Global Value Chains: Firm Organization and Trade Policy

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  - iPhone's software and product design are done by Apple, most parts are produced by independent suppliers around the world (Xing, 2011)
- As a result of the fragmentation of production processes across countries, intermediates account for 2/3 of total trade (Johnson and Noguera, 2012).

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Internalizing Global Value Chains: A Firm-Level Analysis

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HBS

Pol Antràs
Harvard

Davin Chor
NUS

Paola Conconi
ECARES

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- Firm-level tests of these theories are still relatively sparse.

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- Using Input-Output tables, we also construct new measure of upstreamness of each input i in the production of final good j).
- Exploiting variation across and within firms, we find strong support for our model's predictions concerning how integration choices depend on
  - elasticity of demand for the final good
  - profile of contractibility of the inputs along the value chain
  - firm productivity
- In general, the firm-level patterns that we uncover suggest that contractual frictions critically shape firms' ownership decisions along their value chains.

Related Literature

- Theoretical studies on integration vs outsourcing decisions of firms

  (Grossman and Hart 1986; Grossman and Helpman 2002, 2005; Antràs 2003; Antràs and Helpman 2004, 2008; Acemoglu, Antràs and Helpman 2007)

- Empirical studies testing property-rights theory of firm boundaries

  (Yeaple 2006; Nunn and Trefler 2008, 2013; Corcos *et al.* 2013; Defever and Toubal 2013, Díez 2014; Antràs 2015)

- Theoretical studies on how the sequential nature of production affects location and organizational decisions of firms

  (Harms, Lorz and Urban 2012; Baldwin and Venables 2013; Costinot, Vogel and Wang 2013; Antràs and Chor 2013; Fally and Hillberry 2014)

- Empirical studies on firm boundaries based on D&B (and similar datasets)

  (Fan and Lang 2000; Acemoglu, Johnson and Mitton 2009; Alfaro and Charlton 2009; Alfaro and Chen 2012; Alfaro, Conconi, Fadinger and Newman 2013; Fajgelbaum, Grossman and Helpman 2014; Del Prete and Rungi 2015)

Plan of Talk

- Introduction
- **Theory**
- Dataset and Variables
- Empirical Analysis
- Conclusions

Model Environment

- Property rights model à la Grossman-Hart-Moore: suppliers undertake relationship-specific investments to make their components compatible with those of other suppliers along the value chain.

- Production entails a continuum of uniquely sequenced inputs, $i \in [0,1]$.

- Each i is sourced from a distinct supplier (facing a marginal cost $c(i)$).

The Model

- For a given firm, production in quality-adjusted units of output:

$$q = \theta \left(\int_0^1 (\psi(i) x(i))^\alpha I(i) di \right)^{1/\alpha}$$

where $x(i)$ denotes services of compatible stage-i inputs

$$I(i) = \begin{cases} 1, & \text{if input } i \text{ is produced after all inputs } i' < i, \\ 0, & \text{otherwise.} \end{cases}$$

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  Two key parameters:

  - $\alpha \in (0, 1)$: degree of substitutability between stage inputs
  - $\rho \in (0, 1)$: degree of concavity of revenue function ($pq = A^{1-\rho} q^{\rho}$)

Contracting Environment

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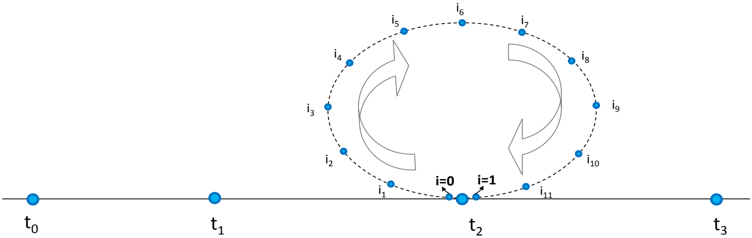
Timing of Events



Firm posts **contracts** for each stage i ∈[0,1]

Contract states whether i is integrated or not

Suppliers apply and the firm **selects** one supplier for each i

Sequential production. At each stage i:

- the supplier is handed the semi-finished good completed up to i;
- after observing its value, the supplier chooses an input level, x(i);
- After observing x(i), the firm and supplier bargain over the supplier's addition to total revenue

Final good assembled and sold to consumers

Marginal revenue

- Revenue accrued up to stage m:

$$r(m) = A^{1-\rho} \left(\int_0^m (\psi(i) x(i))^\alpha I(i) di \right)^{\frac{\rho}{\alpha}}.$$

- Final good producer and supplier at stage m bargain over incremental marginal revenue generated at that stage:

$$r'(m) = \frac{\rho}{\alpha} \left(A^{1-\rho} \right)^{\frac{\alpha}{\rho}} r(m)^{\frac{\rho-\alpha}{\rho}} (\psi(m) x(m))^\alpha.$$

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  Two cases:

  - $\rho > \alpha$: Sequential complements
  - $\rho < \alpha$: Sequential substitutes

Solving the Model

- Each supplier i chooses $x(i)$, taking the organizational decisions of the firm and the upstream investment levels – i.e., $x(i')$ for all $i' < i$ – as given.
- At the start of the game, parent firm's decision problem is to decide on integration ($\beta(i) = \beta_V$) vs outsourcing ($\beta(i) = \beta_O$) for each stage i.

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After some algebra:

Optimal investment choice of the supplier at stage m:

$$x^*(m) = \arg\max_{x(m)} \left\{ (1-\beta(m)) \frac{\rho}{\alpha} \left(A^{1-\rho} \right)^{\frac{\alpha}{\rho}} r(m)^{\frac{\rho-\alpha}{\rho}} \psi(m)^{\alpha} x(m)^{\alpha} - c(m) x(m) \right\}.$$

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Firm's optimal integration decision:

$$\beta^*(m) = 1 - \alpha \left[\frac{\int_0^m (\psi(k)/c(k))^{\frac{\alpha}{1-\alpha}} dk}{\int_0^1 (\psi(k)/c(k))^{\frac{\alpha}{1-\alpha}} dk} \right]^{\frac{\alpha-\rho}{\alpha}} .$$

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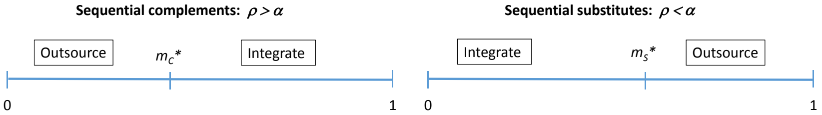

Figure 1: Firm Boundary Choices along the Value Chain

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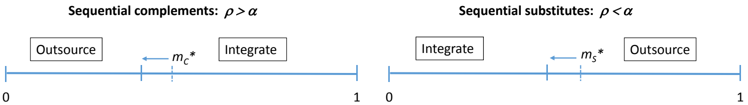
Figure 2: The Effect of an Increase in Upstream Contractibility



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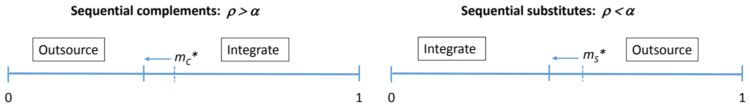

- Intuition: firms rely less on the organizational mode to counteract distortions associated with inefficient investments upstream.

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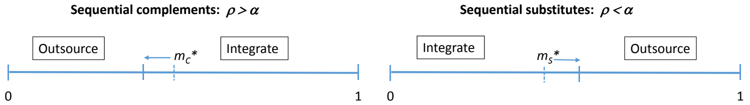
- Regardless of the sign of $\rho - \alpha$, more productive firms will tend to integrate more production stages. they should have a higher propensity to integrate downstream (upstream) in the complements (substitutes) case.

Figure 3: The Effect of an Increase in Productivity of the Final Good Producer



Empirical Predictions

- P.1 (Cross): A firm's **propensity to integrate upstream** (as opposed to downstream) inputs should fall with ρ_j.

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- P.2 (Cross): A greater degree of **contractibility of upstream inputs** should decrease a firm's propensity to integrate upstream (as opposed to downstream) inputs when the firm is in a final-good industry with low ρ_j Conversely, it should increase that propensity when the firm is in a final-good industry with a high ρ_j.
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- P.3: **More productive firms** should integrate more inputs, irrespective of ρ_j.Relative to less productive firms, they should have a higher propensity to integrate downstream (relative to upstream inputs) when ρ_j is low, and a higher propensity to integrate upstream (relative to downstream inputs) when ρ_j.

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- D&B enables us to link each of these to their subsidiaries, including information on country and SIC activities (70,008 subsidiaries)
- 6,370 of the parents are multinationals, i.e., ≥ 1 one foreign subsidiary

Identifying Integrated and Non-integrated Inputs

To study firm boundaries, we merge WorldBase with Input-Output data.

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- Set $I(p)$ of integrated inputs: SICs of parent p and its subsidiaries (if any): inputs that the parent could in principle obtain within its boundaries.

Identifying Integrated and Non-integrated Inputs

To study firm boundaries, we merge WorldBase with Input-Output data.

- For each parent p producing final good j (primary SIC), deduce set $S(j)$ of inputs used in production of j from I-O tables (inputs i for which $tr_{ij} > 0$).
- Set $I(p)$ of integrated inputs: SICs of parent p and its subsidiaries (if any): inputs that the parent could in principle obtain within its boundaries.
- We can then define the complement set $NI(p) = S(j) \setminus I(p)$ of non-integrated inputs.

Measuring Upstreamness

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  - $\sum_{k=1}^{N} d_{ik} d_{kj}$: Value used indirectly (2 stages).
  - $\sum_{k=1}^{N} \sum_{l=1}^{N} d_{ik} d_{kl} d_{lj}$: Value used indirectly (3 stages), etc ...

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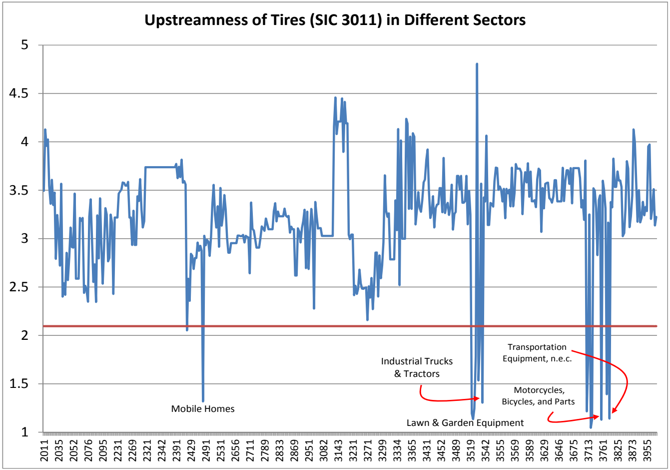
- Measure of input i's upstreamness in the production of j:

$$Upstreamness_{ij} = \frac{d_{ij} + 2\sum_{k=1}^{N} d_{ik} d_{kj} + 3\sum_{k=1}^{N} \sum_{l=1}^{N} d_{ik} d_{kl} d_{lj} + \ldots}{d_{ij} + \sum_{k=1}^{N} d_{ik} d_{kj} + \sum_{k=1}^{N} \sum_{l=1}^{N} d_{ik} d_{kl} d_{lj} + \ldots}$$

- Weighted-average of the number of production stages to get from i to j, with weights proportional to value of input use.

