The Globalization of Production

ESNIE 2015 Lecture

Pol Antràs

Harvard University

May 19, 2015

Three Major Developments

- Three major developments in the world economy in the last 25 years:

Three Major Developments

- Three major developments in the world economy in the last 25 years:

1. Information and communication technology (ICT) revolution

Three Major Developments

- Three major developments in the world economy in the last 25 years:

1. Information and communication technology (ICT) revolution
2. Deepening of trade liberalization and continuing transportation cost reduction

Three Major Developments

- Three major developments in the world economy in the last 25 years:

1. Information and communication technology (ICT) revolution
2. Deepening of trade liberalization and continuing transportation cost reduction
3. Political developments expanding the reach of globalization

ICT Revolution

1. Information and communication technology (ICT) revolution
    - Processing power and memory capacity of computers
    - Cost of transmitting information over an optical network

ICT Revolution

1. Information and communication technology (ICT) revolution
    - Processing power and memory capacity of computers
    - Cost of transmitting information over an optical network

ICT Revolution

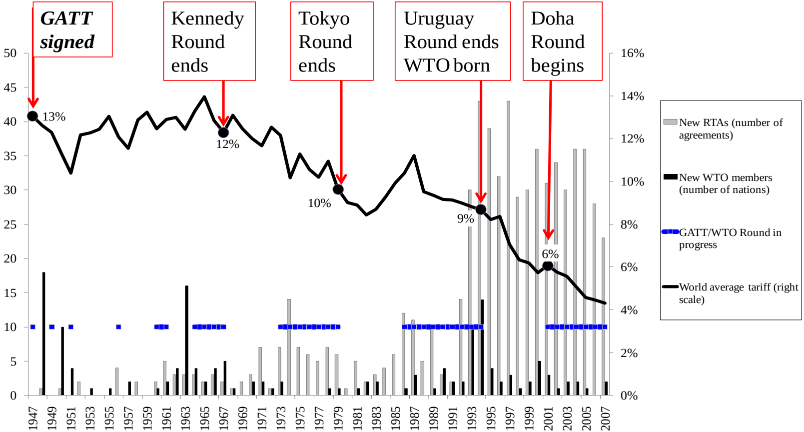
1. Information and communication technology (ICT) revolution
    - Processing power and memory capacity of computers
    - Cost of transmitting information over an optical network

Falling Trade Costs

2. Deepening trade liberalization and falling transportation costs
   - EU, NAFTA, Mercosur, ASEAN FTA, China's WTO accession, etc.

Falling Trade Costs

2. Deepening trade liberalization and falling transportation costs
   - EU, NAFTA, Mercosur, ASEAN FTA, China's WTO accession, etc.



Sources: RTAs: WTO online databases & Hufbauer-Schott RTA database; tariffs: Clemson and Williamson (2004) up to 1988, then World DataBank (weighted tariffs all products)

Political Developments

3. Political developments expanding the reach of globalization
   - Fall of communism, worldwide ideological shift to the right in large parts of the globe

Political Developments

3. Political developments expanding the reach of globalization
    - Fall of communism, worldwide ideological shift to the right in large parts of the globe

Political Developments

3. Political developments expanding the reach of globalization
   - Fall of communism, worldwide ideological shift to the right in large parts of the globe

An Implication: Rise of Global Value Chains

- Gradual disintegration of production processes across borders

An Implication: Rise of Global Value Chains

- Gradual disintegration of production processes across borders
- "Made in" labels in manufactured goods have become archaic symbols of an old era

An Implication: Rise of Global Value Chains

- Gradual disintegration of production processes across borders
- "Made in" labels in manufactured goods have become archaic symbols of an old era
- Every author has his/her pet word to describe this phenomenon:
  - "slicing of the value chain"
  - "fragmentation of the production process"
  - "disintegration of production"
  - "delocalization"
  - "vertical specialization"
  - "global production sharing"
  - "unbundling"
  - "offshoring"
  - "flattening of the world"

An Example: Everybody's Favorite Toy

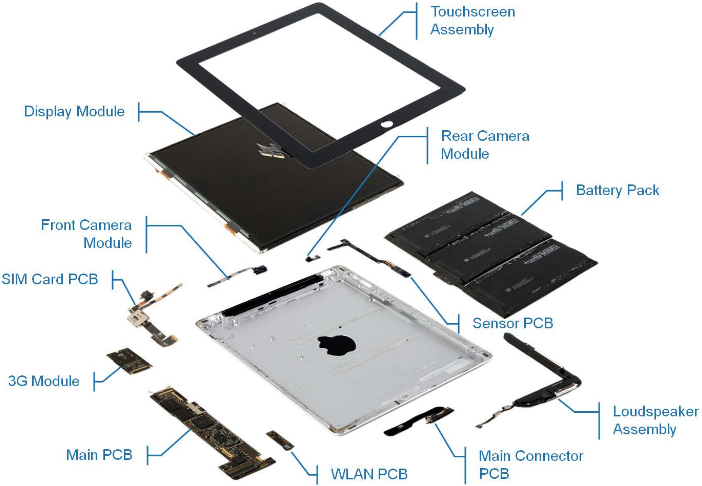
An Example: Everybody's Favorite Toy

An Example: Everybody's Favorite Toy

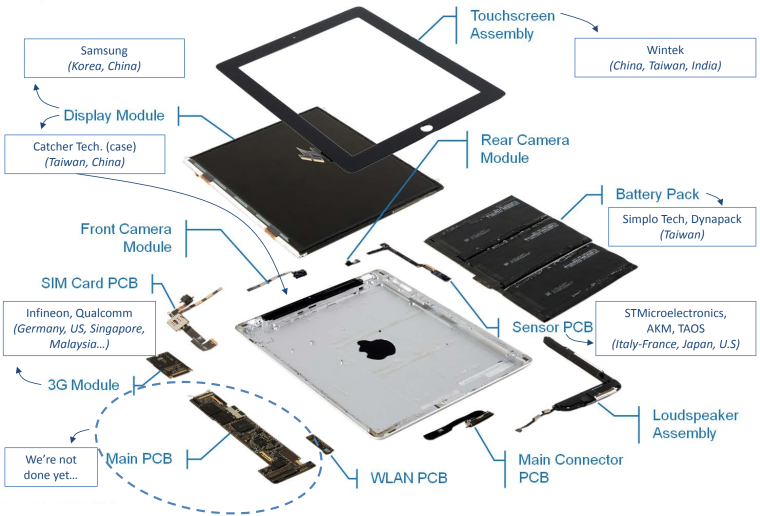
Designed by Apple in California, Assembled in China

Assembled in China (and now also in Brazil) by Foxconn and Pegatron

Tearing Down an iPad 3

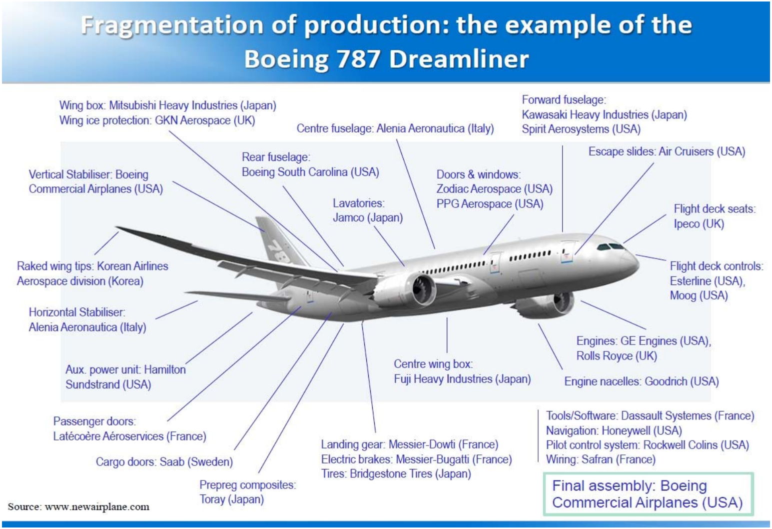


Tearing Down an iPad 3



It's Not Just North-South Fragmentation

It's Not Just North-South Fragmentation



It's Not Just Manufacturing

- Offshoring of Services: "Third Industrial Revolution"
  - India's customer service call centers
  - Reading X-rays
  - Software development
  - Tax form preparation

It's Not Just Manufacturing

- Offshoring of Services: "Third Industrial Revolution"
  - India's customer service call centers
  - Reading X-rays
  - Software development
  - Tax form preparation

Man outsources his own job to China, watches cat videos

1/17/13 | By James Eng of MSN News

SHARE 1.8K TWEET 64 EMAIL

A software developer for a U.S. company paid a fraction of his six-figure salary to a contractor in China to do his work, then spent the bulk of his workday surfing the Web.

By all accounts, Bob was a model employee, a software developer who consistently wrote clean code for his company and never missed deadlines. Then investigators found out it wasn't Bob who was doing his job.

Turns out Bob had outsourced his work to China, paying a lowly overseas surrogate a fraction of his six-figure salary to do his 9-to-5 job. All the while, Bob sat at his desk, pretending to be busy while actually surfing the Internet, updating his Facebook page and watching cat videos.

Different Types of Fragmentation

- Two key organizational decisions of firms:

Different Types of Fragmentation

- Two key organizational decisions of firms:

1. *Location* of different stages in the value chain

Different Types of Fragmentation

- Two key organizational decisions of firms:

1. *Location* of different stages in the value chain
2. Extent of *control* that firms exert over these different production stages

Different Types of Fragmentation

- Two key organizational decisions of firms:

1. *Location* of different stages in the value chain
2. Extent of *control* that firms exert over these different production stages

	Within-Firm	Arm's-Length
Domestic	Domestic Insourcing	Domestic Outsourcing
Foreign	Foreign Insourcing (*intra-firm trade*)	Foreign Outsourcing (*arm's-length trade*)

Measurement

Conceptual Issues

- **Goal:** Quantify the geography of worldwide production

Conceptual Issues

- **Goal:** Quantify the geography of worldwide production
  - allocating value added along the value chain across borders;

Conceptual Issues

- **Goal:** Quantify the geography of worldwide production
  - allocating value added along the value chain across borders;
  - which countries' value added is used as an input in generating a country's value added?

Conceptual Issues

- **Goal:** Quantify the geography of worldwide production
  - allocating value added along the value chain across borders;
  - which countries' value added is used as an input in generating a country's value added?
- **Challenge:** International trade flow data is recorded on a gross output (sales) basis

Conceptual Issues

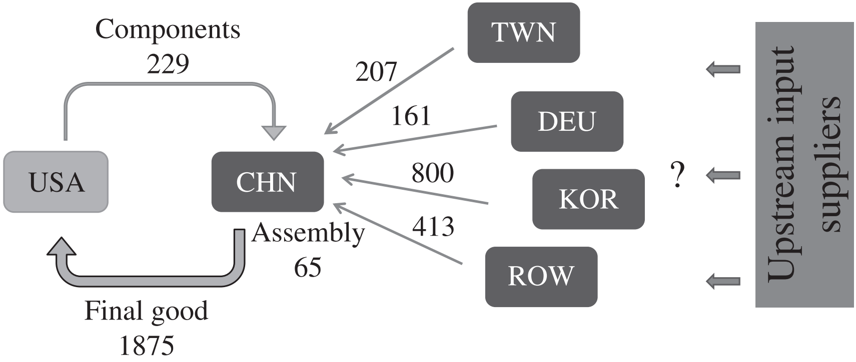
- **Goal:** Quantify the geography of worldwide production
  - allocating value added along the value chain across borders;
  - which countries' value added is used as an input in generating a country's value added?
- **Challenge:** International trade flow data is recorded on a gross output (sales) basis
- **Recent Approach:** Construction of World Input Output Tables (WIOD project)

Conceptual Issues

- **Goal:** Quantify the geography of worldwide production
  - allocating value added along the value chain across borders;
  - which countries' value added is used as an input in generating a country's value added?
- **Challenge:** International trade flow data is recorded on a gross output (sales) basis
- **Recent Approach:** Construction of World Input Output Tables (WIOD project)
  - combines International Trade Statistics + Various Countries' Input-Output Tables + Assumptions

An Illustration

- Approach essentially amounts to a scaled-up version of this iPhone example

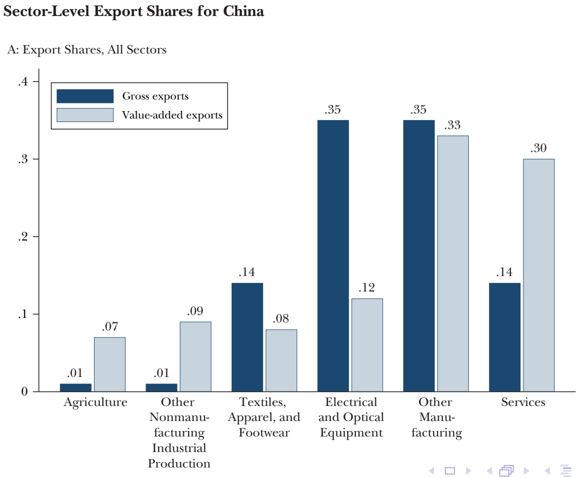


Some Interesting Implications

- China does not appear to dominate certain sectors as much as standard trade statistics would suggest

Some Interesting Implications

- China does not appear to dominate certain sectors as much as standard trade statistics would suggest

