$pp (16% of the mean).
- ⋆ 1-SD shift from $\bar{W}$ to $\bar{B}$, holding H fixed: $+0.39$pp (26% of the mean).

Robustness checks:

- ☐ Political-economy controls: checks and balances, election proximity, political orientation.
- ☐ Alternative measurement windows and five-year agreement horizons.
- ☐ Excluding fuels, imposing trade-size thresholds, and restricting to first base treaties.

The composition effect is stable; the separate within-sector effect is less precise.

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