Measuring Upstreamness (cont.)



Dependent Variable

- In the cross-firm regressions, our dependent variable is the ratio of upstreamness of a parent's integrated inputs versus non-integrated inputs:

$$Ratio\text{-}Upstreamness_{jp} = \frac{\sum_{i \in I(p)} \theta^{I}_{ijp} upst_{ij}}{\sum_{i \in NI(p)} \theta^{NI}_{ijp} upst_{ij}}.$$

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- In the within-firm regressions, we adopt as the dependent variable a 0-1 indicator for whether $i \in I(p)$.

Key Control Variables

To assess the validity of the model's predictions, we also use measures of

- Elasticity of demand faced by the parent for its final good j (ρ_j) from Broda and Weinstein (2006).
  - Start with a median cutoff: $\beta_1 \mathbf{1}(\rho_j > \rho_{med})$
  - Later use a set of quintile dummies: $\sum_{n=2}^{5} \beta_n \mathbf{1}(\rho_j \in Quint_n(\rho))$
  - Focus on consumption and/or capital goods (UN BEC classification)
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- Contractibility of input i (ψ_i) inferred from I-O tables: extent to which production involves use of homogenous inputs (Nunn, 2007)
- Upstream contractibility is the total requirements weighted-covariance between the upstreamness and contractibility of inputs:

$$Upstream\text{-}Contractibility_j = \sum_{i \in S^m(j)} \theta_{ij}^m \left(upst_{ij} - \overline{upst}_{ij}\right)\left(cont_i - \overline{cont}_i\right)$$

Plan of Talk

- Introduction
- Theory
- Dataset and Variables
- **Empirical Analysis**
- Conclusions

Cross-Firm Regressions

$$\log \textit{Ratio-Upstreamness}_{jpc} = \beta_0 + \beta_1 \mathbf{1}(\rho_j > \rho_{med}) + \beta_X X_j + \beta_W W_p + D_c + \epsilon_{jpc}.$$

$\textit{Ratio-Upstreamness}_{jpc}$: propensity of firm p in country c to integrate upstream inputs

$\mathbf{1}(\rho_j > \rho_{med})$: indicator capturing industries falling in complements case

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Standard errors clustered by output industry j

According to prediction P.1 (Cross), β_1 should be negative: as we transition to industries that fall under the complements case, the propensity to integrate upstream relative to downstream inputs should fall.

Table 1

Upstreamness of Integrated vs Non-Integrated Inputs: Median Elasticity Cutoff

Dependent variable:	Log Ratio-Upstreamness$_{jpc}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Ind.(Elas$_j$ > Median)	-0.0354*	-0.0612***	-0.0604***	-0.0593***	-0.1138***	-0.1073***
	[0.0204]	[0.0188]	[0.0185]	[0.0215]	[0.0261]	[0.0275]
Log (Skilled Emp./Workers)$_j$		0.0100	0.0091	0.0111	-0.0219	-0.0082
		[0.0243]	[0.0245]	[0.0278]	[0.0360]	[0.0364]
Log (Equip. Capital/Workers)$_j$		0.1139***	0.1120***	0.0808***	0.0835***	0.0960***
		[0.0206]	[0.0202]	[0.0207]	[0.0254]	[0.0262]
Log (Plant Capital/Workers)$_j$		-0.0405*	-0.0397*	-0.0174	-0.0320	-0.0417
		[0.0229]	[0.0225]	[0.0274]	[0.0322]	[0.0317]
Log (Materials/Workers)$_j$		-0.0279	-0.0289	-0.0393*	-0.0059	-0.0129
		[0.0222]	[0.0222]	[0.0229]	[0.0296]	[0.0294]
R&D intensity$_j$		0.0049	0.0039	0.0103	0.0058	0.0024
		[0.0058]	[0.0058]	[0.0074]	[0.0085]	[0.0091]
(Value-added/Shipments)$_j$		-0.1050	-0.1141	-0.0705	0.1683	0.1600
		[0.1278]	[0.1286]	[0.1294]	[0.1587]	[0.1573]
Log (No. of Establishments)$_p$			0.0574***	0.0614***	0.0661***	0.0652***
			[0.0032]	[0.0037]	[0.0049]	[0.0048]
Year Started$_p$			0.0001	0.0001	0.0002*	0.0002**
			[0.0001]	[0.0001]	[0.0001]	[0.0001]
Multinational$_p$			0.0102**	0.0147**	0.0259***	0.0286***
			[0.0050]	[0.0065]	[0.0081]	[0.0083]
Log (Total Employment)$_p$			-0.0010	-0.0002	-0.0007	-0.0006
			[0.0016]	[0.0017]	[0.0019]	[0.0020]
Log (Total USD Sales)$_p$			0.0006	0.0000	0.0001	0.0005
			[0.0008]	[0.0010]	[0.0013]	[0.0013]
Elasticity based on:	All goods	All goods	All goods	BEC cons. & cap. goods	BEC cons. goods	BEC cons. & α proxy
Parent country dummies	Y	Y	Y	Y	Y	Y
Observations	316,977	316,977	286,072	206,490	144,107	144,107
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R^2	0.0334	0.1372	0.1447	0.1511	0.2051	0.2027

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Table 2

Upstreamness of Integrated vs Non-Integrated Inputs: Elasticity Quintiles

Dependent variable:	Log Ratio-Upstreamness$_{jpc}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Ind.(Quintile 2 Elas$_j$)	-0.0209	-0.0290	-0.0278	-0.0590	-0.0802*	0.0634
	[0.0345]	[0.0319]	[0.0314]	[0.0447]	[0.0474]	[0.0550]
Ind.(Quintile 3 Elas$_j$)	-0.0742**	-0.0802**	-0.0782**	-0.0569	-0.0982**	-0.0379*
	[0.0336]	[0.0316]	[0.0309]	[0.0454]	[0.0429]	[0.0224]
Ind.(Quintile 4 Elas$_j$)	-0.0480	-0.0893***	-0.0881***	-0.1068**	-0.1685***	-0.0942***
	[0.0365]	[0.0337]	[0.0331]	[0.0459]	[0.0457]	[0.0259]
Ind.(Quintile 5 Elas$_j$)	-0.0588	-0.0955***	-0.0947***	-0.1156***	-0.1849***	-0.1026***
	[0.0377]	[0.0325]	[0.0318]	[0.0420]	[0.0459]	[0.0317]
Log (Skilled Emp./Workers)$_j$		0.0080	0.0069	0.0073	-0.0290	-0.0215
		[0.0238]	[0.0239]	[0.0290]	[0.0379]	[0.0386]
Log (Equip. Capital/Workers)$_j$		0.1127***	0.1112***	0.0731***	0.0768***	0.0949***
		[0.0195]	[0.0192]	[0.0183]	[0.0205]	[0.0257]
Log (Plant Capital/Workers)$_j$		-0.0331	-0.0325	-0.0087	-0.0240	-0.0316
		[0.0210]	[0.0207]	[0.0228]	[0.0276]	[0.0290]
Log (Materials/Workers)$_j$		-0.0311	-0.0322	-0.0397*	-0.0099	-0.0190
		[0.0222]	[0.0222]	[0.0237]	[0.0290]	[0.0317]
R&D intensity$_j$		0.0053	0.0044	0.0113	0.0048	0.0017
		[0.0058]	[0.0057]	[0.0070]	[0.0086]	[0.0103]
(Value-added/Shipments)$_j$		-0.1270	-0.1356	-0.0840	0.1725	0.1453
		[0.1295]	[0.1301]	[0.1323]	[0.1699]	[0.1665]
Log (No. of Establishments)$_p$			0.0570***	0.0612***	0.0661***	0.0640***
			[0.0031]	[0.0037]	[0.0047]	[0.0052]
Year Started$_p$			0.0001	0.0001*	0.0002**	0.0003***
			[0.0001]	[0.0001]	[0.0001]	[0.0001]
Multinational$_p$			0.0105**	0.0125**	0.0192**	0.0304***
			[0.0048]	[0.0060]	[0.0079]	[0.0085]
Log (Total Employment)$_p$			-0.0003	0.0004	0.0005	-0.0005
			[0.0016]	[0.0017]	[0.0019]	[0.0019]
Log (Total USD Sales)$_p$			0.0003	-0.0004	-0.0003	-0.0001
			[0.0008]	[0.0009]	[0.0011]	[0.0012]
Elasticity based on:	All goods	All goods	All goods	BEC cons. & cap. goods	BEC cons. goods	BEC cons. & α proxy
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R^2	0.0449	0.1504	0.1580	0.1770	0.2333	0.2268

The propensity to increase upstream (versus downstream) inputs falls with ρ

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Log (Plant Capital/Workers)$_j$		-0.0331	-0.0325	-0.0087	-0.0240	-0.0316
		[0.0210]	[0.0207]	[0.0228]	[0.0276]	[0.0290]
Log (Materials/Workers)$_j$		-0.0311	-0.0322	-0.0397*	-0.0099	-0.0190
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Effect of Upstream Contractibility

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$$\log \textit{Ratio-Upstreamness}_{jpc} = \beta_0 + \beta_1 \mathbf{1}(\rho_j > \rho_{med}) + \beta_{U1} \mathbf{1}(\rho_j < \rho_{med}) \times \textit{UpstCont}_j$$
$$+ \beta_{U2} \mathbf{1}(\rho_j > \rho_{med}) \times \textit{UpstCont}_j + \beta_X X_j + \beta_W W_p + D_c + \epsilon_{jpc}.$$

- According to prediction P.2 (Cross), higher upstream contractibility should

  raise the propensity to integrate upstream in the complements case ($\beta_{U1} < 0$)

  lower it in the substitutes case ($\beta_{U2} > 0$)

Table 3

Effect of Upstream Contractibility: Median Elasticity Cutoff

Dependent variable:	Log Ratio-Upstreamness$_{jpc}$			
	(1)	(2)	(3)	(4)
Ind.(Elas$_j$ > Median)	-0.0910***	-0.1306***	-0.1432***	-0.1372***
	[0.0210]	[0.0256]	[0.0263]	[0.0249]
Upstream Contractibility$_j$				
$\times$ Ind.(Elas$_j$ < Median)	-0.8943***	-1.1148***	-1.2395***	-1.2195***
	[0.2869]	[0.3838]	[0.4345]	[0.4363]
$\times$ Ind.(Elas$_j$ > Median)	0.5044***	1.0224***	0.8871***	0.9451***
	[0.1717]	[0.1571]	[0.1505]	[0.1415]
p-value: Q5 at median *UpstCont$_j$*	[0.0004]	[0.0054]	[0.0000]	[0.0000]
Elasticity based on:	All goods	BEC cons. & cap. goods	BEC cons. goods	BEC cons. & α proxy
Industry controls	Y	Y	Y	Y
Firm controls	Y	Y	Y	Y
Parent country dummies	Y	Y	Y	Y
Observations	286,072	206,490	144,107	144,107
No. of industries	459	305	219	219
R^2	0.1882	0.2609	0.2910	0.2888