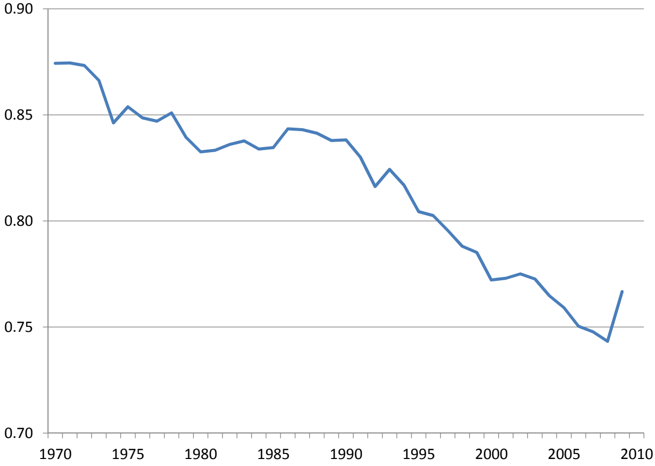


A Smoking Gun

- Declining valued-added share in exports demonstrates rise of GVCs

A Smoking Gun

- Declining valued-added share in exports demonstrates rise of GVCs



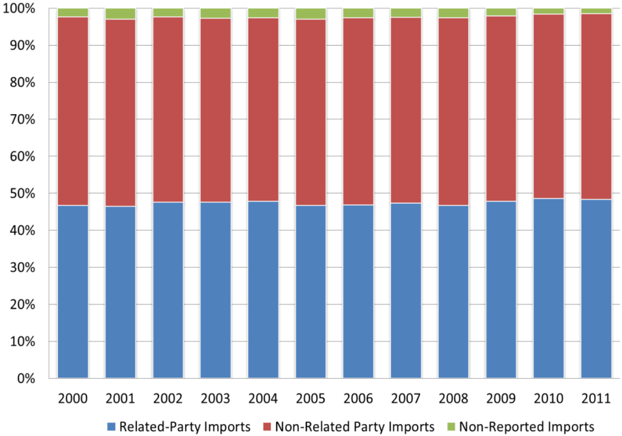
Source: Johnson and Noguera (2012b)

Relevance of Intrafirm Trade Flows

- Intrafirm transactions are remarkably **prevalent** in U.S. trade (close to 50% of imports and around 30% of exports)

Relevance of Intrafirm Trade Flows

- Intrafirm transactions are remarkably **prevalent** in U.S. trade (close to 50% of imports and around 30% of exports)



Source: U.S. Census Related-Party Trade Database

Old and New Theories

- First wave of work: fragmentation in otherwise neoclassical models
    - Feenstra and Hanson (1996), Jones (2000), Deardorff (2001), Grossman and Rossi-Hansberg (2008)

Old and New Theories

- First wave of work: fragmentation in otherwise neoclassical models
  - Feenstra and Hanson (1996), Jones (2000), Deardorff (2001), Grossman and Rossi-Hansberg (2008)
- Common theme: fragmentation generates nontrivial effects on productivity
  - novel predictions for the effects of reductions in trade costs on patterns of specialization and factor prices

Old and New Theories

- First wave of work: fragmentation in otherwise neoclassical models
  - Feenstra and Hanson (1996), Jones (2000), Deardorff (2001), Grossman and Rossi-Hansberg (2008)
- Common theme: fragmentation generates nontrivial effects on productivity
  - novel predictions for the effects of reductions in trade costs on patterns of specialization and factor prices
- Insightful body of work, but misses (at least) two important characteristics of intermediate input trade

Some Limitations of Neoclassical Models of Fragmentation

1. Parts and components are frequently customized to the needs of their intended buyers (e.g, iPad 3)
    - growth of trade in *differentiated* intermediate inputs

Some Limitations of Neoclassical Models of Fragmentation

1. Parts and components are frequently customized to the needs of their intended buyers (e.g, iPad 3)
    - growth of trade in *differentiated* intermediate inputs
2. Global production entails intensive *contracting* between parties subject to distinct legal systems

Some Limitations of Neoclassical Models of Fragmentation

1. Parts and components are frequently customized to the needs of their intended buyers (e.g, iPad 3)
   - growth of trade in *differentiated* intermediate inputs
2. Global production entails intensive *contracting* between parties subject to distinct legal systems
   - irrelevant in a world with perfect (or complete) contracting across borders

Some Limitations of Neoclassical Models of Fragmentation

1. Parts and components are frequently customized to the needs of their intended buyers (e.g, iPad 3)
    - growth of trade in *differentiated* intermediate inputs
2. Global production entails intensive *contracting* between parties subject to distinct legal systems
    - irrelevant in a world with perfect (or complete) contracting across borders
    - but real-world commercial contracts are incomplete (or incompletely enforceable)

Contract Difficulties in International Trade

- Contract disputes in international trade: which country's laws apply?
  - *choice-of-law* clause is not often included and, when it is included, adjudicating courts may not uphold it

Contract Difficulties in International Trade

- Contract disputes in international trade: which country's laws apply?
  - *choice-of-law* clause is not often included and, when it is included, adjudicating courts may not uphold it
- Local courts may be unwilling to enforce a contract signed between residents of two different countries
  - particularly, if unfavorable outcome for local residents

Contract Difficulties in International Trade

- Contract disputes in international trade: which country's laws apply?
    - *choice-of-law* clause is not often included and, when it is included, adjudicating courts may not uphold it
- Local courts may be unwilling to enforce a contract signed between residents of two different countries
    - particularly, if unfavorable outcome for local residents
- Complication with enforcement of remedies stipulated in verdicts
    - what if the party having to pay damages does not have any assets in the court's country?

Contract Difficulties in International Trade

- Contract disputes in international trade: which country's laws apply?
  - *choice-of-law* clause is not often included and, when it is included, adjudicating courts may not uphold it
- Local courts may be unwilling to enforce a contract signed between residents of two different countries
  - particularly, if unfavorable outcome for local residents
- Complication with enforcement of remedies stipulated in verdicts
  - what if the party having to pay damages does not have any assets in the court's country?
- Detrimental effects of imperfect contract enforcement are particularly acute for transactions involving intermediate inputs

Contract Difficulties in International Trade

- Contract disputes in international trade: which country's laws apply?
  - *choice-of-law* clause is not often included and, when it is included, adjudicating courts may not uphold it
- Local courts may be unwilling to enforce a contract signed between residents of two different countries
  - particularly, if unfavorable outcome for local residents
- Complication with enforcement of remedies stipulated in verdicts
  - what if the party having to pay damages does not have any assets in the court's country?
- Detrimental effects of imperfect contract enforcement are particularly acute for transactions involving intermediate inputs
  - longer time lags between order and delivery

Contract Difficulties in International Trade

- Contract disputes in international trade: which country's laws apply?
  - *choice-of-law* clause is not often included and, when it is included, adjudicating courts may not uphold it
- Local courts may be unwilling to enforce a contract signed between residents of two different countries
  - particularly, if unfavorable outcome for local residents
- Complication with enforcement of remedies stipulated in verdicts
  - what if the party having to pay damages does not have any assets in the court's country?
- Detrimental effects of imperfect contract enforcement are particularly acute for transactions involving intermediate inputs
  - longer time lags between order and delivery
  - more relationship-specific investments and other sources of lock-in

Attempts to Reduce Contractual Insecurity

1. United Nations Convention on Contracts for the International Sale of Goods (CISG) or Vienna Convention
   - uniform rules to govern contracts for the international sale of goods

Attempts to Reduce Contractual Insecurity

1. United Nations Convention on Contracts for the International Sale of Goods (CISG) or Vienna Convention
   - uniform rules to govern contracts for the international sale of goods
2. Use of International Arbitration (e.g., Int'l Chamber of Commerce)
   - can be invoked via a *forum-of-law* clause in a contract

Attempts to Reduce Contractual Insecurity

1. United Nations Convention on Contracts for the International Sale of Goods (CISG) or Vienna Convention
   - uniform rules to govern contracts for the international sale of goods
2. Use of International Arbitration (e.g., Int'l Chamber of Commerce)
   - can be invoked via a *forum-of-law* clause in a contract
3. Resort to implicit contracting to sustain 'cooperation'

Attempts to Reduce Contractual Insecurity

1. United Nations Convention on Contracts for the International Sale of Goods (CISG) or Vienna Convention
   - uniform rules to govern contracts for the international sale of goods
2. Use of International Arbitration (e.g., Int'l Chamber of Commerce)
   - can be invoked via a *forum-of-law* clause in a contract
3. Resort to implicit contracting to sustain 'cooperation'

- Rodrik (2000): "ultimately, [international] contracts are often neither explicit nor implicit; they simply remain incomplete"

Firm Responses to Contractual Insecurity

- Two key organizational decisions of firms:

Firm Responses to Contractual Insecurity

- Two key organizational decisions of firms:

1. *Location* of different stages in the value chain

Firm Responses to Contractual Insecurity

- Two key organizational decisions of firms:

1. *Location* of different stages in the value chain
    - R&D and product development, parts and components production, assembly, and so on

Firm Responses to Contractual Insecurity

- Two key organizational decisions of firms:

1. *Location* of different stages in the value chain
    - R&D and product development, parts and components production, assembly, and so on
2. Extent of *control* that firms exert over these different production stages

Firm Responses to Contractual Insecurity

- Two key organizational decisions of firms:

1. *Location* of different stages in the value chain
    - R&D and product development, parts and components production, assembly, and so on
2. Extent of *control* that firms exert over these different production stages
    - should these production stages be kept within firm boundaries or should they be contracted out to suppliers or assemblers

Firm Responses to Contractual Insecurity

- Two key organizational decisions of firms:

1. *Location* of different stages in the value chain
   - R&D and product development, parts and components production, assembly, and so on
2. Extent of *control* that firms exert over these different production stages
   - should these production stages be kept within firm boundaries or should they be contracted out to suppliers or assemblers

- Neoclassical models of fragmentation are all about location
  - complete contracting $\Longrightarrow$ firm boundaries indeterminate and irrelevant

The Firm Boundary Decision under Incomplete Contracts

- Firms contemplating doing business in a country with weak contracting institutions might decide to do so within firm boundaries to have more 'control'

The Firm Boundary Decision under Incomplete Contracts

- Firms contemplating doing business in a country with weak contracting institutions might decide to do so within firm boundaries to have more 'control'
- But lack of contract enforceability might also turn firms to independent suppliers

The Firm Boundary Decision under Incomplete Contracts

- Firms contemplating doing business in a country with weak contracting institutions might decide to do so within firm boundaries to have more 'control'
- But lack of contract enforceability might also turn firms to independent suppliers
- Important theme in my own work (Antràs, 2003, 2005; Antràs and Helpman, 2004, 2008): internalization is a **double-edged sword**

The Firm Boundary Decision under Incomplete Contracts

- Firms contemplating doing business in a country with weak contracting institutions might decide to do so within firm boundaries to have more 'control'
- But lack of contract enforceability might also turn firms to independent suppliers
- Important theme in my own work (Antràs, 2003, 2005; Antràs and Helpman, 2004, 2008): internalization is a **double-edged sword**
  - it may partly protect the integrating party from the vagaries of international contracting...

The Firm Boundary Decision under Incomplete Contracts

- Firms contemplating doing business in a country with weak contracting institutions might decide to do so within firm boundaries to have more 'control'
- But lack of contract enforceability might also turn firms to independent suppliers
- Important theme in my own work (Antràs, 2003, 2005; Antràs and Helpman, 2004, 2008): internalization is a **double-edged sword**
    - it may partly protect the integrating party from the vagaries of international contracting...
    - but it might dilute the integrated party's incentives to produce efficiently
- We see foreign direct investments, but also foreign direct divestments

Studying the Firm Boundary Decision

- Much can be learned from a theoretical and empirical study of the **fundamental** forces that shape this decision (regardless of sector or firm)

Studying the Firm Boundary Decision

- Much can be learned from a theoretical and empirical study of the **fundamental** forces that shape this decision (regardless of sector or firm)
- Some react skeptically to low-dimensional models capturing complex and idiosyncratic firm decisions

Studying the Firm Boundary Decision

- Much can be learned from a theoretical and empirical study of the **fundamental** forces that shape this decision (regardless of sector or firm)
- Some react skeptically to low-dimensional models capturing complex and idiosyncratic firm decisions
- Belief compounded by the fact that:
  - comprehensive datasets on the integration decisions of firms are not available

Studying the Firm Boundary Decision

- Much can be learned from a theoretical and empirical study of the **fundamental** forces that shape this decision (regardless of sector or firm)
- Some react skeptically to low-dimensional models capturing complex and idiosyncratic firm decisions
- Belief compounded by the fact that:
  - comprehensive datasets on the integration decisions of firms are not available
  - business school cases often highlight peculiarities

Studying the Firm Boundary Decision

- Much can be learned from a theoretical and empirical study of the **fundamental** forces that shape this decision (regardless of sector or firm)
- Some react skeptically to low-dimensional models capturing complex and idiosyncratic firm decisions
- Belief compounded by the fact that:
  - comprehensive datasets on the integration decisions of firms are not available
  - business school cases often highlight peculiarities
  - formal empirical studies of firm boundaries rely on data from specific industries or firms

A Comparative Advantage of Trade Statistics

- Data on international transactions are particularly accessible (official records of goods and services crossing borders)
  - e.g., data on U.S. imports for all countries and over 17,000 goods

A Comparative Advantage of Trade Statistics

- Data on international transactions are particularly accessible (official records of goods and services crossing borders)
  - e.g., data on U.S. imports for all countries and over 17,000 goods
- Some of these same detailed country- and product-level data also contain information on the extent to which trade flows involve related parties or non-related parties

A Comparative Advantage of Trade Statistics

- Data on international transactions are particularly accessible (official records of goods and services crossing borders)
  - e.g., data on U.S. imports for all countries and over 17,000 goods
- Some of these same detailed country- and product-level data also contain information on the extent to which trade flows involve related parties or non-related parties
- U.S. Related Party Trade database: U.S. intrafirm imports and exports for all countries at the six-digit Harmonized System (HS) classification (around 5,000 categories)

A Comparative Advantage of Trade Statistics

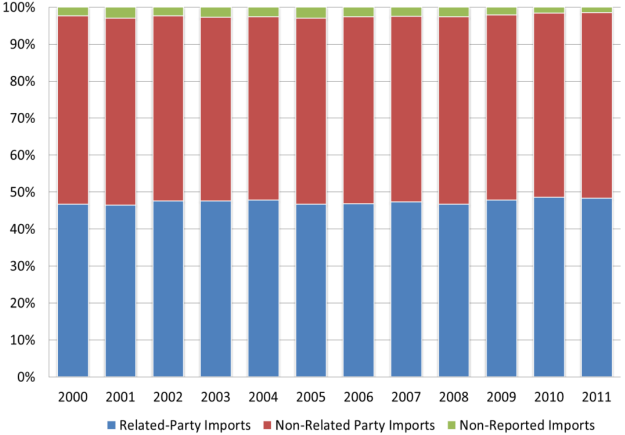
- Data on international transactions are particularly accessible (official records of goods and services crossing borders)
  - e.g., data on U.S. imports for all countries and over 17,000 goods
- Some of these same detailed country- and product-level data also contain information on the extent to which trade flows involve related parties or non-related parties
- U.S. Related Party Trade database: U.S. intrafirm imports and exports for all countries at the six-digit Harmonized System (HS) classification (around 5,000 categories)
  - so hundreds of thousands of observations *per year* on the relative prevalence of integration across products and countries

Some Features of the U.S. Intrafirm Trade Data

1. Intrafirm transactions are remarkably **prevalent** in U.S. trade (close to 50% of imports and around 30% of exports)

Some Features of the U.S. Intrafirm Trade Data

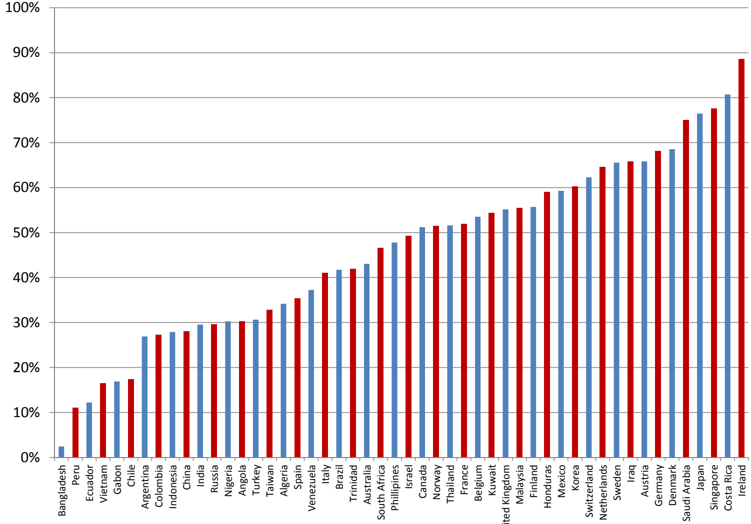
1. Intrafirm transactions are remarkably **prevalent** in U.S. trade (close to 50% of imports and around 30% of exports)



Source: U.S. Census Related-Party Trade Database

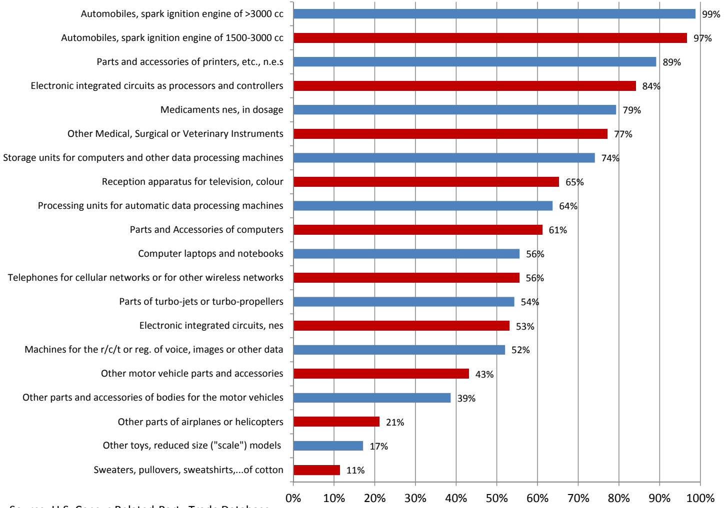
Some Features of the U.S. Intrafirm Trade Data

2. The share of U.S. intrafirm imports varies widely across countries



Some Features of the U.S. Intrafirm Trade Data

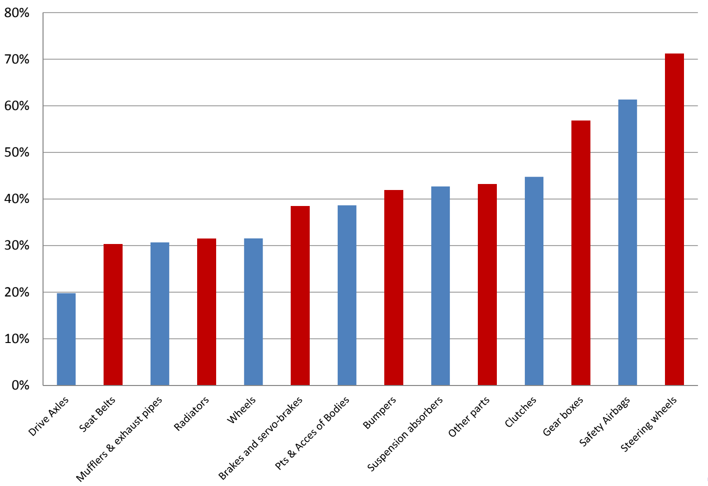
3. The share of U.S. intrafirm imports varies widely *across* sectors



Source: U.S. Census Related-Party Trade Database

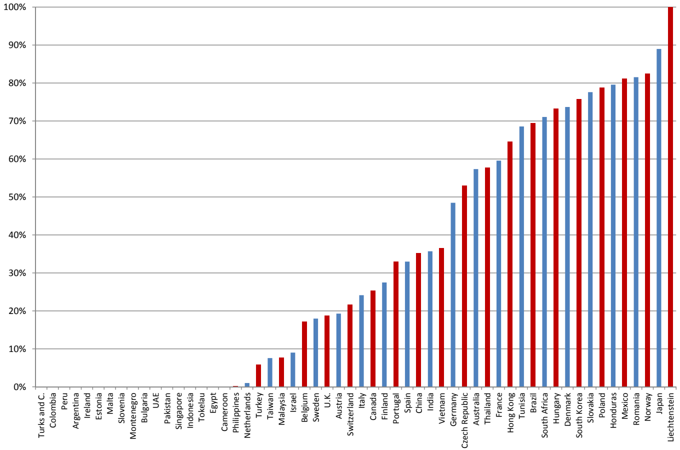
Some Features of the U.S. Intrafirm Trade Data

4. The share of U.S. intrafirm imports varies widely *within* sectors, say Auto Parts (NAICS 8708)



Some Features of the U.S. Intrafirm Trade Data

5. The share of U.S. intrafirm imports varies widely across countries within narrowly defined sectors, say Steering Wheels (NAICS 870894)



Source: U.S. Census Related-Party Trade Database

Is This Variation Random?

- Large variation might seem to validate the skeptics' view that the decision to integrate foreign production processes is largely driven by idiosyncratic factors

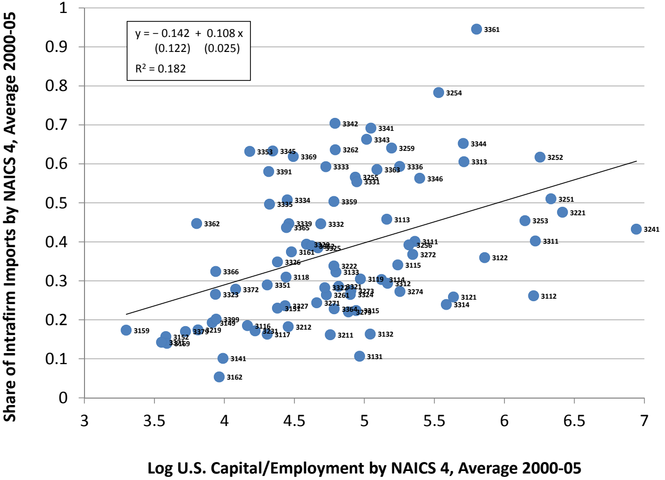
Is This Variation Random?

- Large variation might seem to validate the skeptics' view that the decision to integrate foreign production processes is largely driven by idiosyncratic factors
- But if that were the case, we would also expect this variation to be uncorrelated with simple industry or country-level variables

Is This Variation Random?

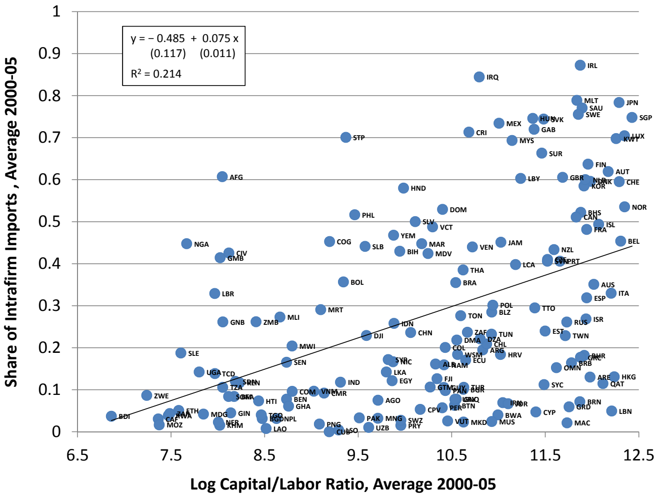
- Large variation might seem to validate the skeptics' view that the decision to integrate foreign production processes is largely driven by idiosyncratic factors
- But if that were the case, we would also expect this variation to be uncorrelated with simple industry or country-level variables
- The evidence, however, suggests otherwise (Antràs, 2003)

Intrafirm Trade and Capital Intensity



Sources: U.S. Census Related-Party Trade Database and NBER-CES Manufacturing Industry Database

Intrafirm Trade and Capital Abundance



Sources: U.S. Census Related-Party Trade Database and Penn World Tables (using perpetual inventory method of Caselli, 2005)

Back to the Location Decision

- Imperfect contracting also influences firms' geographical location decisions

Back to the Location Decision

- Imperfect contracting also influences firms' geographical location decisions
- Effective costs of doing international business are not solely explained by the factors highlighted by neoclassical theory

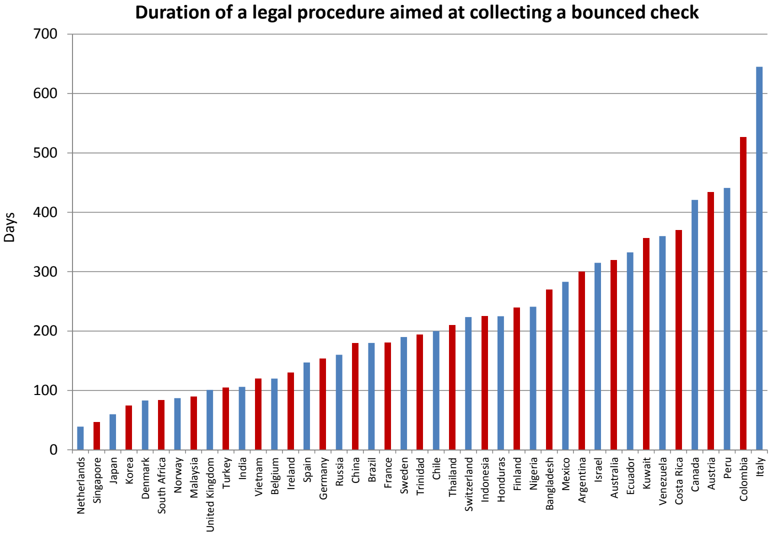
Back to the Location Decision

- Imperfect contracting also influences firms' geographical location decisions
- Effective costs of doing international business are not solely explained by the factors highlighted by neoclassical theory
- Unappealing to offshore in:
  - low-wage countries where suppliers are unreliable and tend not respect contracts, and where local courts are unlikely to effectively enforce contracts

Back to the Location Decision

- Imperfect contracting also influences firms' geographical location decisions
- Effective costs of doing international business are not solely explained by the factors highlighted by neoclassical theory
- Unappealing to offshore in:
  - low-wage countries where suppliers are unreliable and tend not respect contracts, and where local courts are unlikely to effectively enforce contracts
  - countries in which advanced technologies could be productively deployed (due to complementary factors), but in which the contractual environment might not provide enough security to firms
- Active empirical literature: Nunn (2007), Levchenko (2007)

Heterogeneity in Contracting Environments



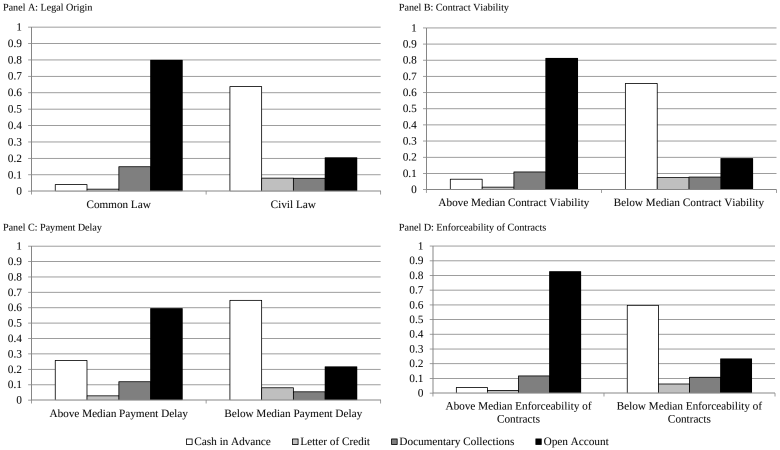
Source: Djankov et al. (2003)

Further Implications of Imperfect Contracting for Trade

- Choice of payment method (cash-in-advance vs. open account)

Further Implications of Imperfect Contracting for Trade

- Choice of payment method (cash-in-advance vs. open account)



Source: Antràs and Foley (2014)

Conclusion: Some Implications for Policy

- Global production with imperfect contracting: positive but also normative implications

Conclusion: Some Implications for Policy

- Global production with imperfect contracting: positive but also normative implications
- Novel normative implications tied to the nature of price determination (bargaining, renegotiation)

Conclusion: Some Implications for Policy

- Global production with imperfect contracting: positive but also normative implications
- Novel normative implications tied to the nature of price determination (bargaining, renegotiation)
- Two Examples:

Conclusion: Some Implications for Policy

- Global production with imperfect contracting: positive but also normative implications
- Novel normative implications tied to the nature of price determination (bargaining, renegotiation)
- Two Examples:

1. Unilateral improvement of contract enforcement not necessarily beneficial (Antràs, 2005)

Conclusion: Some Implications for Policy

- Global production with imperfect contracting: positive but also normative implications
- Novel normative implications tied to the nature of price determination (bargaining, renegotiation)
- Two Examples:

1. Unilateral improvement of contract enforcement not necessarily beneficial (Antràs, 2005)
2. Simple principles of WTO negotiations no longer sufficient to ensure efficiency (Antràs and Staiger, 2012)

Internalizing Global Value Chains: A Firm-Level Analysis

Laura Alfaro
HBS

Pol Antràs
Harvard

Davin Chor
NUS

Paola Conconi
ECARES

ESNIE 2015
May 19, 2015

Preamble

- Production processes of global firms have become increasingly complex:
  - Procurement and assembly of *multiple* inputs from *multiple* countries.