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Upstream Contractibility$_j$				
× Ind.(Elas$_j$ < Median)	-0.8943***	-1.1148***	-1.2395***	-1.2195***
	[0.2869]	[0.3838]	[0.4345]	[0.4363]
× Ind.(Elas$_j$ > Median)	0.5044***	1.0224***	0.8871***	0.9451***
	[0.1717]	[0.1571]	[0.1505]	[0.1415]
p-value: Q5 at median *UpstCont$_j$*	[0.0004]	[0.0054]	[0.0000]	[0.0000]
Elasticity based on:	All goods	BEC cons. & cap. goods	BEC cons. goods	BEC cons. & α proxy
Industry controls	Y	Y	Y	Y
Firm controls	Y	Y	Y	Y
Parent country dummies	Y	Y	Y	Y
Observations	286,072	206,490	144,107	144,107
No. of industries	459	305	219	219
R^2	0.1882	0.2609	0.2910	0.2888

Table 4

Effect of Upstream Contractibility: Elasticity Quintiles

Dependent variable:	Log Ratio-Upstreamness$_{jpc}$			
	(1)	(2)	(3)	(4)
Ind.(Quintile 2 Elas$_j$)	-0.0350	-0.0611	-0.0490	0.0763**
	[0.0300]	[0.0396]	[0.0429]	[0.0323]
Ind.(Quintile 3 Elas$_j$)	-0.1104***	-0.0566	-0.0683**	-0.0476**
	[0.0288]	[0.0405]	[0.0328]	[0.0223]
Ind.(Quintile 4 Elas$_j$)	-0.1207***	-0.1605***	-0.1611***	-0.1185***
	[0.0304]	[0.0292]	[0.0277]	[0.0236]
Ind.(Quintile 5 Elas$_j$)	-0.1409***	-0.1760***	-0.1643***	-0.1108***
	[0.0297]	[0.0306]	[0.0292]	[0.0260]
Upstream Contractibility$_j$				
× Ind.(Quintile 1 Elas$_j$)	-1.5540***	-1.5492***	-1.8562***	-0.8114
	[0.4934]	[0.4177]	[0.4446]	[0.5369]
× Ind.(Quintile 2 Elas$_j$)	-0.9810***	-0.5723	-0.6886	-2.0195***
	[0.3165]	[0.5973]	[0.7621]	[0.6896]
× Ind.(Quintile 3 Elas$_j$)	0.3271	-0.3234	-0.4171	0.1796
	[0.2408]	[0.3742]	[0.3855]	[0.1727]
× Ind.(Quintile 4 Elas$_j$)	0.3849	1.0662***	0.6855***	0.9811***
	[0.2867]	[0.2319]	[0.2106]	[0.2565]
× Ind.(Quintile 5 Elas$_j$)	0.7106***	1.0530***	1.1171***	1.0419***
	[0.2148]	[0.2149]	[0.2273]	[0.2275]
p-value: Q5 at median $UpstCont_j$	[0.0002]	[0.0001]	[0.0000]	[0.0000]
Elasticity based on:	All goods	BEC cons. & cap. goods	BEC cons. goods	BEC cons. & α proxy
Industry controls	Y	Y	Y	Y
Firm controls	Y	Y	Y	Y
Parent country dummies	Y	Y	Y	Y
Observations	286,072	206,490	144,107	144,107
No. of industries	459	305	219	219
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	[0.0288]	[0.0405]	[0.0328]	[0.0223]
Ind.(Quintile 4 Elas$_j$)	-0.1207***	-0.1605***	-0.1611***	-0.1185***
	[0.0304]	[0.0292]	[0.0277]	[0.0236]
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Elasticity based on:	All goods	BEC cons. & cap. goods	BEC cons. goods	BEC cons. & α proxy
Industry controls	Y	Y	Y	Y
Firm controls	Y	Y	Y	Y
Parent country dummies	Y	Y	Y	Y
Observations	286,072	206,490	144,107	144,107
No. of industries	459	305	219	219
R^2	0.2204	0.2792	0.3064	0.3191

Cross-firm Regressions: Additional Robustness Checks

- The results above are robust to
  - focusing on the set of "ever-integrated inputs"
  - different sub-samples (single-establishment firms, domestic firms, MNCs)
  - additional firm and industry variables that relate to alternative motives for the vertical integration decisions of firms
  - alternative treatments of the identity of the primary output industry for multi-product firms
  - alternative constructions of the ratio-upstreamness dependent variable

Within-sector, Cross-firm Heterogeneity

Within-sector, Cross-firm Heterogeneity

$$\log\left(\textit{No. of integrated inputs}\right)_{jpc} = \beta_0 + \sum_{n=2}^{5} \beta_n \mathbf{1}(\theta_p > \theta_{j,med}) \times \mathbf{1}(\rho_j \in Quint_n(\rho)) + \beta_W W_p + D_{jc} + \epsilon_{jpc}.$$

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- $\mathbf{1}(\log\theta_{jp} > \log\theta_{j,med})$: Indicator for whether parent p in output industry j has an above-median value of $log(Sales/Emp)$.
- The source of variation we focus on here is that across firms within a given industry, so we include country-industry fixed effects (D_{jc}).

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- According to the first part of prediction P.3, more productive firms should integrate more inputs, in both complements and substitutes cases ($\beta_n > 0$)

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- According to the second part of P.3, more productive firms should exhibit a higher (lower) ratio-upstreamness in the complements (substitutes) case.

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- According to the first part of prediction P.3, more productive firms should integrate more inputs, in both complements and substitutes cases ($\beta_n > 0$)
- According to the second part of P.3, more productive firms should exhibit a higher (lower) ratio-upstreamness in the complements (substitutes) case.
- To verify this, we replace $Log(\textit{No. of integrated inputs})$ with $Log(\textit{Ratio-Upstreamness}_{jpc})$.

Table 5

Within-Sector, Cross-Firm Heterogeneity in Effects

Dependent variable:	Log (No. of Int. Inputs)$_{jpc}$		Log Ratio-Upstreamness$_{jpc}$			
	All inputs	All inputs	All inputs	All inputs	Ever-Int. inputs	Ever-Int. inputs
	(1)	(2)	(3)	(4)	(5)	(6)
Ind.(Log(Sales/Emp)$_p$ > Median)						
× Ind.(Quintile 1 Elas$_j$)	0.0195***	0.0123	-0.0026**	-0.0023**	-0.0029**	-0.0023**
	[0.0066]	[0.0081]	[0.0013]	[0.0010]	[0.0014]	[0.0010]
× Ind.(Quintile 2 Elas$_j$)	0.0190	0.0216***	-0.0002	-0.0035*	-0.0001	-0.0036*
	[0.0117]	[0.0066]	[0.0018]	[0.0020]	[0.0018]	[0.0020]
× Ind.(Quintile 3 Elas$_j$)	0.0342***	0.0373**	0.0039	0.0064**	0.0041	0.0065**
	[0.0120]	[0.0171]	[0.0033]	[0.0027]	[0.0033]	[0.0027]
× Ind.(Quintile 4 Elas$_j$)	0.0334***	0.0286***	0.0061***	0.0060***	0.0061***	0.0059***
	[0.0095]	[0.0092]	[0.0014]	[0.0014]	[0.0014]	[0.0014]
× Ind.(Quintile 5 Elas$_j$)	0.0212*	0.0204*	0.0082***	0.0078***	0.0082***	0.0078***
	[0.0109]	[0.0106]	[0.0024]	[0.0024]	[0.0024]	[0.0024]
Elasticity based on:	BEC cons.	BEC cons. & α proxy	BEC cons.	BEC cons. & α proxy	BEC cons.	BEC cons. & α proxy
Firm controls	Y	Y	Y	Y	Y	Y
Parent country-industry dummies	Y	Y	Y	Y	Y	Y
Observations	142,135	142,135	142,135	142,135	142,135	142,135
No. of industries	219	219	219	219	219	219
R^2	0.3809	0.3809	0.7665	0.7666	0.7631	0.7632

Table 5

Within-Sector, Cross-Firm Heterogeneity in Effects

Dependent variable:	Log (No. of Int. Inputs)$_{jpc}$		Log Ratio-Upstreamness$_{jpc}$			
	All inputs (1)	All inputs (2)	All inputs (3)	All inputs (4)	Ever-Int. inputs (5)	Ever-Int. inputs (6)
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	[0.0120]	[0.0171]	[0.0033]	[0.0027]	[0.0033]	[0.0027]
× Ind.(Quintile 4 Elas$_j$)	0.0334***	0.0286***	0.0061***	0.0060***	0.0061***	0.0059***
	[0.0095]	[0.0092]	[0.0014]	[0.0014]	[0.0014]	[0.0014]
× Ind.(Quintile 5 Elas$_j$)	0.0212*	0.0204*	0.0082***	0.0078***	0.0082***	0.0078***
	[0.0109]	[0.0106]	[0.0024]	[0.0024]	[0.0024]	[0.0024]
Elasticity based on:	BEC cons.	BEC cons. & α proxy	BEC cons.	BEC cons. & α proxy	BEC cons.	BEC cons. & α proxy
Firm controls	Y	Y	Y	Y	Y	Y
Parent country-industry dummies	Y	Y	Y	Y	Y	Y
Observations	142,135	142,135	142,135	142,135	142,135	142,135
No. of industries	219	219	219	219	219	219
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Dependent variable:	Log (No. of Int. Inputs)$_{jpc}$		Log Ratio-Upstreamness$_{jpc}$			
	All inputs	All inputs	All inputs	All inputs	Ever-Int. inputs	Ever-Int. inputs
	(1)	(2)	(3)	(4)	(5)	(6)
Ind.(Log(Sales/Emp)$_p$ > Median)						
× Ind.(Quintile 1 Elas$_j$)	0.0195***	0.0123	-0.0026**	-0.0023**	-0.0029**	-0.0023**
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Elasticity based on:	BEC cons.	BEC cons. & α proxy	BEC cons.	BEC cons. & α proxy	BEC cons.	BEC cons. & α proxy
Firm controls	Y	Y	Y	Y	Y	Y
Parent country-industry dummies	Y	Y	Y	Y	Y	Y
Observations	142,135	142,135	142,135	142,135	142,135	142,135
No. of industries	219	219	219	219	219	219
R^2	0.3809	0.3809	0.7665	0.7666	0.7631	0.7632

Within-Firm Regressions

We expand the dataset to the firm-input level and estimate

$$Integration_{ijp} = \gamma_0 + \sum_{n=1}^{5} \gamma_n \mathbf{1}(\rho_j \in Quint_n(\rho)) \times Upstreamness_{ij} + \gamma_X \mathbf{X}_{ij} + D_i + D_p + \epsilon_{ijp}$$

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$Integration_{ijp}$: dummy equal to 1 if firm p with primary output j integrates input i

D_p: Parent firm fixed effects

D_i: SIC input fixed effects

$\mathbf{X}_{ij}$: industry pair characteristics

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To make sure LHS variable not too sparse:

Focus on parents that have integrated at least one manufacturing SIC $i \neq j$

For each p, include the top 100 manufacturing inputs i by tr in the set "ever-integrated" inputs

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We expand the dataset to the firm-input level and estimate

$$Integration_{ijp} = \gamma_0 + \sum_{n=1}^{5} \gamma_n \mathbf{1}(\rho_j \in Quint_n(\rho)) \times Upstreamness_{ij} + \gamma_X \mathbf{X}_{ij} + D_i + D_p + \epsilon_{ijp}$$

- $Integration_{ijp}$: dummy equal to 1 if firm p with primary output j integrates input i
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- D_i: SIC input fixed effects
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To make sure LHS variable not too sparse:

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- For each p, include the top 100 manufacturing inputs i by tr in the set "ever-integrated" inputs

According to prediction P.1 (Within), $\gamma_1 > \gamma_5$.

Table 7
Integration Decisions within Firms: The Role of Upstreamness

Dependent variable:	Integration$_{ijp}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Upstreamness$_{ij}$						
× Ind.(Quintile 1 Elas$_j$)	-0.0043***	0.0032*	0.0048***	0.0054***	0.0036*	-0.0005
	[0.0014]	[0.0018]	[0.0018]	[0.0019]	[0.0020]	[0.0021]
× Ind.(Quintile 2 Elas$_j$)	-0.0111***	-0.0042**	-0.0022	-0.0030	-0.0044	0.0035
	[0.0027]	[0.0020]	[0.0019]	[0.0019]	[0.0034]	[0.0023]
× Ind.(Quintile 3 Elas$_j$)	-0.0102***	-0.0023	0.0001	-0.0002	-0.0028	-0.0054
	[0.0017]	[0.0021]	[0.0022]	[0.0021]	[0.0027]	[0.0039]
× Ind.(Quintile 4 Elas$_j$)	-0.0129***	0.0023	0.0043	0.0034	0.0012	0.0016
	[0.0033]	[0.0033]	[0.0030]	[0.0028]	[0.0023]	[0.0025]
× Ind.(Quintile 5 Elas$_j$)	-0.0229***	-0.0169***	-0.0153***	-0.0146***	-0.0077**	-0.0079**
	[0.0047]	[0.0056]	[0.0055]	[0.0052]	[0.0034]	[0.0033]
Self-SIC$_{ij}$	0.9664***	0.9207***	0.9134***	0.8823***	0.8517***	0.8517***
	[0.0033]	[0.0085]	[0.0091]	[0.0164]	[0.0177]	[0.0176]
Log (Total Requirements$_{ij}$)	0.0016**	0.0022***	0.0034***	0.0028***	0.0035***	0.0038***
	[0.0008]	[0.0008]	[0.0008]	[0.0008]	[0.0012]	[0.0012]
Upstream-Complementarity$_{ij}$		0.0403***	0.0367***	0.0174***	0.0200***	0.0200***
		[0.0039]	[0.0038]	[0.0037]	[0.0037]	[0.0037]
Downstream-Complementarity$_{ij}$		0.0284***	0.0260***	0.0129**	0.0171***	0.0163***
		[0.0065]	[0.0064]	[0.0052]	[0.0059]	[0.0057]
Diff. Log (Skilled Emp./Workers)$_{ij}$			-0.0170***	-0.0156***	-0.0213***	-0.0217***
			[0.0039]	[0.0037]	[0.0044]	[0.0045]
Diff. Log (Equip. Capital/Workers)$_{ij}$			-0.0034	-0.0038*	-0.0089***	-0.0089***
			[0.0024]	[0.0023]	[0.0030]	[0.0030]
Diff. Log (Plant Capital/Workers)$_{ij}$			-0.0015	-0.0008	0.0041	0.0041
			[0.0023]	[0.0023]	[0.0026]	[0.0026]
Diff. R&D Intensity$_{ij}$			-0.0010	0.0004	0.0004	0.0004
			[0.0006]	[0.0007]	[0.0006]	[0.0006]
Same-SIC2$_{ij}$				0.0204***	0.0166***	0.0160***
				[0.0041]	[0.0028]	[0.0028]
Same-SIC3$_{ij}$				0.0457***	0.0416***	0.0419***
				[0.0149]	[0.0126]	[0.0127]
p-value: Upstreamness$_{ij}$, Quintile 1 minus Quintile 5	[0.0000]	[0.0003]	[0.0002]	[0.0001]	[0.0005]	[0.0161]
Elasticity based on:	BEC cons.	BEC cons.	BEC cons.	BEC cons.	BEC cons.	BEC cons. & α proxy
Observations	2,648,348	2,467,486	2,467,486	2,467,486	2,467,486	2,467,486
R^2	0.5376	0.5398	0.5407	0.5440	0.5646	0.5646
Firm fixed effects	Y	Y	Y	Y	Y	Y
Input industry *i* fixed effects	N	N	N	N	Y	Y
No. of *i*-*j* pairs	8,548	7,225	7,225	7,225	7,225	7,225

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Dependent variable:	Integration$_{ijp}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Upstreamness$_{ij}$						
× Ind.(Quintile 1 Elas$_j$)	-0.0043***	0.0032*	0.0048***	0.0054***	0.0036*	-0.0005
	[0.0014]	[0.0018]	[0.0018]	[0.0019]	[0.0020]	[0.0021]
× Ind.(Quintile 2 Elas$_j$)	-0.0111***	-0.0042**	-0.0022	-0.0030	-0.0044	0.0035
	[0.0027]	[0.0020]	[0.0019]	[0.0019]	[0.0034]	[0.0023]
× Ind.(Quintile 3 Elas$_j$)	-0.0102***	-0.0023	0.0001	-0.0002	-0.0028	-0.0054
	[0.0017]	[0.0021]	[0.0022]	[0.0021]	[0.0027]	[0.0039]
× Ind.(Quintile 4 Elas$_j$)	-0.0129***	0.0023	0.0043	0.0034	0.0012	0.0016
	[0.0033]	[0.0033]	[0.0030]	[0.0028]	[0.0023]	[0.0025]
× Ind.(Quintile 5 Elas$_j$)	-0.0229***	-0.0169***	-0.0153***	-0.0146***	-0.0077**	-0.0079**
	[0.0047]	[0.0056]	[0.0055]	[0.0052]	[0.0034]	[0.0033]
Self-SIC$_{ij}$	0.9664***	0.9207***	0.9134***	0.8823***	0.8517***	0.8517***
	[0.0033]	[0.0085]	[0.0091]	[0.0164]	[0.0177]	[0.0176]
Log (Total Requirements$_{ij}$)	0.0016**	0.0022***	0.0034***	0.0028***	0.0035***	0.0038***
	[0.0008]	[0.0008]	[0.0008]	[0.0008]	[0.0012]	[0.0012]
Upstream-Complementarity$_{ij}$		0.0403***	0.0367***	0.0174***	0.0200***	0.0200***
		[0.0039]	[0.0038]	[0.0037]	[0.0037]	[0.0037]
Downstream-Complementarity$_{ij}$		0.0284***	0.0260***	0.0129**	0.0171***	0.0163***
		[0.0065]	[0.0064]	[0.0052]	[0.0059]	[0.0057]
Diff. Log (Skilled Emp./Workers)$_{ij}$			-0.0170***	-0.0156***	-0.0213***	-0.0217***
			[0.0039]	[0.0037]	[0.0044]	[0.0045]
Diff. Log (Equip. Capital/Workers)$_{ij}$			-0.0034	-0.0038*	-0.0089***	-0.0089***
			[0.0024]	[0.0023]	[0.0030]	[0.0030]
Diff. Log (Plant Capital/Workers)$_{ij}$			-0.0015	-0.0008	0.0041	0.0041
			[0.0023]	[0.0023]	[0.0026]	[0.0026]
Diff. R&D Intensity$_{ij}$			-0.0010	0.0004	0.0004	0.0004
			[0.0006]	[0.0007]	[0.0006]	[0.0006]
Same-SIC2$_{ij}$				0.0204***	0.0166***	0.0160***
				[0.0041]	[0.0028]	[0.0028]
Same-SIC3$_{ij}$				0.0457***	0.0416***	0.0419***
				[0.0149]	[0.0126]	[0.0127]
p-value: Upstreamness$_{ij}$, Quintile 1 minus Quintile 5	[0.0000]	[0.0003]	[0.0002]	[0.0001]	[0.0005]	[0.0161]
Elasticity based on:	BEC cons.	BEC cons.	BEC cons.	BEC cons.	BEC cons.	BEC cons. & α proxy
Observations	2,648,348	2,467,486	2,467,486	2,467,486	2,467,486	2,467,486
R^2	0.5376	0.5398	0.5407	0.5440	0.5646	0.5646
Firm fixed effects	Y	Y	Y	Y	Y	Y
Input industry i fixed effects	N	N	N	N	Y	Y
No. of i-j pairs	8,548	7,225	7,225	7,225	7,225	7,225

Table 8

Integration Decisions within Firms: The Role of Contractibility

Dependent variable:	Integration$_{ijp}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Contractibility-up-to-i_{ij}						
× Ind.(Quintile 1 Elas$_j$)	0.0216***	-0.0017	-0.0065	-0.0105	0.0014	0.0148**
	[0.0050]	[0.0061]	[0.0064]	[0.0066]	[0.0063]	[0.0058]
× Ind.(Quintile 2 Elas$_j$)	0.0388***	0.0158*	0.0097	0.0120	0.0232***	0.0020
	[0.0084]	[0.0084]	[0.0080]	[0.0074]	[0.0070]	[0.0067]
× Ind.(Quintile 3 Elas$_j$)	0.0356***	0.0093	0.0035	0.0032	0.0221***	0.0267***
	[0.0053]	[0.0072]	[0.0075]	[0.0068]	[0.0073]	[0.0086]
× Ind.(Quintile 4 Elas$_j$)	0.0497***	-0.0036	-0.0085	-0.0058	0.0122	0.0127
	[0.0119]	[0.0126]	[0.0120]	[0.0108]	[0.0084]	[0.0083]
× Ind.(Quintile 5 Elas$_j$)	0.0822***	0.0514***	0.0470***	0.0445***	0.0418***	0.0411***
	[0.0144]	[0.0163]	[0.0161]	[0.0153]	[0.0108]	[0.0103]
Self-SIC$_{ij}$	0.9601***	0.9204***	0.9140***	0.8827***	0.8513***	0.8512***
	[0.0039]	[0.0083]	[0.0089]	[0.0163]	[0.0177]	[0.0178]
Log (Total Requirements$_{ij}$)	0.0003	0.0016	0.0028***	0.0023**	0.0013	0.0015
	[0.0009]	[0.0010]	[0.0010]	[0.0009]	[0.0011]	[0.0011]
Upstream-Complementarity$_{ij}$		0.0393***	0.0360***	0.0167***	0.0205***	0.0207***
		[0.0041]	[0.0039]	[0.0037]	[0.0036]	[0.0037]
Downstream-Complementarity$_{ij}$		0.0278***	0.0255***	0.0124**	0.0172***	0.0159***
		[0.0069]	[0.0067]	[0.0054]	[0.0058]	[0.0056]
Diff. Log (Skilled Emp.Workers)$_{ij}$			-0.0169***	-0.0154***	-0.0210***	-0.0209***
			[0.0039]	[0.0036]	[0.0044]	[0.0044]
Diff. Log (Equip. Capital/Workers)$_{ij}$			-0.0029	-0.0034	-0.0087***	-0.0087***
			[0.0021]	[0.0021]	[0.0030]	[0.0030]
Diff. Log (Plant Capital/Workers)$_{ij}$			-0.0015	-0.0008	0.0042	0.0041
			[0.0023]	[0.0022]	[0.0027]	[0.0027]
Diff. R&D Intensity$_{ij}$			-0.0011*	0.0003	0.0003	0.0003
			[0.0006]	[0.0007]	[0.0006]	[0.0006]
Same-SIC2$_{ij}$				0.0203***	0.0160***	0.0153***
				[0.0040]	[0.0028]	[0.0028]
Same-SIC3$_{ij}$				0.0461***	0.0422***	0.0429***
				[0.0148]	[0.0126]	[0.0127]
p-value: Contractibility-up-to-i_{ij}, Quintile 1 minus Quintile 5	[0.0000]	[0.0007]	[0.0005]	[0.0002]	[0.0001]	[0.0068]
Elasticity based on:	BEC cons.	BEC cons	BEC cons.	BEC cons.	BEC cons.	BEC cons. & α proxy
Firm fixed effects	Y	Y	Y	Y	Y	Y
Input industry *i* fixed effects	N	N	N	N	Y	Y
Observations	2,648,348	2,467,486	2,467,486	2,467,486	2,467,486	2,467,486
No. of parent firms	46,992	41,931	41,931	41,931	41,931	41,931
No. of *i*-*j* pairs	8,548	7,225	7,225	7,225	7,225	7,225
R^2	0.5383	0.5397	0.5406	0.5438	0.5647	0.5647