Preamble

- Production processes of global firms have become increasingly complex:
  - Procurement and assembly of *multiple* inputs from *multiple* countries.
- Global production lines feature (at least some element) of sequentiality:
  - Example: Production of integrated circuits in semiconductors industry

    Design $\longrightarrow$ Wafer Fabrication $\longrightarrow$ Assembly $\longrightarrow$ Testing

Preamble

- Production processes of global firms have become increasingly complex:
  - Procurement and assembly of *multiple* inputs from *multiple* countries.
- Global production lines feature (at least some element) of sequentiality:
  - Example: Production of integrated circuits in semiconductors industry

    Design $\longrightarrow$ Wafer Fabrication $\longrightarrow$ Assembly $\longrightarrow$ Testing
  - Sequentiality particularly relevant when production crosses national boundaries.

Preamble

- Production processes of global firms have become increasingly complex:
  - Procurement and assembly of *multiple* inputs from *multiple* countries.
- Global production lines feature (at least some element) of sequentiality:
  - Example: Production of integrated circuits in semiconductors industry

    Design $\longrightarrow$ Wafer Fabrication $\longrightarrow$ Assembly $\longrightarrow$ Testing
  - Sequentiality particularly relevant when production crosses national boundaries.
- Growing interest in how the sequential nature of production affects location and organizational decisions of global firms.

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

Preamble

- Production processes of global firms have become increasingly complex:
  - Procurement and assembly of *multiple* inputs from *multiple* countries.
- Global production lines feature (at least some element) of sequentiality:
  - Example: Production of integrated circuits in semiconductors industry

    Design ⟶ Wafer Fabrication ⟶ Assembly ⟶ Testing
  - Sequentiality particularly relevant when production crosses national boundaries.
- Growing interest in how the sequential nature of production affects location and organizational decisions of global firms.

  (Harms, Lorz and Urban 2012; Baldwin and Venables 2013; Costinot, Vogel and Wang 2013; Antràs and Chor 2013; Kikuchi, Nishimura and Stachurski 2014; Fally and Hillberry 2014)
- **However:** Firm-level tests of the implications of these theories still relatively sparse.

Introduction and Overview: This Project

- A firm-level exploration of integration patterns. . .
- . . . using detailed information on ownership linkages *and* the SIC activities of parents/subsidiaries from around the world, contained in Dun & Bradstreet WorldBase

Introduction and Overview: This Project

- A firm-level exploration of integration patterns...
- ... using detailed information on ownership linkages *and* the SIC activities of parents/subsidiaries from around the world, contained in Dun & Bradstreet WorldBase
- For each industry pair, compute a measure of the upstreamness of input i in the production of j, using U.S. Input-Output Tables.

Introduction and Overview: This Project

- A firm-level exploration of integration patterns. . .
- . . . using detailed information on ownership linkages *and* the SIC activities of parents/subsidiaries from around the world, contained in Dun & Bradstreet WorldBase
- For each industry pair, compute a measure of the upstreamness of input i in the production of j, using U.S. Input-Output Tables.
- Find strong and robust evidence that patterns of integration over SIC activities correlate with upstreamness, as in Antràs and Chor (2013).
  - Key role of *demand elasticity* versus *input substitutability*. . .
  - . . . in shaping whether integration happens over upstream or downstream inputs.

Plan of Talk

1. Introduction and Motivation
2. **Theory**
   - Baseline model
   - The role of contractibility
3. Empirical Setting
   - Data and measures
   - Regression specifications
4. Findings
   - From cross-firm variation
   - From within-firm, cross-input variation
5. Conclusions

The Model

- Firm/"Parent" produces quality-adjusted output via a sequence of stages:

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

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

where $x(i)$ is the services of compatible stage-i inputs.

The Model

- Firm/"Parent" produces quality-adjusted output via a sequence of stages:

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

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

where $x(i)$ is the services of compatible stage-i inputs.

- Analogous to Antràs and Chor (2013), but includes $\psi(i)$.

The Model

- Firm/"Parent" produces quality-adjusted output via a sequence of stages:

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

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

where $x(i)$ is the services of compatible stage-i inputs.

- Analogous to Antràs and Chor (2013), but includes $\psi(i)$.
- Firm lives in a Dixit-Stiglitz industry and faces demand $q = Ap^{-1/(1-\rho)}$.

The Model

- Firm/"Parent" produces quality-adjusted output via a sequence of stages:

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

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

where $x(i)$ is the services of compatible stage-i inputs.

- Analogous to Antràs and Chor (2013), but includes $\psi(i)$.
- Firm lives in a Dixit-Stiglitz industry and faces demand $q = Ap^{-1/(1-\rho)}$.

Two key parameters:

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

Marginal revenue

- Revenue accrued up to stage m:

$$r(m) = A^{1-\rho}\theta^{\rho}\left(\int_0^m (\psi(i)\,x(i))^{\alpha}\,I(i)di\right)^{\frac{\rho}{\alpha}}. \tag{2}$$

Marginal revenue

- Revenue accrued up to stage m:

$$r(m) = A^{1-\rho}\theta^{\rho}\left(\int_0^m (\psi(i)\, x(i))^{\alpha}\, I(i)di\right)^{\frac{\rho}{\alpha}}. \tag{2}$$

- *Incremental marginal revenue* generated at stage m:

$$r'(m) = \frac{\rho}{\alpha}\left(A^{1-\rho}\theta^{\rho}\right)^{\frac{\alpha}{\rho}} r(m)^{\frac{\rho-\alpha}{\rho}} (\psi(m)x(m))^{\alpha}. \tag{3}$$

Marginal revenue

- Revenue accrued up to stage m:

$$r(m) = A^{1-\rho}\theta^{\rho}\left(\int_0^m (\psi(i)\, x(i))^{\alpha}\, I(i) di\right)^{\frac{\rho}{\alpha}}. \qquad (2)$$

- *Incremental marginal revenue* generated at stage m:

$$r'(m) = \frac{\rho}{\alpha}\left(A^{1-\rho}\theta^{\rho}\right)^{\frac{\alpha}{\rho}} r(m)^{\frac{\rho-\alpha}{\rho}} (\psi(m)x(m))^{\alpha}. \qquad (3)$$

- How do upstream input services embodied in $r(m)$ affect $r'(m)$?

  Two cases:

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

Contracting Environment

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

Contracting Environment

- Each i is sourced from a distinct supplier (facing a marginal cost $c(i)$).
- Firm specifies integration or outsourcing for each stage before contracting with suppliers.

Contracting Environment

- Each i is sourced from a distinct supplier (facing a marginal cost $c(i)$).
- Firm specifies integration or outsourcing for each stage before contracting with suppliers.
- Property rights model in the tradition of Grossman-Hart-Moore.

Contracting Environment

- Each i is sourced from a distinct supplier (facing a marginal cost $c(i)$).
- Firm specifies integration or outsourcing for each stage before contracting with suppliers.
- Property rights model in the tradition of Grossman-Hart-Moore.
- Contracts are incomplete. Agents' payoffs are determined in ex-post (generalized) Nash Bargaining.

Contracting Environment

- Each i is sourced from a distinct supplier (facing a marginal cost $c(i)$).
- Firm specifies integration or outsourcing for each stage before contracting with suppliers.
- Property rights model in the tradition of Grossman-Hart-Moore.
- Contracts are incomplete. Agents' payoffs are determined in ex-post (generalized) Nash Bargaining.
- Baseline: Bargain with stage-i supplier over the *incremental marginal revenue* at that stage.

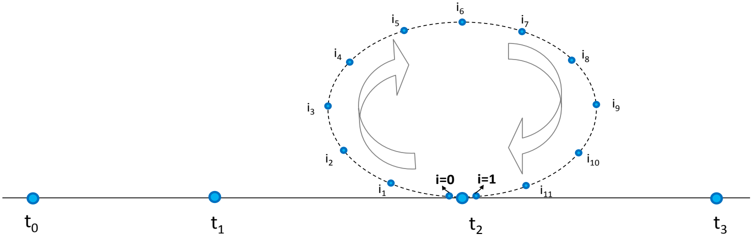
Contracting Environment

- Each i is sourced from a distinct supplier (facing a marginal cost $c(i)$).
- Firm specifies integration or outsourcing for each stage before contracting with suppliers.
- Property rights model in the tradition of Grossman-Hart-Moore.
- Contracts are incomplete. Agents' payoffs are determined in ex-post (generalized) Nash Bargaining.
- Baseline: Bargain with stage-i supplier over the *incremental marginal revenue* at that stage.
- Tradeoff: Outsourcing provides supplier with better incentives to invest in quality, but integration confers the firm a better bargaining position by virtue of her residual rights of control ($\beta_V > \beta_O$).

Contracting Environment

- Each i is sourced from a distinct supplier (facing a marginal cost $c(i)$).
- Firm specifies integration or outsourcing for each stage before contracting with suppliers.
- Property rights model in the tradition of Grossman-Hart-Moore.
- Contracts are incomplete. Agents' payoffs are determined in ex-post (generalized) Nash Bargaining.
- Baseline: Bargain with stage-i supplier over the *incremental marginal revenue* at that stage.
- Tradeoff: Outsourcing provides supplier with better incentives to invest in quality, but integration confers the firm a better bargaining position by virtue of her residual rights of control ($\beta_V > \beta_O$).
- Sequentiality: Organizational decisions made upstream have *spillovers on downstream stages*.

Timing of Events



t_0: Firm posts **contracts** for each stage i ∈[0,1]

Contract states whether i is integrated or not

t_1: Suppliers apply and the firm **selects** one supplier for each i

t_2: **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

t_3: **Final good** assembled and sold to consumers

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.

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.

After some algebra:

$$\begin{array}{ll} \max\limits_{\beta(i)} & \pi_F = \Theta \int_0^1 \beta(i) \left(\frac{(1-\beta(i))\psi(i)}{c(i)} \right)^{\frac{\alpha}{1-\alpha}} \left[\int_0^i \left(\frac{(1-\beta(k))\psi(k)}{c(k)} \right)^{\frac{\alpha}{1-\alpha}} dk \right]^{\frac{\rho-\alpha}{\alpha(1-\rho)}} di \\ \text{s.t.} & \beta(i) \in \{\beta_V, \beta_O\}. \end{array}$$

- If $\psi(i) = c(i) = 1$ for all stages i, we are back to the maximization problem in Antràs and Chor (2013).

Relaxed Problem

- Consider the relaxed problem where the firm chooses $\beta(i)$ flexibly, instead of constraining it to be a discrete choice between β_V and β_O.
- Assume $\beta(i)$ is piecewise continuous and differentiable. Euler-Lagrange condition of this calculus of variations problem yields:

$$\beta^*(i) = 1 - \alpha \left[\frac{\int_0^i \left(\psi\left(k\right)/c\left(k\right)\right)^{\frac{\alpha}{1-\alpha}} dk}{\int_0^1 \left(\psi\left(k\right)/c\left(k\right)\right)^{\frac{\alpha}{1-\alpha}} dk} \right]^{\frac{\alpha-\rho}{\alpha}} . \quad (4)$$

Relaxed Problem

- Consider the relaxed problem where the firm chooses $\beta(i)$ flexibly, instead of constraining it to be a discrete choice between β_V and β_O.
- Assume $\beta(i)$ is piecewise continuous and differentiable. Euler-Lagrange condition of this calculus of variations problem yields:

$$\beta^*(i) = 1 - \alpha \left[\frac{\int_0^i (\psi(k)/c(k))^{\frac{\alpha}{1-\alpha}} dk}{\int_0^1 (\psi(k)/c(k))^{\frac{\alpha}{1-\alpha}} dk} \right]^{\frac{\alpha-\rho}{\alpha}} . \quad (4)$$

- When $\rho > \alpha$: $\beta^*(i)$ is increasing in i.

  When $\rho < \alpha$: $\beta^*(i)$ is decreasing in i.
- $\beta^*(i)$ depends on the *entire profile* of $\psi(k)/c(k)$.