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	[0.0050]	[0.0061]	[0.0064]	[0.0066]	[0.0063]	[0.0058]
× Ind.(Quintile 2 Elas$_j$)	0.0388***	0.0158*	0.0097	0.0120	0.0232***	0.0020
	[0.0084]	[0.0084]	[0.0080]	[0.0074]	[0.0070]	[0.0067]
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	[0.0053]	[0.0072]	[0.0075]	[0.0068]	[0.0073]	[0.0086]
× Ind.(Quintile 4 Elas$_j$)	0.0497***	-0.0036	-0.0085	-0.0058	0.0122	0.0127
	[0.0119]	[0.0126]	[0.0120]	[0.0108]	[0.0084]	[0.0083]
× Ind.(Quintile 5 Elas$_j$)	0.0822***	0.0514***	0.0470***	0.0445***	0.0418***	0.0411***
	[0.0144]	[0.0163]	[0.0161]	[0.0153]	[0.0108]	[0.0103]
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	[0.0039]	[0.0083]	[0.0089]	[0.0163]	[0.0177]	[0.0178]
Log (Total Requirements$_{ij}$)	0.0003	0.0016	0.0028***	0.0023**	0.0013	0.0015
	[0.0009]	[0.0010]	[0.0010]	[0.0009]	[0.0011]	[0.0011]
Upstream-Complementarity$_{ij}$		0.0393***	0.0360***	0.0167***	0.0205***	0.0207***
		[0.0041]	[0.0039]	[0.0037]	[0.0036]	[0.0037]
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Diff. Log (Skilled Emp.Workers)$_{ij}$			-0.0169***	-0.0154***	-0.0210***	-0.0209***
			[0.0039]	[0.0036]	[0.0044]	[0.0044]
Diff. Log (Equip. Capital/Workers)$_{ij}$			-0.0029	-0.0034	-0.0087***	-0.0087***
			[0.0021]	[0.0021]	[0.0030]	[0.0030]
Diff. Log (Plant Capital/Workers)$_{ij}$			-0.0015	-0.0008	0.0042	0.0041
			[0.0023]	[0.0022]	[0.0027]	[0.0027]
Diff. R&D Intensity$_{ij}$			-0.0011*	0.0003	0.0003	0.0003
			[0.0006]	[0.0007]	[0.0006]	[0.0006]
Same-SIC2$_{ij}$				0.0203***	0.0160***	0.0153***
				[0.0040]	[0.0028]	[0.0028]
Same-SIC3$_{ij}$				0.0461***	0.0422***	0.0429***
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p-value: Contractibility-up-to-i_{ij}, Quintile 1 minus Quintile 5	[0.0000]	[0.0007]	[0.0005]	[0.0002]	[0.0001]	[0.0068]
Elasticity based on:	BEC cons.	BEC cons	BEC cons.	BEC cons.	BEC cons.	BEC cons. & α proxy
Firm fixed effects	Y	Y	Y	Y	Y	Y
Input industry i fixed effects	N	N	N	N	Y	Y
Observations	2,648,348	2,467,486	2,467,486	2,467,486	2,467,486	2,467,486
No. of parent firms	46,992	41,931	41,931	41,931	41,931	41,931
No. of i-j pairs	8,548	7,225	7,225	7,225	7,225	7,225
R^2	0.5383	0.5397	0.5406	0.5438	0.5647	0.5647

In line with prediction P.2 (Within), a greater degree of contractibility upstream of input *i* raises

Conclusions

Conclusions

- The emergence of global value chains has attracted much attention from policymakers and academics alike.
- Few empirical studies attempt to shed light on the determinants of firms' decision to control different segments of their production processes.
- We develop a richer theoretical framework of firm boundary choices along value chains that can guide an empirical analysis using firm-level data.
- Available data on the activities of firms can be combined with information from Input-Output tables to study integration choices along value chains.

Conclusions (cont.)

- In line with the model's predictions, we find that whether a firm integrates suppliers located upstream or downstream depends crucially on
  - the size of the elasticity of demand faced by the firm
  - the extent to which contractible inputs are located in the early or late stages
  - the proudutivity of the final good producers
- The firm-level patterns that we uncover provide strong evidence that considerations driven by contractual frictions critically shape firms' ownership decisions along their value chains.

From Final Goods to Inputs: the Cascade Effect of Preferential Rules of Origin

Paola Conconi
ULB (ECARES), CEPR and CESifo

Manuel García-Santana
UPF, Barcelona GSE, and CEPR

Laura Puccio
European Parliament

Roberto Venturini
ULB (ECARES)

- **GVCs** are actually **regional**: trade in intermediates is concentrated within "Factory North America, Factory Europe, and Factory Asia" (Baldwin, 2013)

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  90% are Free Trade Agreements (FTAs) RTAs

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- Recent decades have seen the proliferation of **regional trade agreements**

  90% are Free Trade Agreements (FTAs) RTAs

- **FTAs** can **distort sourcing decisions** through two channels:
  - **Lower tariffs** when importing from FTA partners
  - **Rules of Origin** (RoO)

Some information about RoO

- RoO define the **conditions that products must satisfy to obtain preferential tariff treatment**, to avoid that products from non-FTA members are transhipped from low-tariff to high-tariff FTA partners.

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- There are two main types of rules:

  1. Value-added requirements

     At least $X\%$ of the the value of the final good must be "domestic" VA

  2. Change of tariff classification

     Some inputs cannot be sourced (at all) from outside the FTA

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- Theoretically, it is has long been known that RoO **distort sourcing** and lead to **trade diversion in intermediate goods** (e.g. Grossman, 1981).
- In a large survey by the ITC (2015), RoO emerge as the **most problematic non-tariff measure** faced by manufacturing firms.

In this paper

- We investigate the effects of RoO on imports of intermediate goods

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  - **Endogeneity of the rules**

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      RoO are mostly defined in terms of change of tariff classification
  - **Endogeneity of the rules**
    - We run difference-in-differences regressions, focusing on Mexican imports (NAFTA RoO were to a large extent inherited from CUSFTA)
    - We use CUSFTA RoO as an instrument
    - We run triple-difference regressions exploiting variation in RoO treatment between NAFTA and non-NAFTA countries

Main results

- RoO on final goods acted as input tariffs, distorting sourcing decisions and giving rise to **trade diversion in intermediate goods**.

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- RoO decreased the growth of Mexican imports of restricted intermediates from third countries by between 13 and 117 log points (representing between 5% and 52% of the actual change in imports of treated goods).

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  - Whether the rules are **rigid or flexible**
- RoO decreased the growth of Mexican imports of restricted intermediates from third countries by between 13 and 117 log points (representing between 5% and 52% of the actual change in imports of treated goods).
- Our results challenge those by Caliendo and Parro (2015): abstracting from RoO, they find that "the rest of the world was hardly affected by NAFTA."

Related literature

- **Empirical studies** on the effects of FTAs abstract from RoO (e.g. Kehoe and Ruhl, 2013, Caliendo and Parro, 2015).
- **Theoretical studies** emphasize that RoO can distort trade in intermediaries (e.g. Grossman, 1981; Falvey and Reed, 2002).
- Direct evidence of this effect has been lacking, due to to the **legal complexity of the rules**, which makes measurement difficult.
- To measure the restrictiveness of RoO, previous studies use **synthetic indices** (e.g. Estevadeordal, 2000; Cadot *et al*, 2006).
- This is the first paper to map the **input-output linkages** embedded in RoO and examine how they affect trade in intermediaries.

Outline of the talk

1. Introduction
2. **Brief history of NAFTA**
3. Construction of the dataset on NAFTA RoO
4. Empirical methodology and results
5. Next steps and conclusions

Brief history of NAFTA

- 1988: Canada and US signed Canada-US Free Trade Agreement.
- 1990: Mexico approached the US to form a free trade agreement.
- 1991: Canada joined the negotiations, with the goal of creating one free trade area in North America.
- 1994: entry into force of NAFTA. Around 50% of tariffs eliminated upon entry; most other tariffs phased out within 10 years.

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Construction of dataset on NAFTA RoO

- Four steps to codify sourcing restrictions in NAFTA RoO:

  1. NAFTA RoO in Annex 401
  2. Coding Annex 401
  3. Mapping input-output linkages in NAFTA RoO
  4. Construction of RoO variables

Step 1: Annex 401

- **NAFTA RoO on textile fabric HS 6203.42 (men's or boys' trousers)**:

  "change[s] to subheadings 6203.41 through 6203.49 from any other chapter, except from headings 5106 through 5113, 5204 through 5212, 5307 through 5308 or 5310 through 5311, chapter 54, or heading 5508 through 5516, 5801 through 5802 or 6001 through 6002."

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- **Main rule** ("change[s] to subheadings 6203.41 through 6203.49 from any other chapter"): any input that falls within chapter 62 must be sourced within NAFTA for the textile fabric to obtain origin status.

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- **Additional requirements** (from "except from headings 5106" to the end): any input falling into the listed tariff items must be sourced within NAFTA (e.g. 5106 through 5113: yarn or fabrics of wool).

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- **Additional requirements** (from "except from headings 5106" to the end): any input falling into the listed tariff items must be sourced within NAFTA (e.g. 5106 through 5113: yarn or fabrics of wool).

- In some cases, alternative or complementary **value added rules** are used, but only in combination with change of classification rules.

Step 2: Coding Annex 401

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Figure 4: RoO on HS 6203.42

Output	Rule Type	Alternative VA	Complementary VA	Main Input Req	AdReq 1	AdReq 2	AdReq 3
62.03.41-62.03.49	CC	0	0	chapter 62	51.06-51.13	52.04-52.12	53.07-53.08
62.04.11-62.04.13	CC	0	0	chapter 62	51.06-51.13	52.04-52.12	53.07-53.08

Step 3: Mapping output-input linkages in NAFTA RoO

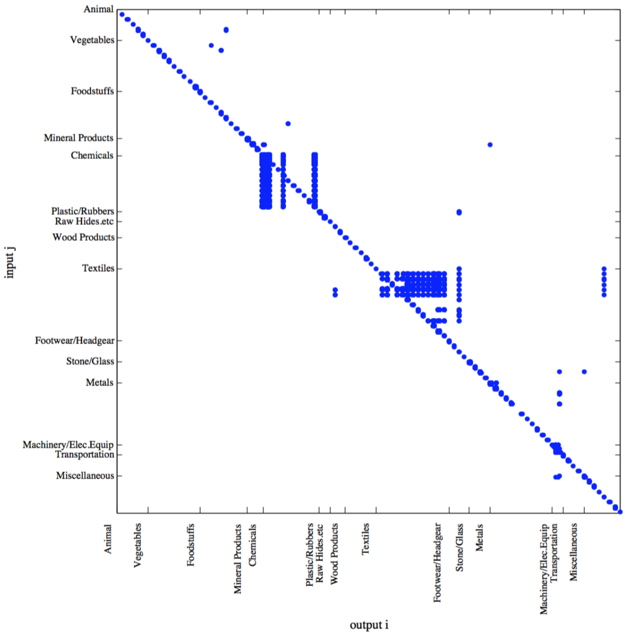
output	input
620342	550810
620342	550820
620342	550911
620342	550912
620342	550921
620342	550922
620342	550931
620342	550932
620342	550941
620342	550942
620342	550951
620342	550952
620342	550953
620342	550959
620342	550961
620342	550962
620342	550969
620342	550991
620342	550992

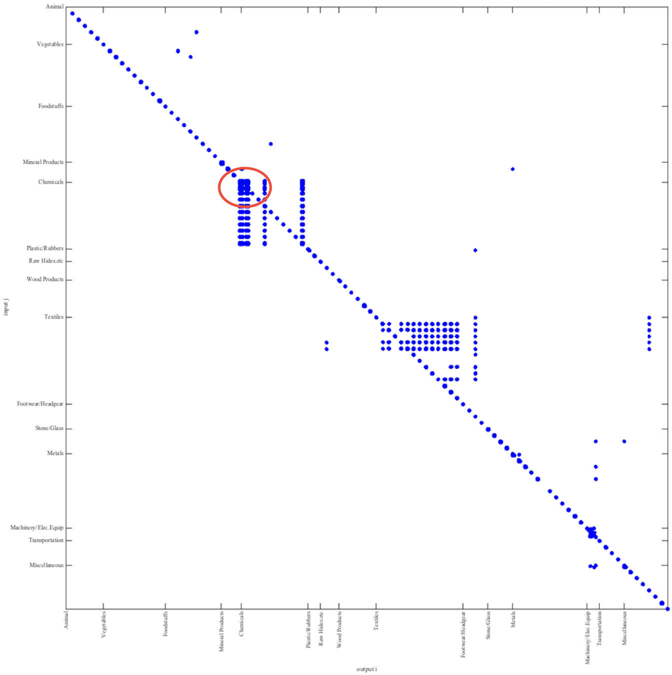
Step 4: Constructing RoO variables

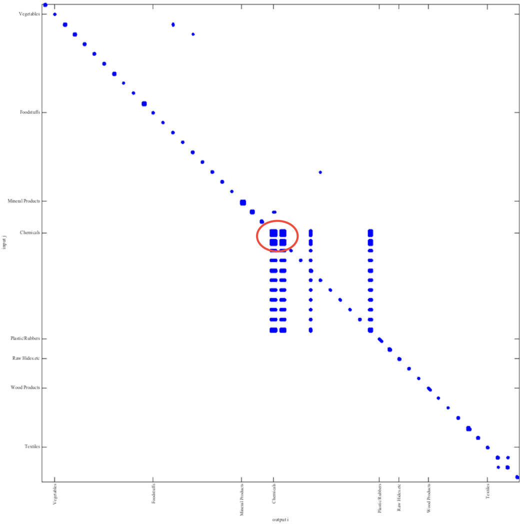
input	output
550810	620342
550810	620343
550810	620349
550810	620411
550810	620412
550810	620413
550810	620419
550810	620421
550810	620422
550810	620423
550810	620429
550810	620431
550810	620432
550810	620433
550810	620439
550810	620441
550810	620442

- RoO_{ij}: dummy equal to 1 is RoO on final good i restricts sourcing of j.

NAFTA Rules of Origin (RoO_{ij})




Animal
Vegetables
Foodstuffs
Mineral Products
Chemicals
Plastic/Rubbers
Raw Hides.etc
Wood Products
Textiles
Footwear/Headgear
Stone/Glass
Metals
Machinery/Elec.Equip
Transportation
Miscellaneous
input j
output i



Vegetables
Foodstuffs
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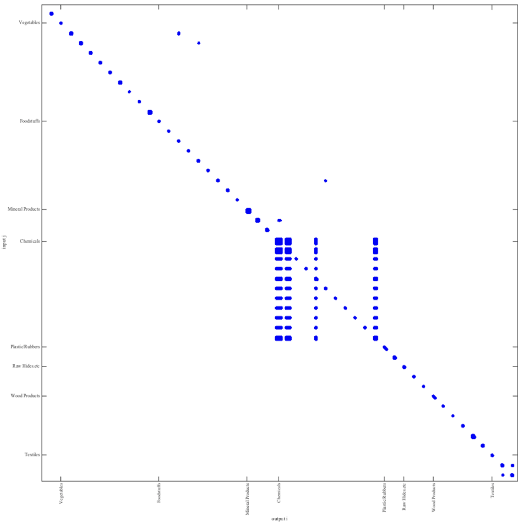
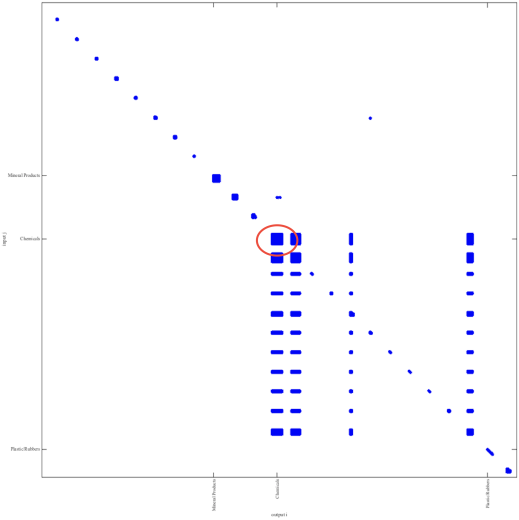
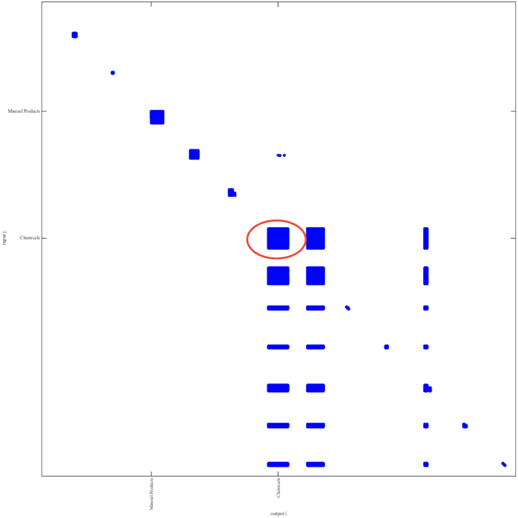
Wood Products
Textiles
input j
output i

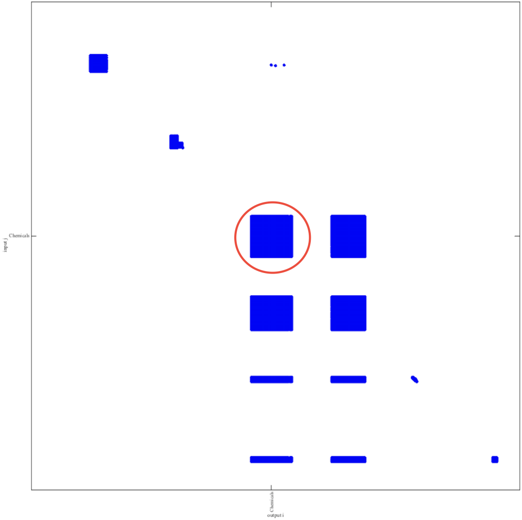


Vegetables
Foodstuffs
Mineral Products
Chemicals
Plastic/Rubbers
Raw Hides,etc
Wood Products
Textiles
input j
output i



Mineral Products
Chemicals
Plastic/Rubbers
input j
Mineral Products
Chemicals
Plastic/Rubbers
output i


Mineral Products
Chemicals
input j
Mineral Products
Chemicals
output i



Chemicals
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Chemicals
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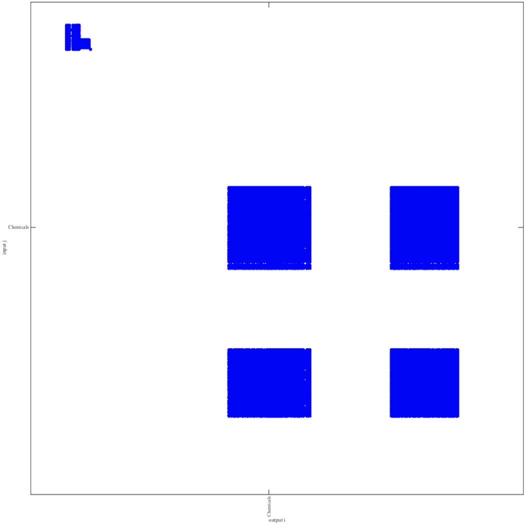
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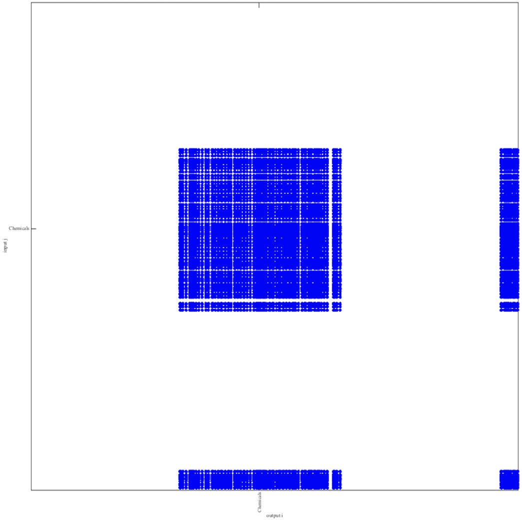

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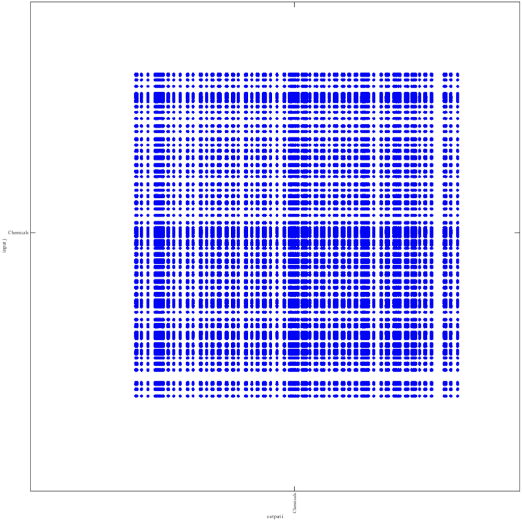
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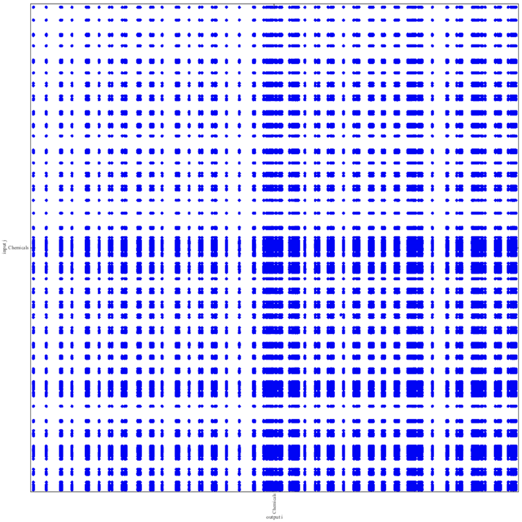