Relaxed Problem

- Consider the relaxed problem where the firm chooses $\beta(i)$ flexibly, instead of constraining it to be a discrete choice between β_V and β_O.
- Assume $\beta(i)$ is piecewise continuous and differentiable. Euler-Lagrange condition of this calculus of variations problem yields:

$$\beta^*(i) = 1 - \alpha \left[\frac{\int_0^i \left(\psi(k)/c(k)\right)^{\frac{\alpha}{1-\alpha}} dk}{\int_0^1 \left(\psi(k)/c(k)\right)^{\frac{\alpha}{1-\alpha}} dk} \right]^{\frac{\alpha-\rho}{\alpha}} . \tag{4}$$

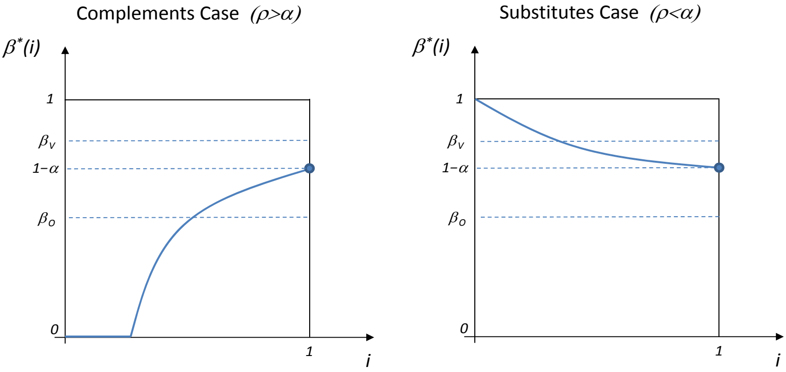
- When $\rho > \alpha$: $\beta^*(i)$ is increasing in i.
  When $\rho < \alpha$: $\beta^*(i)$ is decreasing in i.
- $\beta^*(i)$ depends on the *entire profile* of $\psi(k)/c(k)$.
- When no within-chain heterogeneity in marginal productivity or costs,

$$\beta^*(i) = 1 - \alpha i^{\frac{\alpha-\rho}{\alpha}} . \tag{5}$$

Core Prediction

Main prediction of Antràs and Chor (2013) is preserved:

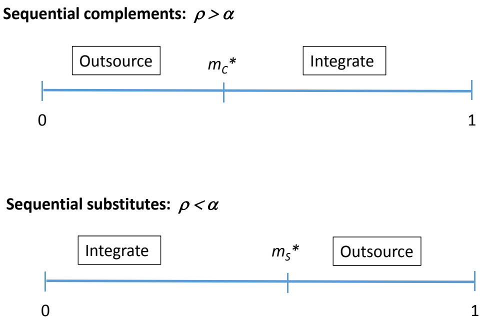
- Complements case ($\rho > \alpha$): Greater propensity to integrate *downstream*.
- Substitutes case ($\rho < \alpha$): Greater propensity to integrate *upstream*.



Integration and Upstreamness

Proposition

There exist thresholds $m_C^* \in (0,1]$ and $m_S^* \in (0,1]$ such that, in the complements case, all production stages $m \in [0, m_C^*)$ are outsourced and all stages $m \in [m_C^*, 1]$ are integrated, while in the substitutes case, all production stages $m \in [0, m_S^*)$ are integrated, while all stages $m \in [m_S^*, 1]$ are outsourced.



Introducing Contractibility

Mapping $\psi(i)$ to the contractibility of inputs:

- Let $x(i)$ refer to the non-contractible investments embodied in input i (chosen by supplier i).
- Let $\psi(i)$ refer to contractible investments that can be specified in the initial contract (chosen by the firm at time t_0).

Introducing Contractibility

Mapping $\psi(i)$ to the contractibility of inputs:

- Let $x(i)$ refer to the non-contractible investments embodied in input i (chosen by supplier i).
- Let $\psi(i)$ refer to contractible investments that can be specified in the initial contract (chosen by the firm at time t_0).
- Suppose that per unit contracting costs for specifying $\psi(i)$ are exogenously given by $\psi(i)^{\phi}/\mu(i)$

  $\phi > 1$: captures the idea that such contracting unit costs are plausibly convex.

Introducing Contractibility

Mapping $\psi(i)$ to the contractibility of inputs:

- Let $x(i)$ refer to the non-contractible investments embodied in input i (chosen by supplier i).
- Let $\psi(i)$ refer to contractible investments that can be specified in the initial contract (chosen by the firm at time t_0).
- Suppose that per unit contracting costs for specifying $\psi(i)$ are exogenously given by $\psi(i)^{\phi}/\mu(i)$

  $\phi > 1$: captures the idea that such contracting unit costs are plausibly convex.
- Then, the level of $\psi(i)$ specified in the initial contract will be inversely related to $1/\mu(i)$, so long as $\phi > \alpha/(1-\alpha)$.

Introducing Contractibility

Mapping $\psi(i)$ to the contractibility of inputs:

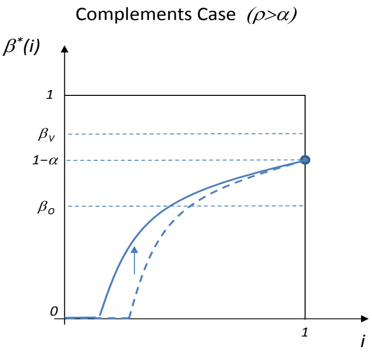
- Let $x(i)$ refer to the non-contractible investments embodied in input i (chosen by supplier i).
- Let $\psi(i)$ refer to contractible investments that can be specified in the initial contract (chosen by the firm at time t_0).
- Suppose that per unit contracting costs for specifying $\psi(i)$ are exogenously given by $\psi(i)^{\phi}/\mu(i)$

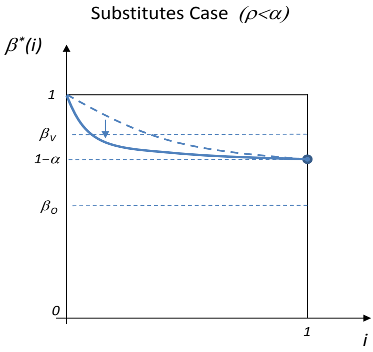
  $\phi > 1$: captures the idea that such contracting unit costs are plausibly convex.
- Then, the level of $\psi(i)$ specified in the initial contract will be inversely related to $1/\mu(i)$, so long as $\phi > \alpha/(1-\alpha)$.
- So we can interpret a high value of $\psi(i)$ as reflecting high contractibility of that stage input.

The Role of Contractibility

In industries that feature a higher level of **upstream** contractibility:

- Complements case: *Greater* propensity to integrate upstream relative to downstream.
- Substitutes case: *Lower* propensity to integrate upstream relative to downstream.

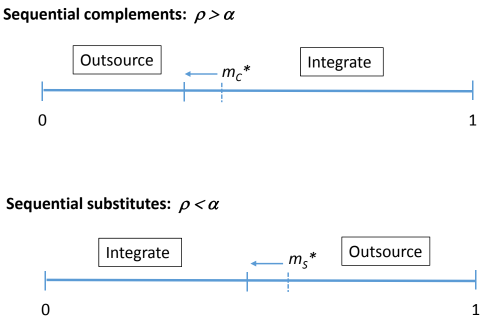




The Role of Contractibility

In industries that feature a higher level of **upstream** contractibility:

- Complements case: *Greater* propensity to integrate upstream relative to downstream.
- Substitutes case: *Lower* propensity to integrate upstream relative to downstream.



Plan of Talk

1. Introduction and Motivation
2. Theory
   - Baseline model
   - The role of contractibility
3. **Empirical Setting**
   - Data and measures
   - Regression Specifications
4. Findings
   - From cross-firm variation
   - From within-firm, cross-input variation
5. Conclusions

Testing the Model: What Would an Ideal Dataset Look Like?

1. "Parent" firm's use of various inputs (regardless of whether they flow directly to the Parent)

Testing the Model: What Would an Ideal Dataset Look Like?

1. "Parent" firm's use of various inputs (regardless of whether they flow directly to the Parent)

2. Whether the suppliers of these inputs are integrated or not ($\beta(i) = \beta_V$ or β_O)

Testing the Model: What Would an Ideal Dataset Look Like?

1. "Parent" firm's use of various inputs (regardless of whether they flow directly to the Parent)

2. Whether the suppliers of these inputs are integrated or not ($\beta(i) = \beta_V$ or β_O)

3. Position or Upstreamness of those inputs in the value chain (index i, relative to the Parent)

Testing the Model: What Would an Ideal Dataset Look Like?

1. "Parent" firm's use of various inputs (regardless of whether they flow directly to the Parent)
2. Whether the suppliers of these inputs are integrated or not ($\beta(i) = \beta_V$ or β_O)
3. Position or Upstreamness of those inputs in the value chain (index i, relative to the Parent)
4. Elasticity of demand faced by the parent (ρ)

Testing the Model: What Would an Ideal Dataset Look Like?

1. "Parent" firm's use of various inputs (regardless of whether they flow directly to the Parent)
2. Whether the suppliers of these inputs are integrated or not ($\beta(i) = \beta_V$ or β_O)
3. Position or Upstreamness of those inputs in the value chain (index i, relative to the Parent)
4. Elasticity of demand faced by the parent (ρ)
5. Elasticity of substitution across inputs (α)

Testing the Model: What Would an Ideal Dataset Look Like?

1. "Parent" firm's use of various inputs (regardless of whether they flow directly to the Parent)
2. Whether the suppliers of these inputs are integrated or not ($\beta(i) = \beta_V$ or β_O)
3. Position or Upstreamness of those inputs in the value chain (index i, relative to the Parent)
4. Elasticity of demand faced by the parent (ρ)
5. Elasticity of substitution across inputs (α)
6. Degree of contractibility of each of the inputs (ψ_i)

Testing the Model: What Would an Ideal Dataset Look Like?

1. "Parent" firm's use of various inputs (regardless of whether they flow directly to the Parent)
2. Whether the suppliers of these inputs are integrated or not ($\beta(i) = \beta_V$ or β_O)
3. Position or Upstreamness of those inputs in the value chain (index i, relative to the Parent)
4. Elasticity of demand faced by the parent (ρ)
5. Elasticity of substitution across inputs (α)
6. Degree of contractibility of each of the inputs (ψ_i)
7. Marginal cost of production for each input (c_i)

Testing the Model: Our Approach

1. “Parent” firm’s use of various inputs: inferred from Input-Output Tables.

Testing the Model: Our Approach

1. "Parent" firm's use of various inputs: inferred from Input-Output Tables.
2. Whether the suppliers of these inputs are integrated or not ($\beta(i) = \beta_V$ or β_O): use Dun & Bradstreet WorldBase dataset.

Testing the Model: Our Approach

1. "Parent" firm's use of various inputs: inferred from Input-Output Tables.
2. Whether the suppliers of these inputs are integrated or not ($\beta(i) = \beta_V$ or β_O): use Dun & Bradstreet WorldBase dataset.
3. Position or Upstreamness of those inputs in the value chain (index i, relative to the Parent): inferred from I-O tables in the same spirit as Antràs et al. (2012).

Testing the Model: Our Approach

1. "Parent" firm's use of various inputs: inferred from Input-Output Tables.
2. Whether the suppliers of these inputs are integrated or not ($\beta(i) = \beta_V$ or β_O): use Dun & Bradstreet WorldBase dataset.
3. Position or Upstreamness of those inputs in the value chain (index i, relative to the Parent): inferred from I-O tables in the same spirit as Antràs et al. (2012).
4. Elasticity of demand faced by the parent (ρ): inferred from Parent SIC industry using Broda and Weinstein (2006).

Testing the Model: Our Approach

1. "Parent" firm's use of various inputs: inferred from Input-Output Tables.
2. Whether the suppliers of these inputs are integrated or not ($\beta(i) = \beta_V$ or β_O): use Dun & Bradstreet WorldBase dataset.
3. Position or Upstreamness of those inputs in the value chain (index i, relative to the Parent): inferred from I-O tables in the same spirit as Antràs et al. (2012).
4. Elasticity of demand faced by the parent (ρ): inferred from Parent SIC industry using Broda and Weinstein (2006).
5. Elasticity of substitution across inputs (α): unobserved.

Testing the Model: Our Approach

1. "Parent" firm's use of various inputs: inferred from Input-Output Tables.
2. Whether the suppliers of these inputs are integrated or not ($\beta(i) = \beta_V$ or β_O): use Dun & Bradstreet WorldBase dataset.
3. Position or Upstreamness of those inputs in the value chain (index i, relative to the Parent): inferred from I-O tables in the same spirit as Antràs et al. (2012).
4. Elasticity of demand faced by the parent (ρ): inferred from Parent SIC industry using Broda and Weinstein (2006).
5. Elasticity of substitution across inputs (α): unobserved.
6. Degree of contractibility of each of the inputs (ψ_i): inferred from I-O tables as in Nunn (2007).

Testing the Model: Our Approach

1. "Parent" firm's use of various inputs: inferred from Input-Output Tables.
2. Whether the suppliers of these inputs are integrated or not ($\beta(i) = \beta_V$ or β_O): use Dun & Bradstreet WorldBase dataset.
3. Position or Upstreamness of those inputs in the value chain (index i, relative to the Parent): inferred from I-O tables in the same spirit as Antràs et al. (2012).
4. Elasticity of demand faced by the parent (ρ): inferred from Parent SIC industry using Broda and Weinstein (2006).
5. Elasticity of substitution across inputs (α): unobserved.
6. Degree of contractibility of each of the inputs (ψ_i): inferred from I-O tables as in Nunn (2007).
7. Marginal cost of production for each input (c_i): unobserved.

Core Dataset: Dun & Bradstreet (D&B) WorldBase

- Comprehensive coverage of establishments in 120 countries (year: 2005)
- Compiled from different sources, including: registers, telephone directory records, websites, self-registration etc.
- Good information of a "business register" nature
  - Each observation has a unique identifier (DUNS number)
  - Name, Location, Global Parent (if any)
  - Up to six 4-digit SIC87 industry activities

Core Dataset: Dun & Bradstreet (D&B) WorldBase

- Comprehensive coverage of establishments in 120 countries (year: 2005)
- Compiled from different sources, including: registers, telephone directory records, websites, self-registration etc.
- Good information of a "business register" nature
  - Each observation has a unique identifier (DUNS number)
  - Name, Location, Global Parent (if any)
  - Up to six 4-digit SIC87 industry activities
- Extract 116,843 firms from 89 countries identified in D&B as "global ultimates" whose primary SIC activity is in manufacturing (*parents*)
- D&B enables us to link each of these to their subsidiaries, including information on country and SIC activities (90,159 *subsidiaries*)

Core Dataset: Dun & Bradstreet (D&B) WorldBase

- Comprehensive coverage of establishments in 120 countries (year: 2005)
- Compiled from different sources, including: registers, telephone directory records, websites, self-registration etc.
- Good information of a "business register" nature
  - Each observation has a unique identifier (DUNS number)
  - Name, Location, Global Parent (if any)
  - Up to six 4-digit SIC87 industry activities
- Extract 116,843 firms from 89 countries identified in D&B as "global ultimates" whose primary SIC activity is in manufacturing (*parents*)
- D&B enables us to link each of these to their subsidiaries, including information on country and SIC activities (90,159 *subsidiaries*)
- Average parent has 1.77 establishments; active in 1.14 countries and in 2.35 SIC activities. Details
- 6,983 of these parents are multinationals, i.e., ≥ 1 one foreign subsidiary

Merging D&B with Input-Output Data

- Some notation. Use:
  - p to index parent
  - j to index parent *output* industry (primary SIC)
  - i to index SIC *input* industry
  - For each j, deduce the set of inputs $S(j)$ that are used in the production of j from Input-Output Tables

    Specifically: $S(j)$ is the set of inputs i for which the total requirements coefficient, tr_{ij}, of the use of i in the production of j is positive.