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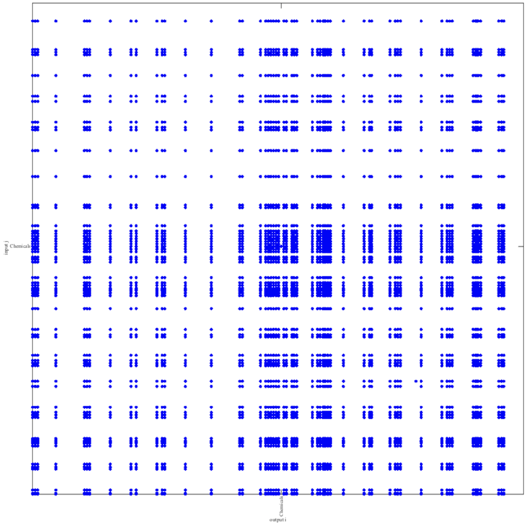
input j
Chemicals
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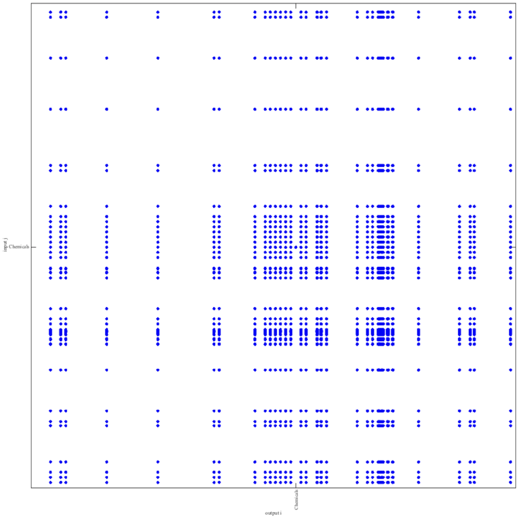

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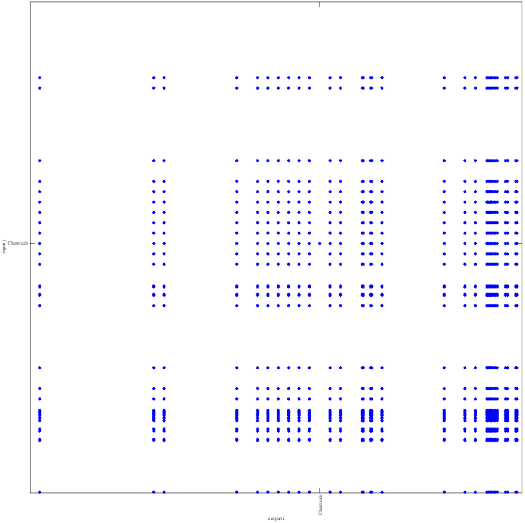
Chemicals



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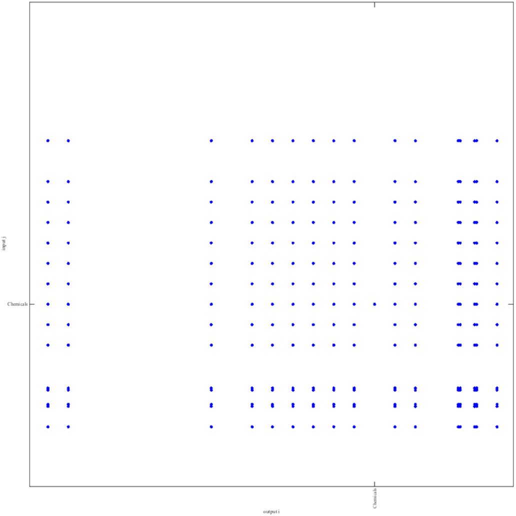
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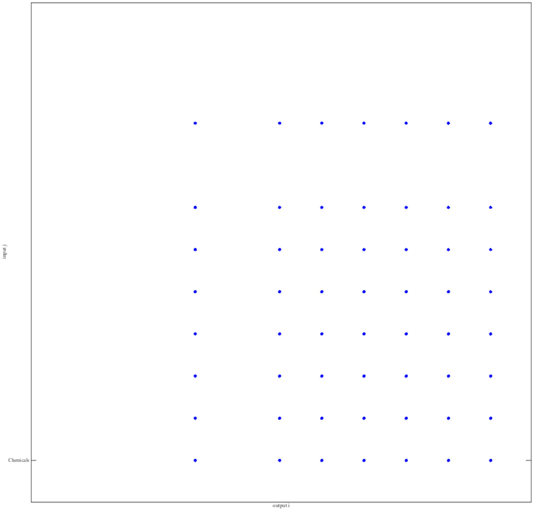
Chemicals
output i
Chemicals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Chemicals
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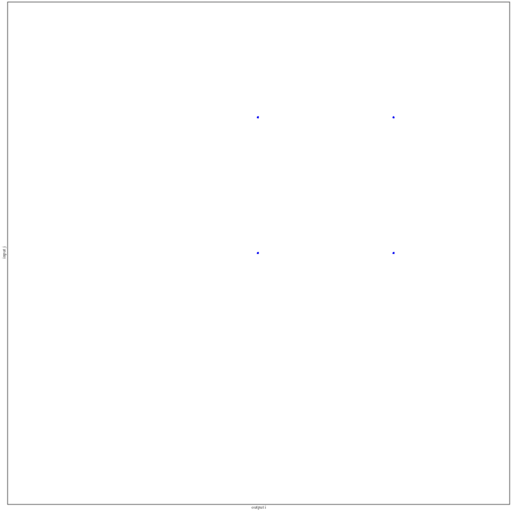

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output i

RoO variables

- Main treatment variables for a given intermediate good j:

$$RoO_j^x = \sum_i RoO_{ij}^x$$

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RoO variables

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$$RoO_j^x = \sum_i RoO_{ij}^x$$

  - $x = 1$: all final goods i with sourcing restrictions on j
  - $x = 2$ excludes final goods i with zero preference margin
  - $x = 3$ further excludes final goods i with alternative VA rules

RoO variables

- RoO_{ij} can be constructed for rules written at the chapter (2 digits), heading (4 digits) and sub-heading (6 digits) level.

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- To verify this, we have converted I-O tables into HS classification. conversion
- Percentage of RoO that apply to vertically-related goods:
  - Rules defined at 2 digits: around 50% of the cases
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  - Rules defined at 2 digits: around 50% of the cases
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  - Rules defined at 6 digits: around 96% of the cases
- In our first regressions, we focus on RoO defined at 6 digits.

Table 9

Descriptive statistics on NAFTA RoO

	Panel (A): RoO_{ij}^1			Panel (B): RoO_{ij}^2			Panel (C): RoO_{ij}^3		
HS	mean	min	max	mean	min	max	mean	min	max
01-05: Animal Products	57.39	0	87	18.01	0	24	17.86	0	24
06-15: Vegetables	39.77	0	57	23.43	0	43	22.80	0	41
16-24: Foodstuffs	23.60	0	44	18.49	0	37	17.95	0	36
25-27: Mineral Products	54.04	0	74	13.56	0	32	13.36	0	32
28-38: Chemicals	553.87	0	591	445.67	0	483	1.98	0	33
39-40: Plastics/Rubbers	21.03	1	61	12.89	0	36	10.69	0	28
41-43: Raw Hides, Skins, Leathers	21.39	9	34	18.82	4	30	17.44	4	27
44-49: Wood Products	38.52	0	93	27.89	0	77	19.11	0	58
50-63: Textiles	280.21	4	722	276.66	1	715	276.61	1	715
64-67: Footwear/Headgear	17.01	2	29	16.50	1	29	15.56	1	27
68-71: Stone/Glass	37.18	0	57	23.01	0	52	27.22	0	50
72-83: Metals	39.81	0	96	33.13	0	81	28.94	0	53
84-85: Machinery/Electrical	8.78	0	65	5.08	0	63	4.45	0	56
86-89: Transportation	9.54	1	22	8.30	0	20	6.81	0	20
90-97: Miscellaneous	19.94	0	44	15.59	0	41	13.96	0	41
All sector categories	148.15	0	722	124.24	0	715	55.98	0	715
Total number of RoO	746,383			625,957			281,976		

Table 10

Descriptive statistics on imports and tariffs

HS Code	Description	Panel A Mexican imports 1991	 2003	 MFN 1991	Panel B Mexican tariffs MFN 2003	 NAFTA 2003	Panel C US and Canadian tariffs MFN 2003	 NAFTA 2003
01-05	Animal Products	105.01	396.70	13.91	32.70	1.22	2.11	0.23
06-15	Vegetables	163.74	245.05	12.46	18.21	0.00	3.35	0.02
16-24	Foodstuffs	81.74	133.05	17.06	25.84	0.11	8.74	0.51
25-27	Mineral Products	122.19	718.77	9.34	11.67	0.00	0.44	0.01
28-38	Chemicals	166.60	1194.19	11.21	12.56	0.01	2.67	0.00
39-40	Plastic/Rubbers	164.09	1365.55	13.46	16.31	0.00	3.71	0.00
41-43	Raw Hides,Skins,Leathers	22.95	222.964	13.05	20.82	0.00	3.95	0.00
44-49	Wood Products	39.23	359.85	11.80	15.70	0.00	0.65	0.00
50-63	Textiles	325.96	1468.04	16.78	24.47	0.00	10.21	0.00
64-67	Footwear/Headgear	82.53	260.92	19.17	29.85	0.00	9.28	0.48
68-71	Stone/Glass	39.36	525.58	15.65	18.47	0.00	2.85	0.14
72-83	Metals	192.86	1585.28	12.65	16.83	0.00	2.01	0.00
84-85	Machinery/Electrical	1224.04	21999.53	13.61	13.25	0.00	1.55	0.00
86-89	Transportation	135.93	1444.66	14.28	18.38	0.00	4.28	0.00
90-97	Miscellaneous	324.50	1839.53	15.05	18.44	0.00	2.76	0.01

Outline of the talk

Difference-in-differences results

- Main specification:

$$\Delta Imports_{j,o} = \alpha_0 + \alpha_1 \ \Delta Preferential\ Tariff_{j,o} + \beta_2 \ RoO_j^x + \delta_{k(j)} + \delta_o + \epsilon_{j,o}$$

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$\Delta Imports_{j,o}$: log change in Mexican imports of HS6 good j from third country o

$\Delta Preferential\ Tariff_j$: difference between the log change in tariff applied by Mexico to imports of good j from non-NAFTA country and from NAFTA partners

RoO^x_j: log number of RoO imposing sourcing restrictions on j

$\delta_{k(j)}$: sector fixed effects (at 3 or 4 digits)

δ_o: country of origin fixed effects

Standard errors clustered by industry (at 6 digits)

Table 3

NAFTA RoO and change in Mexican imports from non-NAFTA countries
(rules written at sub-heading level)

	(1)	(2)	(3)	(4)	(5)	(6)
RoO_j^1	-0.010	0.005				
	(0.061)	(0.060)				
RoO_j^2			-0.144**	-0.085		
			(0.057)	(0.056)		
RoO_j^3					-0.158***	-0.096*
					(0.059)	(0.058)
$\Delta \textit{Preferential Tariff}_j$		-0.329***		-0.320***		-0.319***
		(0.063)		(0.064)		(0.064)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Country of origin FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	28,067	28,067	28,067	28,067	28,067	28,067
R-squared	0.215	0.217	0.215	0.218	0.215	0.218

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- The effect is significant when we include only rules that are **relevant** (final good producers have something to gain by complying to them).
- Based on column 6, RoO of final goods reduced the growth rate of imports of “treated” intermediates from third countries by around 13 log points.