Merging D&B with Input-Output Data

- Some notation. Use:
  - p to index parent
  - j to index parent *output* industry (primary SIC)
  - i to index SIC *input* industry
  - For each j, deduce the set of inputs $S(j)$ that are used in the production of j from Input-Output Tables

    Specifically: $S(j)$ is the set of inputs i for which the total requirements coefficient, tr_{ij}, of the use of i in the production of j is positive.

- **Key idea:** View secondary SICs of parent p and all SICs of its subsidiaries as inputs that the parent could in principle obtain within firm boundaries.
  - Call the set of these integrated SICs: $I(p)$.
  - Call the set of non-integrated SICs: $NI(p)$.
  - Note: $I(p) \bigcup NI(p) = S(j)$ for a parent p whose output industry is j.
  - 98.3% of the observed (i, j) pairs in the D&B data have $tr_{ij} > 0$. More

Measuring Upstreamness

Turn to Input-Output Tables for measures of the production line position of each input i vis-à-vis output j.

- Fally (2012) and Antràs et al. (2012):
  - Develop a measure of the upstreamness between i and final use.
  - Can be obtained via different foundations.
- In this work:
  - Build an analogous measure of the upstreamness between input i and output j.
  - Similar in spirit to the concept of "average propagation lengths" in the Input-Output literature (Dietzenbacher et al. 2005)

Measuring Upstreamness (Cont.)

In an N-industry economy, accounting for the value of input i that goes into the production of $1 of output j:

- d_{ij}: Value used directly (1 stage), aka direct requirements coefficient.
- $\sum_{k=1}^{N} d_{ik} d_{kj}$: 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...

Measuring Upstreamness (Cont.)

In an N-industry economy, accounting for the value of input i that goes into the production of \$1 of output j:

- d_{ij}: Value used directly (1 stage), aka direct requirements coefficient.
- $\sum_{k=1}^{N} d_{ik} d_{kj}$: 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...

Motivates the following measure of input i's upstreamness in the production of j:

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

- A weighted-average measure of the number of production stages to get from i to j, with weights proportional to the value of input use that takes the said number of stages.
- Note: Denominator is tr_{ij}.

Measuring Upstreamness (Cont.)

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

Straightforward to show that:

- $upst_{ij} \geq 1$;
- Numerator of $upst_{ij}$ is the (i,j)-th entry of $[I - D]^{-2}D$; and
- Denominator of $upst_{ij}$ is the (i,j)-th entry of $[I - D]^{-1}D$;

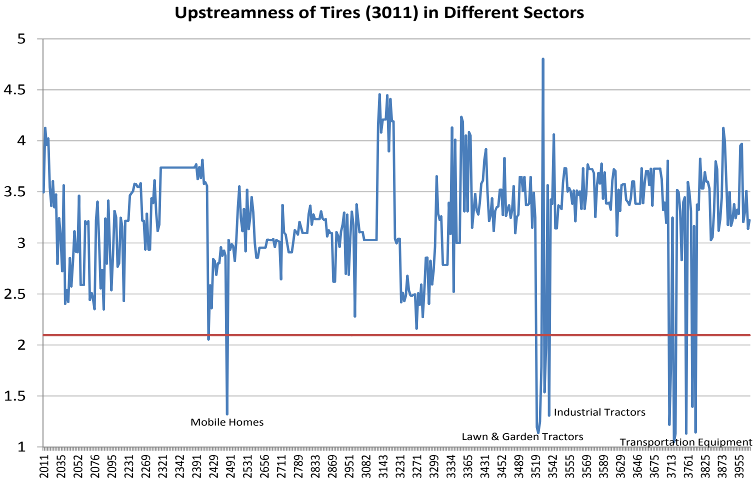
where D is the matrix of d_{ij}'s, and I is the identity matrix.

Use the above properties to compute both $upst_{ij}$ and tr_{ij} from the 1992 U.S. Benchmark Input-Output Tables.

Practical Implementation Issues
Summary Statistics

Measuring Upstreamness (Cont.)

Comparing $upst_{ij}$ (this paper) against the upstreamness of i wrt final demand (from Antràs et al. 2012)



Cross-Firm Analysis: Specification

$$\log R_{jpc} = \beta_0 + \beta_1 \mathbf{1}(\rho_j > \rho_{med}) + \beta_X X_j + \beta_W W_p + D_c + \epsilon_{jpc}$$

R_{jpc} is a measure of p's propensity to integrate upstream vs downstream inputs:

$$R_{jp} \equiv \frac{\sum_{i \in I(p)} \ \theta^{I}_{ijp} upst_{ij}}{\sum_{i \in NI(p)} \ \theta^{NI}_{ijp} upst_{ij}}$$

where $\theta^{I}_{ijp} = tr_{ij} / \sum_{i \in I(p)} tr_{ij}$ and $\theta^{NI}_{ijp} = tr_{ij} / \sum_{i \in NI(p)} tr_{ij}$.

Cross-Firm Analysis: Specification

$$\log R_{jpc} = \beta_0 + \beta_1 \mathbf{1}(\rho_j > \rho_{med}) + \beta_X X_j + \beta_W W_p + D_c + \epsilon_{jpc}$$

R_{jpc} is a measure of p's propensity to integrate upstream vs downstream inputs:

$$R_{jp} \equiv \frac{\sum_{i \in I(p)} \theta^{I}_{ijp} upst_{ij}}{\sum_{i \in NI(p)} \theta^{NI}_{ijp} upst_{ij}}$$

where $\theta^{I}_{ijp} = tr_{ij} / \sum_{i \in I(p)} tr_{ij}$ and $\theta^{NI}_{ijp} = tr_{ij} / \sum_{i \in NI(p)} tr_{ij}$.

- "Ratio-upstreamness": Weighted-average upstreamness of integrated to non-integrated stages (for each p).
- Weights reflect the importance of each input (tr coefficients).
- R_{jp} increases in the propensity to integrate more upstream inputs.
- Consider several variants of R_{jp} (manuf. inputs only, drop parent SIC,...)

Cross-Firm Analysis: Other Variables

$$\log R_{jpc} = \beta_0 + \beta_1 \mathbf{1}(\rho_j > \rho_{med}) + \beta_X X_j + \beta_W W_p + D_c + \epsilon_{jpc}$$

- Focus on differences in demand elasticities to distinguish between complements and substitutes cases, following Antràs and Chor (2013)
  - Baseline: import demand elasticities from Broda and Weinstein (2006)
  - Also pursue refinements that restrict construction of demand elasticities to consumption and/or capital goods (UN BEC classification)
- Start with a median cutoff: $\beta_1 \mathbf{1}(\rho_j > \rho_{med})$. Theory suggests: $\beta_1 < 0$.
- Later use a set of quintile dummies: $\sum_{n=2}^{5} \beta_n \mathbf{1}(\rho_j \in Quint_n(\rho))$

Cross-Firm Analysis: Other Variables

$$\log R_{jpc} = \beta_0 + \beta_1 \mathbf{1}(\rho_j > \rho_{med}) + \beta_X X_j + \beta_W W_p + D_c + \epsilon_{jpc}$$

- X_j: Vector of industry controls ▸ Details
  - Log Nonproduction emp., Equipment capital, Plant capital, Materials (all in per worker terms) from NBER-CES
  - Log (0.001 + R&D expenditures/Sales) from Nunn and Trefler (2013)
- W_p: Vector of firm controls
  - Log number of subsidiaries, Indicator for MNC status, Year started
  - Log total employment, Log sales in USD
- D_c: Parent country fixed effects
- Cluster standard errors by output industry j
- Later introduce interactions with "Upstream Contractibility"

Within-Firm Analysis

$$D\_INT_{ijp} = \gamma_0 + \sum_{n=1}^{5} \gamma_n \mathbf{1}(\rho_j \in Quint_n(\rho)) \times upst_{ij} + \gamma_S \mathbf{1}(i = j) + D_p + D_i + \epsilon_{ijp}$$

- Expand the dataset to the parent firm by SIC input level
- Focus on parent firms that have integrated at least one manufacturing SIC input $i \neq j$
- For each p, include the top 100 manufacturing inputs i by tr value
  - This covers between 88-98% of the tr value of the output industry
- LHS: Indicator variable, D_INT_{ijp}, for whether parent firm p with output industry j has input i within firm boundaries
- Estimate as a linear probability model

Within-Firm Analysis

$$D\_INT_{ijp} = \gamma_0 + \sum_{n=1}^{5} \gamma_n \mathbf{1}(\rho_j \in Quint_n(\rho)) \times upst_{ij} + \gamma_S \mathbf{1}(i=j) + D_p + D_i + \epsilon_{ijp}$$

- Other controls:
  - $\mathbf{1}(i=j)$: Self-SIC dummy
  - D_p: Parent firm fixed effects
  - D_i: SIC input fixed effects
- Cluster standard errors by *i*-*j* pair
- Later introduce interactions with "Contractibility up to *i* in production of *j*"

Plan of Talk

1. Introduction and Motivation
2. Theory
   - Baseline model
   - The role of contractibility
3. Empirical setting
   - Data and measures
   - Regression specifications
4. **Findings**
   - From cross-firm variation
   - From within-firm, cross-input variation
5. Conclusions

Median Cutoff: Negative Coefficient on $\mathbf{1}(\rho_j > \rho_{med})$

Table 3

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

Dependent variable:	Log Ratio-Upstreamnes				
	(1)	(2)	(3)	(4)	(5)
Ind.(Elas > Median)	-0.0417**	-0.0681***	-0.0677***	-0.0667***	-0.1096***
	[0.0207]	[0.0186]	[0.0181]	[0.0214]	[0.0248]
Log (Skilled Emp./Worker)		0.0004	0.0034	0.0000	-0.0310
		[0.0231]	[0.0224]	[0.0259]	[0.0322]
Log (Equip. Capital / Worker)		0.1094***	0.1067***	0.0798***	0.0846***
		[0.0219]	[0.0211]	[0.0226]	[0.0265]
Log (Plant Capital / Worker)		-0.0217	-0.0237	0.0026	-0.0038
		[0.0227]	[0.0223]	[0.0281]	[0.0328]
Log (Materials / Worker)		-0.0527**	-0.0487**	-0.0651**	-0.0471
		[0.0247]	[0.0228]	[0.0257]	[0.0325]
R&D intensity		0.0082	0.0059	0.0113	0.0067
		[0.0055]	[0.0053]	[0.0068]	[0.0076]
Value-added / Shipments		-0.1580	-0.1427	-0.1299	0.0673
		[0.1148]	[0.1108]	[0.1178]	[0.1527]
Elasticity based on:	All codes	All codes	All codes	BEC cons. & cap. goods	BEC cons. only
Parent country dummies?	Y	Y	Y	Y	Y
Firm controls?	Y	Y	Y	Y	Y
Observations	115,800	115,800	84,171	62,377	44,895
No. of industries	459	459	459	305	219
R^2	0.0671	0.1674	0.1896	0.2053	0.2393

Quintile Cutoff: Stronger Effect in Higher Quintiles of ρ_j

Table 4

Upstreamness of Integrated vs Non-Integrated Inputs: By Elasticity Quintiles

Dependent variable:	**Log Ratio-Upstreamness**				
	(1)	(2)	(3)	(4)	(5)
Ind.(Quintile 2 Elas)	-0.0205	-0.0304	-0.0313	-0.0629	-0.0805*
	[0.0307]	[0.0277]	[0.0282]	[0.0426]	[0.0453]
Ind.(Quintile 3 Elas)	-0.0677**	-0.0784***	-0.0797***	-0.0713*	-0.1026**
	[0.0308]	[0.0293]	[0.0295]	[0.0424]	[0.0415]
Ind.(Quintile 4 Elas)	-0.0334	-0.0832***	-0.0845***	-0.1035**	-0.1506***
	[0.0336]	[0.0312]	[0.0311]	[0.0432]	[0.0449]
Ind.(Quintile 5 Elas)	-0.0715*	-0.1021***	-0.1043***	-0.1287***	-0.1890***
	[0.0375]	[0.0315]	[0.0312]	[0.0418]	[0.0448]
Log (Skilled Emp./Worker)		0.0001	0.0022	-0.0042	-0.0370
		[0.0225]	[0.0219]	[0.0274]	[0.0335]
Log (Equip. Capital / Worker)		0.1084***	0.1058***	0.0750***	0.0800***
		[0.0207]	[0.0198]	[0.0199]	[0.0214]
Log (Plant Capital / Worker)		-0.0154	-0.0167	0.0134	0.0053
		[0.0211]	[0.0206]	[0.0235]	[0.0287]
Log (Materials / Worker)		-0.0561**	-0.0520**	-0.0707***	-0.0541*
		[0.0243]	[0.0223]	[0.0257]	[0.0314]
R&D intensity		0.0078	0.0058	0.0112*	0.0039
		[0.0053]	[0.0052]	[0.0063]	[0.0079]
Value-added / Shipments		-0.1732	-0.1572	-0.1454	0.0707
		[0.1159]	[0.1113]	[0.1188]	[0.1617]
Elasticity based on:	All codes	All codes	All codes	BEC cons. & cap. goods	BEC cons. only
Parent country dummies?	Y	Y	Y	Y	Y
Firm controls?	Y	Y	Y	Y	Y
Observations	115,800	115,800	84,171	62,377	44,895
No. of industries	459	459	459	305	219
R^2	0.0777	0.1773	0.2005	0.2300	0.2707

Baseline with Quintile Cutoff (cont.)

Remarks:

- Magnitude of effects larger as we refine the ρ proxy to include information only on final good demand elasticities (UN BEC)
- Coefficient of $\mathbf{1}(\rho_j \in Quint_5(\rho))$: Corresponds to a decrease in the propensity to integrate upstream vs downstream stages of about one standard deviation (Column 5), when moving from Q1 to Q5
- Robust to controlling further for:
  - VI index used in Acemoglu et al. (2009), Alfaro et al. (2013)
  - Share of tr_{ij} that can be obtained from integrated foreign suppliers
  - Country dummy variables for establishment presence
  - Double marginalization motive: Weighted-average demand elasticity of inputs used

Effect of Upstream Contractibility: Empirical Specification

$$\log R_{jpc} = \beta_0 + \beta_k \sum_{k=2}^{5} \mathbf{1}(\rho_j \in Quint_k(\rho)) + \gamma_k \sum_{k=1}^{5} \mathbf{1}(\rho_j \in Quint_k(\rho)) \times \log UpstCont_j$$
$$+\beta_X X_j + \beta_W W_p + D_c + \epsilon_{jpc}$$

- Constructing $UpstCont_j$:
  - Contractibility follows Nunn (2007): Extent to which production involves the use of HS products classified as homogenous (Rauch 1999).
  - Look at all manufacturing inputs i:

    Let the set of inputs with above-median contractibility values be $\mathcal{H}$, and the set with below-median contractibility values be $\mathcal{L}$.

Effect of Upstream Contractibility: Empirical Specification

$$\log R_{jpc} = \beta_0 + \beta_k \sum_{k=2}^{5} \mathbf{1}(\rho_j \in Quint_k(\rho)) + \gamma_k \sum_{k=1}^{5} \mathbf{1}(\rho_j \in Quint_k(\rho)) \times \log UpstCont_j$$
$$+\beta_X X_j + \beta_W W_p + D_c + \epsilon_{jpc}$$

- Constructing $UpstCont_j$:
  - Contractibility follows Nunn (2007): Extent to which production involves the use of HS products classified as homogenous (Rauch 1999).
  - Look at all manufacturing inputs i:

    Let the set of inputs with above-median contractibility values be $\mathcal{H}$, and the set with below-median contractibility values be $\mathcal{L}$.
  - Take the (weighted-)average upstreamness of high- to low-contractibility inputs:

    $$UpstCont_j \equiv \frac{\sum_{i\in\mathcal{H}} \theta_{ij}^H upst_{ij}}{\sum_{i\in\mathcal{L}} \theta_{ij}^L upst_{ij}}$$

    where $\theta_{ij}^H = tr_{ij} / \sum_{i\in\mathcal{H}} tr_{ij}$ and $\theta_{ij}^L = tr_{ij} / \sum_{i\in\mathcal{L}} tr_{ij}$.

Effect of Upstream Contractibility

Dependent variable:	Log Ratio-Upstreamness		
	(1)	(2)	(3)
Ind.(Quintile 2 Elas)	-0.0290	-0.0441*	-0.0405
	[0.0186]	[0.0238]	[0.0286]
Ind.(Quintile 3 Elas)	-0.0639***	-0.0538**	-0.0617**
	[0.0205]	[0.0246]	[0.0251]
Ind.(Quintile 4 Elas)	-0.0617***	-0.0753***	-0.0914***
	[0.0223]	[0.0247]	[0.0278]
Ind.(Quintile 5 Elas)	-0.0835***	-0.1041***	-0.0876***
	[0.0207]	[0.0233]	[0.0292]
"Upstream Contractibility"			
X Ind.(Quintile 1 Elas)	-0.1685**	-0.2170***	-0.2270***
	[0.0684]	[0.0635]	[0.0640]
X Ind.(Quintile 2 Elas)	-0.0966**	-0.0673	-0.0834
	[0.0436]	[0.0721]	[0.0802]
X Ind.(Quintile 3 Elas)	0.0533	0.0616*	0.1049***
	[0.0443]	[0.0362]	[0.0382]
X Ind.(Quintile 4 Elas)	0.0476	0.1650***	0.1105***
	[0.0443]	[0.0398]	[0.0373]
X Ind.(Quintile 5 Elas)	0.1204***	0.1962***	0.2434***
	[0.0390]	[0.0352]	[0.0329]
p-value: Q5 at median Upst. Cont.	[0.0000]	[0.0001]	[0.0001]
Elasticity based on:	All codes	BEC cons. & cap. goods	BEC cons. only
Industry controls?	Y	Y	Y
Firm controls?	Y	Y	Y
Parent country fixed effects?	Y	Y	Y
Observations	84,171	62,377	44,895
No. of industries	459	305	219
R^2	0.2399	0.3174	0.3470

- Main effect of elasticity quintiles preserved
- Upstream contractibility:
  Raises propensity to integrate upstream in the complements case. . .

  but lowers it in the substitutes case!
- Similar results when using: (i) tercile cutoff to define $\mathcal{H}$ and $\mathcal{L}$; (ii) a tr-weighted covariance between $upst_{ij}$ and contractibility
  Details
- We perform several robustness tests (focus on large firms, MNCs, exclude own SIC,...)
  Details

Within-Firm Analysis: Empirical Specification

Remember baseline specification:

$$D\_INT_{ijp} \quad = \quad \gamma_0 + \sum_{n=1}^{5} \gamma_n \mathbf{1}(\rho_j \in Quint_n(\rho)) \times upst_{ij} + \gamma_S \mathbf{1}(i = j) + D_i + D_p + \epsilon_{ijp}$$

- $\mathbf{1}(i = j)$: Self-SIC dummy
- D_p: Parent firm fixed effects
- D_i: SIC input fixed effects

.

Within-Firm Analysis: Empirical Specification

Specification with Contractibility up to i:

$$\begin{aligned} D\_INT_{ijp} &= \gamma_0 + \sum_{n=1}^{5} \gamma_n \mathbf{1}(\rho_j \in Quint_n(\rho)) \times upst_{ij} \\ &\quad + \sum_{n=1}^{5} \gamma_n \mathbf{1}(\rho_j \in Quint_n(\rho)) \times ContUpToi_{ij} + \gamma_S \mathbf{1}(i=j) + D_i + D_p + \epsilon_{ijp} \end{aligned}$$

- Recall: $\beta^*(i) = 1 - \alpha \left(\frac{\int_0^i (\psi(k)/c(k))^{\frac{\alpha}{1-\alpha}} dk}{\int_0^1 (\psi(k)/c(k))^{\frac{\alpha}{1-\alpha}} dk} \right)^{\frac{\alpha-\rho}{\alpha}}$
- "Contractibility up to i in prod. of j"

$$ContUpToi_{ij} = \frac{\sum_{k \in S_i^m(j)} tr_{kj} cont_k}{\sum_{k \in S^m(j)} tr_{kj} cont_k}$$

where $S_i^m(j) = \{k : upst_{kj} \geq upst_{ij}\}$ is the set of manufacturing inputs used by j upstream of and including i.

($S^m(j)$ is the set of manufacturing inputs used by j, i.e., $tr_{ij} > 0$.)

Within-Firm Regression Results

Dependent variable:	Indicator variable: Input Integrated?			
	(1)	(2)	(3)	(4)
Upstreamness_ij				
X Ind.(Quintile 1 Elas_j)	-0.0068***	0.0016	0.0021	-0.0037*
	[0.0009]	[0.0017]	[0.0017]	[0.0019]
X Ind.(Quintile 2 Elas_j)	-0.0093***	-0.0000	0.0002	-0.0045
	[0.0020]	[0.0036]	[0.0036]	[0.0037]
X Ind.(Quintile 3 Elas_j)	-0.0123***	-0.0022	-0.0016	-0.0040
	[0.0018]	[0.0042]	[0.0042]	[0.0038]
X Ind.(Quintile 4 Elas_j)	-0.0107***	0.0080***	0.0076***	0.0015
	[0.0016]	[0.0021]	[0.0020]	[0.0017]
X Ind.(Quintile 5 Elas_j)	-0.0127***	0.0061*	0.0059*	0.0027
	[0.0022]	[0.0033]	[0.0032]	[0.0025]
"Contractibility up to i" (in prod. of j)				
X Ind.(Quintile 1 Elas_j)		0.0323***	0.0356***	0.0278***
X Ind.(Quintile 2 Elas_j)		0.0375***	0.0378***	0.0295***
X Ind.(Quintile 3 Elas_j)		0.0378***	0.0360***	0.0324***
X Ind.(Quintile 4 Elas_j)		0.0699***	0.0668***	0.0446***
X Ind.(Quintile 5 Elas_j)		0.0761***	0.0750***	0.0521***
Contractibility of input i				
X Ind.(Quintile 1 Elas_j)			-0.0190***	-0.0079
X Ind.(Quintile 2 Elas_j)			-0.0106***	0.0019
X Ind.(Quintile 3 Elas_j)			-0.0193***	-0.0040
X Ind.(Quintile 4 Elas_j)			-0.0123***	0.0039
X Ind.(Quintile 5 Elas_j)			-0.0098*	0.0068
Dummy: Self-SIC	0.9760***	0.9651***	0.9636***	0.9275***
	[0.0018]	[0.0029]	[0.0030]	[0.0074]
p-value: Quintile 5 - Quintile 1 effect of "Contractibility up to i"	---	[0.0087]	[0.0157]	[0.0671]
Observations	1,452,817	1,452,817	1,452,817	1,452,817
No. of parent firms	14,503	14,503	14,503	14,503
No. of i-j pairs	21,635	21,635	21,635	21,635
R^2	0.4990	0.5008	0.5015	0.5253

- Baseline: Propensity to integrate upstream falls as the elasticity increases
- *ContUpToi* matters:

(i) Raises propensity to integrate in the complements case

(ii) Also does in the substitutes case, but more weakly so

(p-value: reject equality of the Q1 and Q5 interaction coefficients)

Within-Firm Regressions (Cont.)

Similar results with more flexible quintile-by-quintile estimation.

- "Contractibility up to *i*" matters for integration decisions (particularly in Q5), even when controlling for $upst_{ij}$ at the same time.

Dependent variable:	**Indicator variable: Input Integrated?**				
BEC cons. Elas_j:	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
	(1)	(2)	(3)	(4)	(5)
Contractibility up to i (in prod. of j)	0.0338***	0.0264***	0.0321***	0.0312***	0.0532***
	[0.0063]	[0.0077]	[0.0094]	[0.0098]	[0.0150]
Upstreamness_ij	0.0001	-0.0072*	-0.0030	0.0008	0.0001
	[0.0018]	[0.0043]	[0.0044]	[0.0021]	[0.0031]
Dummy: Self-SIC	0.9217***	0.9247***	0.9401***	0.8226***	0.8767***
	[0.0128]	[0.0266]	[0.0135]	[0.0448]	[0.0378]
Firm fixed effects?	Y	Y	Y	Y	Y
Input industry (i) fixed effects?	Y	Y	Y	Y	Y
Observations	332,351	408,227	271,730	222,704	217,805
No. of parent firms	3317	4074	2710	2227	2175
No. of input-output (ij) industry pairs	4206	4411	4304	4401	4313
R^2	0.5158	0.5565	0.4957	0.5636	0.5661

Conclusion

- Production line position matters for firm organizational decisions.
- Available data on the production activities of firms operating in many countries and industries can be combined with information from I-O tables to study the organization of firms along global value chains.
- Evidence from WorldBase confirms that firms are less inclined to integrate upstream production stages as their revenue elasticity increases.
- Above patterns are moderated in industries that exhibit greater "upstream contractibility".
    - Importantly: Entire profile of upstream inputs matters, not just the contractibility of the input itself.
    - Greater upstream contractibility implies less need to rely on organizational mode to elicit desired effort levels from upstream suppliers to mediate downstream spillovers.

Back-Up Slides

Summary Statistics (Firm-level)

Return

Table 1
Summary Statistics: Global Parent Firms

	10th	Median	90th	Mean	Std Dev
A: Global parent firm variables					
All global parents:					
Number of Establishments (incl. self)	1	1	2	1.77	5.81
Number of countries (incl. self)	1	1	1	1.14	1.03
Number of integrated SIC codes	1	2	4	2.35	3.41
Year started	1948	1985	2000	1977	26.17
Log (Total employment), 107656 obs	1.099	3.219	5.704	3.322	1.856
Log (Sales in USD), 87675 obs	12.795	15.305	17.844	15.325	2.055
MNCs only, 6983 obs:					
Number of Establishments (incl. self)	2	3	15	8.05	22.32
Number of countries (incl. self)	2	2	6	3.36	3.51
Number of integrated SIC codes	2	4	16	7.73	11.45

Relevance

First-pass evidence that the information in D&B is relevant in terms of input-output linkages:

- 98.3% of the observed (i, j) pairs in the D&B data have $tr_{ij} > 0$.
- 82.8% of these pairs exceed the median positive tr_{ij} value.
- Similar summary statistics if:
  - restrict to distinct (i, j) pairs within each parent firm.
  - restrict to manufacturing inputs.
  - drop pairs where $i = j$.

Return

Measuring Upstreamness: Practical Implementation Issues ▸ Return

- Applying the open-economy and net-inventories correction to D; see Antràs et al. 2012.)
- Original industry categories: IO1992
- Compute $upst_{ij}$ and tr_{ij} first for IO1992 codes, and then map to SIC.
- For manufacturing: Each SIC is mapped into by a unique IO1992
- For non-manufacturing: Can have multiple IO1992's mapping to an SIC.
- We focus on global parents whose primary output j is in manufacturing, so the mapping issue matters for non-manufacturing inputs.

  Different treatments considered: (pairwise correlation > 0.98)

  (i) Simple average of $upst_{ij}$ over constituent IO1992 input categories
  (ii) Simple median
  (iii) Random pick
  (iv) tr_{ij} weighted-average

- Separate issue: If an IO1992 input maps into multiple SICs, divide up the tr_{ij} coefficient using a simple average.