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& + \beta_3 \ \mathit{RoO}_j^3 + \beta_4 \ \mathit{Preference\ Margin}_{i,NAFTA} + \beta_5 \ \mathit{Exports}_{i,NAFTA} \\
& + \beta_6 \ \Delta \mathit{Preferential\ Tariff}_{j,o} + \delta_j + \delta_o + \epsilon_{j,o}.
\end{aligned}
$$

- RoO should have a more detrimental impact
    - the higher is the **preference margin** on the final good ($\beta_1 < 0$)
    - in sectors for which the US and Canada are **more important export markets** ($\beta_2 < 0$)

Table 4

NAFTA RoO and change in Mexican imports from non-NAFTA countries
(rules written at sub-heading level)

	(1)	(2)	(3)	(4)	(5)	(6)
$RoO^3_j \times Average\ Preference\ Margin_{j,NAFTA}$	-2.073	-2.637*			-2.909**	-3.865***
	(1.301)	(1.371)			(1.359)	(1.464)
$RoO^3_j \times Average\ Exports_{j,NAFTA}$			-0.012	-0.013*	-0.013*	-0.015**
			(0.007)	(0.007)	(0.007)	(0.007)
RoO^3_j	2.736*	3.256**	0.094	-0.265	3.659**	4.252***
	(1.512)	(1.571)	(0.621)	(0.614)	(1.562)	(1.587)
$Average\ Preference\ Margin_{j,NAFTA}$	0.240	0.837			0.955	1.926
	(1.122)	(1.154)			(1.159)	(1.231)
$Average\ Exports_{j,NAFTA}$			0.043	0.050	0.043	0.058*
			(0.034)	(0.032)	(0.032)	(0.032)
$\Delta Preferential\ Tariff_j$		-0.649		-0.739		-0.724*
		(0.406)		(0.473)		(0.431)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Country of origin FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,175	1,175	1,175	1,175	1,175	1,175
R-squared	0.362	0.370	0.352	0.362	0.366	0.375

- The above results are an **underestimate** of the effects of NAFTA RoO:

- The above results are an **underestimate** of the effects of NAFTA RoO:

  1. The treatment variables only include rules written at the sub-heading (HS6) level, which constitute less than 1 percent of all NAFTA RoO.

  2. To the extent that CUSFTA rules modified during the NAFTA negotiations due to **pressure by import-competing producers** located in Mexico, this should make it harder to find evidence for trade diversion.

  3. In 2003, many **firms were still unaware of NAFTA RoO** and had yet to adjust their sourcing decisions.

Results using all rules

- We obtain larger effects when including all rules:

  - Full sample
    - Do not use the IO tables at all

  - Excluding rules with $dr_{i,j} = 0$
    - Exclude RoO that apply to not vertically related goods

  - Weighting rules by $dr_{i,j}$
    - Weight by the intensity of the vertical relation

Instrumenting NAFTA rules with CUSFTA rules

- If policymakers manipulate RoO to protect domestic producers, we would expect them to set stricter rules in sectors characterized by stronger increase in import competition.

- This would work against us, making it harder to find evidence for the trade diverting effects of NAFTA RoO.

- We obtain larger effects when we use the rules contained in the CUSFTA agreement to instrument for NAFTA rules.

Magnitude of the effects

Table 9

Quantification of the effect of RoO

	(1) Table 3	(2) Table 5	(3) Table 6	(4) Table 7	(5) Table 8
$\hat{\beta}_1$	-0.096	-0.294	-0.160	-0.360	-0.390
Mean RoO_j^3	1.416	3.004	2.841	0.758	3.004
$\Delta Imports_j$	2.588	2.231	2.220	2.220	2.231
Effect of RoO_j^3 (in log points)	-13.593	-88.317	-45.456	-27.288	-117.156
Effect of RoO_j^3 (as % of $\Delta Imports_j$)	5.252%	39.586%	20.475%	12.291%	52.492%

Triple-difference results

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- To deal with concerns about possible omitted variables, we exploit both cross-sector and cross-county differences in treatment:

$$\Delta Imports_{j,NON-NAFTAo} - \Delta Imports_{j,NAFTA} = \alpha_0 + \alpha_1 \; RoO_j^x + \delta_o + \epsilon_{j,NAFTAo,NAFTA},$$

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which can be written as the difference between

$$\Delta Imports_{j,NON-NAFTAo} = \beta_0 + \beta_1 \; RoO_j^x + \Delta Preferential \; Tariff_j + X_j + \delta_o + \epsilon_{j,NON-NAFTAo},$$

and

$$\Delta Imports_{j,NAFTA} = \gamma_0 + \gamma_1 \; RoO_j^x + \Delta Preferential \; Tariff_j + X_j + \epsilon_{j,NAFTA},$$

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and

$$\Delta Imports_{j,NAFTA} = \gamma_0 + \gamma_1 \; RoO_j^x + \Delta Preferential \; Tariff_j + X_j + \epsilon_{j,NAFTA},$$

- NAFTA RoO restricting the sourcing of j should only have decreased imports of j from non-NAFTA countries $\rightarrow \alpha_1$ should be negative.

Table 10

NAFTA RoO and change in Mexican imports, triple-difference results
(all rules)

	(1)	(2)	(3)	(4)	(5)	(6)
RoO_j^1	-0.134***	-0.114***				
	(0.019)	(0.020)				
RoO_j^2			-0.139***	-0.117***		
			(0.018)	(0.019)		
RoO_j^3					-0.185***	-0.161***
					(0.019)	(0.021)
$\Delta Preferential\ Tariff_j$		-0.279***		-0.254***		-0.150***
		(0.055)		(0.055)		(0.057)
Country of origin FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	28,053	28,053	28,053	28,053	28,053	28,053
R-squared	0.146	0.150	0.148	0.150	0.152	0.153

Table 11

NAFTA RoO and change in Mexican imports, triple-difference results
(excluding rules for which $dr_{i,j} = 0$)

	(1)	(2)	(3)	(4)	(5)	(6)
RoO_j^1	-0.134***	-0.116***				
	(0.018)	(0.019)				
RoO_j^2			-0.140***	-0.120***		
			(0.017)	(0.018)		
RoO_j^3					-0.191***	-0.170***
					(0.019)	(0.020)
$\Delta Preferential\ Tariff_j$		-0.276***		-0.254***		-0.151***
		(0.054)		(0.054)		(0.055)
Country of origin FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	28,053	28,053	28,053	28,053	28,053	28,053
R-squared	0.147	0.151	0.149	0.151	0.154	0.155

Table 12

NAFTA RoO and change in Mexican imports, triple-difference results
(weighting rules by $dr_{i,j}$)

	(1)	(2)	(3)	(4)	(5)	(6)
RoO_j^1	-0.134***	-0.116***				
	(0.018)	(0.019)				
RoO_j^2			-0.177***	-0.156***		
			(0.030)	(0.030)		
RoO_j^3					-0.297***	-0.262***
					(0.034)	(0.035)
Δ*Preferential Tariff*$_j$		-0.276***		-0.293***		-0.210***
		(0.054)		(0.053)		(0.053)
Country of origin FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	28,053	28,053	28,053	28,053	28,053	28,053
R-squared	0.147	0.151	0.146	0.150	0.152	0.154

Conclusions

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- Input tariffs are low compared to tariffs on final goods (Miroudot *et al.*, 2009). Because of RoO, the **actual level of protection on intermediates** is much higher than what implied by input tariffs.

Policy implications

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- RoO **shift protection from final goods to inputs** ("cascade effect").
- Input tariffs are low compared to tariffs on final goods (Miroudot *et al.*, 2009). Because of RoO, the **actual level of protection on intermediates** is much higher than what implied by input tariffs.
- Our analysis has important policy implications for

  Multilateral trade rules (in particular GATT Article XXIV)

  Brexit negotiations (in particular in the case of a UK-EU FTA)

Avenue of future research

- What are the implications of our results for...

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  - **Productivity and welfare**?

    Include preferential tariffs and RoO in a model of global sourcing à la Antràs *et al*. (2017) or in a framework that accounts for input-output linkages à la Caliendo and Parro (2015).

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  - **Productivity and welfare**?

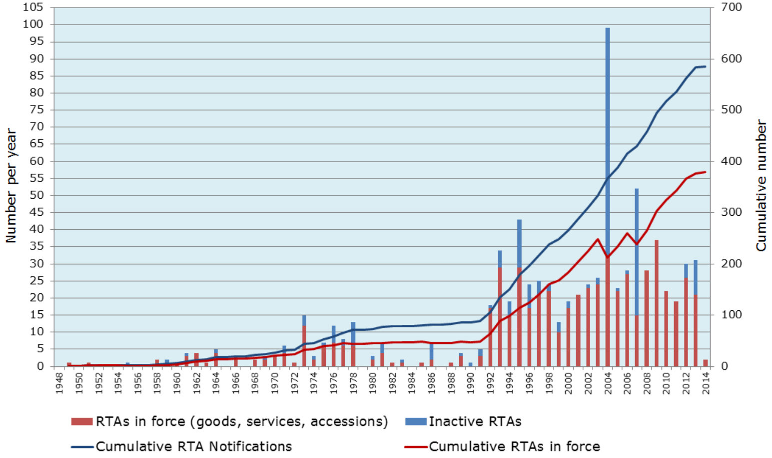
    Include preferential tariffs and RoO in a model of global sourcing à la Antràs *et al*. (2017) or in a framework that accounts for input-output linkages à la Caliendo and Parro (2015).

  - **Inward FDI**?

    Study whether NAFTA sourcing restrictions led to “RoO-jumping” FDI, using disaggregated data on Mexican inward FDI.

Thank you!

Figure 5: Number of RTA notifications and RTA in force (source, WTO Secretariat)



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NAFTA Rules of Origin

- Example of RoO: **watches** (HS 91.02) can only be traded duty free among members if **watch movements** (HS 91.08), **watch straps** (HS 91.13) **watch cases** (HS 91.12) used to produce them are sourced within NAFTA.

NAFTA Rules of Origin

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- We construct a **new dataset on NAFTA RoO**: for every final good, we can trace all the inputs that are subject to RoO requirements; similarly, for every intermediate good, we can link it to all final goods that impose RoO requirements on its sourcing.

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