Summary Statistics (Upstreamness Measures) ▸ Return

Table 2
Upstreamness: Summary Statistics and Some Examples

	10th	Median	90th	Mean	Std Dev
A: From Input-Output Tables (*i*=input; *j*=output) (for *j* in manufacturing only: 416,349 obs.)					
Total Requirements coefficient	0.000006	0.000163	0.002322	0.001311	0.008026
Baseline Upstreamness measure (mean)	1.838	3.094	4.285	3.097	0.955

B: Top ten most commonly observed SIC input-output pairs (in D&B)
(for *i and j* in manufacturing only)

SIC input, *i*	SIC output, *j*	No. such pairs	Upst_ij
Cookies and Crackers (2052)	Bread, Cake and Related Products (2051)	497	3.135
Commercial Printing, Lithographic (2752)	Commercial Printing, n.e.c. (2759)	439	1.186
Periodicals (2721)	Newspapers (2711)	391	1.409
Commercial Printing, n.e.c. (2759)	Commercial Printing, Lithographic (2752)	319	1.186
Commercial Printing, Lithographic (2752)	Newspapers (2711)	299	1.348
Women's and Misses' Outerwear, n.e.c. (2339)	Men's and Boys' Clothing, n.e.c. (2329)	287	1.106
Typesetting (2791)	Commercial Printing, Lithographic (2752)	280	1.151
Bookbinding and Related Work (2789)	Commercial Printing, Lithographic (2752)	273	2.192
Sausages and Other Prepared Meats (2013)	Meat Packing Plants (2011)	272	1.329
Ready-Mixed Concrete (3273)	Concrete Products, n.e.c. (3272)	190	1.074

Ratio-Upstreamness Measures: Summary statistics

	10th	Median	90th	Mean	Std Dev
B: Ratio-Upstreamness measures					
Baseline (mean)	0.490	0.558	0.698	0.586	0.136
Baseline (random pick)	0.494	0.557	0.698	0.586	0.136
Manufacturing inputs only	0.547	0.620	0.779	0.645	0.161
Ever-integrated inputs only (mean)	0.564	0.659	0.821	0.693	0.178
Exclude parent sic (mean)	0.586	0.953	1.607	1.049	0.401
Exclude parent sic, manufacturing only	0.589	1.065	2.110	1.257	0.625

- R_{jp} values tend to be < 1, but this appears to be driven by the parent SIC.
- Correlation between variants is high (typically > 0.8).

  Key exception: When excluding parent SIC, correlation with baseline measures drops to about 0.15.

Return

Summary Statistics (Industry Controls) ▸ Return

Appendix Table 1
Summary Statistics: Industry Characteristics

	10th	Median	90th	Mean	Std Dev
SIC characteristics (459 industries)					
Import demand elasticity (all codes)	2.300	4.820	20.032	8.569	10.181
Import demand elasticity (BEC cons.+cap.)	1.983	4.500	20.289	8.819	11.722
Import demand elasticity (BEC cons. only)	2.000	4.639	15.992	8.366	11.881
Log (Skilled Emp./Worker)	-1.750	-1.363	-0.778	-1.308	0.377
Log (Capital/Worker)	3.493	4.428	5.591	4.495	0.794
Log (Equip. Capital / Worker)	2.869	4.043	5.163	4.039	0.867
Log (Plant Capital / Worker)	2.517	3.302	4.524	3.426	0.755
Log (Materials / Worker)	3.898	4.596	5.681	4.702	0.726
R&D intensity: Log (0.001+ R&D/Sales)	-6.908	-6.097	-3.426	-5.506	1.463
Value-added / Shipments	0.357	0.518	0.660	0.514	0.119
Contractibility (Rauch cons., homog. only)	0.091	0.362	0.816	0.410	0.265
Contractibility (Rauch cons., homog.+ref.priced)	0.006	0.021	0.183	0.073	0.132
Upst. contractibility (Rauch cons., homog. only)	0.549	0.914	1.438	0.966	0.352
Upst. contractibility (Rauch cons., homog.+ref.priced)	0.659	1.011	1.498	1.054	0.333

Alternative $UpstCont_j$ measure ▸ Return

Dependent variable:	Log Ratio-Upstreamness		
	(1)	(2)	(3)
Ind.(Quintile 2 Elas)	-0.0407	-0.0740**	-0.0572
	[0.0282]	[0.0337]	[0.0363]
Ind.(Quintile 3 Elas)	-0.1150***	-0.0871**	-0.0998***
	[0.0295]	[0.0362]	[0.0297]
Ind.(Quintile 4 Elas)	-0.1126***	-0.1576***	-0.1528***
	[0.0312]	[0.0271]	[0.0262]
Ind.(Quintile 5 Elas)	-0.1417***	-0.1748***	-0.1592***
	[0.0289]	[0.0275]	[0.0269]
"Upstream Contractibility"			
X Ind.(Quintile 1 Elas)	-1.2784***	-1.5249***	-1.8220***
	[0.4564]	[0.3683]	[0.3826]
X Ind.(Quintile 2 Elas)	-0.8160***	-0.3932	-0.6059
	[0.2640]	[0.4604]	[0.5864]
X Ind.(Quintile 3 Elas)	0.4082*	-0.0452	0.0563
	[0.2361]	[0.3314]	[0.3535]
X Ind.(Quintile 4 Elas)	0.3364	1.0129***	0.6766***
	[0.2762]	[0.2170]	[0.1989]
X Ind.(Quintile 5 Elas)	0.7606***	1.0618***	1.2564***
	[0.1941]	[0.1913]	[0.2188]
p-value: Q5 at median Upst. Cont.	[0.0000]	[0.0000]	[0.0000]
Elasticity based on:	All codes	BEC cons. & cap. goods	BEC cons. only
Industry controls?	Y	Y	Y
Firm controls?	Y	Y	Y
Parent country fixed effects?	Y	Y	Y
Observations	84,171	62,377	44,895
No. of industries	459	305	219
R^2	0.2568	0.3286	0.3531

Further Robustness Tests ▸ Return

1. Focusing on Larger Firms and MNCs. ▸ Details
2. For MNCs: Excluding purely horizontal affiliates.
3. Secondary manufacturing SIC codes: ▸ Details
   - Restrict to parents with a single SIC output industry
   - Alternatively: Construct R_{jpc} for each output industry j.

     Run a regression with two-way clustering of standard errors by parent firm and by output industry j (Cameron, Gelbach and Miller 2011).
4. Additional contractibility measures:
   - Contractibility of j
   - To confirm that it is variation in production line position matters: $\mathbf{1}(\rho_j \in Quint_k(\rho))$ interacted with a tr-weighted standard deviation of the contractibility of inputs used.
5. Alternative constructions of ratio-upstreamness ▸ Details

Robustness: Focusing on Larger Firms and MNCs ▸ Return

Dependent variable:	Log Ratio-Upstreamness Measure			
	Emp.>=20	**Emp.>=20 & Subs.>=2**	**Emp.>=20 & MNC**	**Emp.>=20 & MNC & SICs>=2**
	(1)	(2)	(3)	(4)
Ind.(Quintile 2 Elas)	-0.0450	-0.0467	-0.0516*	-0.0511*
	[0.0290]	[0.0304]	[0.0297]	[0.0298]
Ind.(Quintile 3 Elas)	-0.0603**	-0.0627**	-0.0468	-0.0455
	[0.0255]	[0.0280]	[0.0302]	[0.0304]
Ind.(Quintile 4 Elas)	-0.0931***	-0.0778***	-0.0616**	-0.0605**
	[0.0278]	[0.0295]	[0.0278]	[0.0282]
Ind.(Quintile 5 Elas)	-0.0987***	-0.0806**	-0.0667*	-0.0633*
	[0.0290]	[0.0323]	[0.0343]	[0.0353]
"Upstream Contractibility"				
X Ind.(Quintile 1 Elas)	-0.2208***	-0.2056***	-0.1858***	-0.1870***
	[0.0633]	[0.0652]	[0.0595]	[0.0604]
X Ind.(Quintile 2 Elas)	-0.0686	-0.0591	-0.0025	-0.0035
	[0.0803]	[0.0803]	[0.0576]	[0.0576]
X Ind.(Quintile 3 Elas)	0.0988**	0.1060*	0.0834	0.0853
	[0.0398]	[0.0568]	[0.0689]	[0.0693]
X Ind.(Quintile 4 Elas)	0.1173***	0.1052**	0.0854*	0.0832*
	[0.0393]	[0.0490]	[0.0435]	[0.0449]
X Ind.(Quintile 5 Elas)	0.2364***	0.2575***	0.2123***	0.2016***
	[0.0345]	[0.0369]	[0.0516]	[0.0531]
p-value: Q5 at median Upst. Cont.	[0.0000]	[0.0009]	[0.0631]	[0.0906]
Elasticity based on:	BEC cons.	BEC cons.	BEC cons.	BEC cons.
Industry controls?	Y	Y	Y	Y
Firm controls?	Y	Y	Y	Y
Parent country fixed effects?	Y	Y	Y	Y
Observations	26,151	7,805	2,490	2,419
No. of industries	219	216	199	197
R^2	0.3307	0.3086	0.2403	0.2292

Multi-industry Parents ▸ Return

Dependent variable:	Log Ratio-Upstreamness Measure			
	Restrict to single SIC code parents		Parent firm by SIC output (two-way cluster)	
	(1)	(2)	(3)	(4)
Ind.(Quintile 2 Elas)	-0.0782	-0.0375	-0.0769*	-0.0379
	[0.0490]	[0.0301]	[0.0410]	[0.0280]
Ind.(Quintile 3 Elas)	-0.1140**	-0.0721***	-0.0901**	-0.0505*
	[0.0448]	[0.0261]	[0.0390]	[0.0263]
Ind.(Quintile 4 Elas)	-0.1489***	-0.0893***	-0.1504***	-0.0938***
	[0.0485]	[0.0297]	[0.0407]	[0.0269]
Ind.(Quintile 5 Elas)	-0.1886***	-0.0805***	-0.1871***	-0.0876***
	[0.0476]	[0.0305]	[0.0424]	[0.0297]
"Upstream Contractibility"				
X Ind.(Quintile 1 Elas)		-0.2353***		-0.2159***
		[0.0638]		[0.0612]
X Ind.(Quintile 2 Elas)		-0.0965		-0.0588
		[0.0857]		[0.0782]
X Ind.(Quintile 3 Elas)		0.1330***		0.0826*
		[0.0367]		[0.0429]
X Ind.(Quintile 4 Elas)		0.1063**		0.1058***
		[0.0413]		[0.0369]
X Ind.(Quintile 5 Elas)		0.2466***		0.2527***
		[0.0349]		[0.0370]
p-value: Q5 at median Upst. Cont.		[0.0004]		[0.0017]
Elasticity based on:	BEC cons. only	BEC cons. only	BEC cons. only	BEC cons. only
Industry controls?	Y	Y	Y	Y
Firm controls?	Y	Y	N	Y
Parent country fixed effects?	Y	Y	Y	Y
Observations	32,126	32,126	64,281	64,281
No. of industries	218	218	---	---
R^2	0.2764	0.3673	0.2633	0.3270

Robustness: More Contractibility Controls and Alternative R_{jpc}'s ▸ Return

Dependent variable:	Log Ratio-Upstreamness Measure				
	More cont. controls	**Random pick**	**"Ever-Integrated" Inputs**	**Mfg. Inputs only**	**Mfg. Inputs and Drop parent SIC**
	(1)	(2)	(3)	(4)	(5)
Ind.(Quintile 2 Elas)	-0.2932	-0.0396	-0.0494*	-0.0274	0.0237
	[0.2978]	[0.0285]	[0.0257]	[0.0318]	[0.0902]
Ind.(Quintile 3 Elas)	-1.0567***	-0.0633**	-0.0369	-0.0538*	-0.0915
	[0.3082]	[0.0253]	[0.0254]	[0.0293]	[0.0630]
Ind.(Quintile 4 Elas)	-0.7486**	-0.0886***	-0.0608**	-0.0884***	-0.1930**
	[0.3089]	[0.0278]	[0.0277]	[0.0307]	[0.0764]
Ind.(Quintile 5 Elas)	-0.6888**	-0.0819***	-0.0987***	-0.0923**	-0.2491**
	[0.2790]	[0.0295]	[0.0289]	[0.0359]	[0.0997]
"Upstream Contractibility"					
X Ind.(Quintile 1 Elas)	-0.1493	-0.2286***	-0.0705	-0.3133***	-0.2565***
	[0.1101]	[0.0635]	[0.0607]	[0.0695]	[0.0954]
X Ind.(Quintile 2 Elas)	-0.0862	-0.0807	-0.1097	-0.1058	0.1134
	[0.0838]	[0.0804]	[0.0943]	[0.0923]	[0.1278]
X Ind.(Quintile 3 Elas)	-0.1848*	0.1098***	0.1398***	0.1030	-0.2827
	[0.0972]	[0.0401]	[0.0534]	[0.0655]	[0.2202]
X Ind.(Quintile 4 Elas)	-0.0195	0.1044***	0.1246**	0.1204***	-0.3512**
	[0.0782]	[0.0388]	[0.0580]	[0.0396]	[0.1395]
X Ind.(Quintile 5 Elas)	0.1282**	0.2758***	0.2823***	0.1410**	-0.0239
	[0.0551]	[0.0410]	[0.0384]	[0.0582]	[0.2007]
p-value: Q5 at median Upst. Cont.	[0.0123]	[0.0002]	[0.0000]	[0.0026]	[0.0134]
Elasticity based on:	BEC cons.	BEC cons.	BEC cons.	BEC cons.	BEC cons.
Industry controls?	Y	Y	Y	Y	Y
Firm controls?	Y	Y	Y	Y	Y
Parent country fixed effects?	Y	Y	Y	Y	Y
Observations	44,895	44,895	44,895	44,780	14,503
No. of industries	219	219	219	218	216
R^2	0.3706	0.3558	0.2578	0.3339	0.1116