# Dark Matter of Trade:
## How Unobserved Intermediate Goods Shape Supply Chains

Sameer Malik

**University of Houston**

Fall 2024

# Research Question

**How do changes in tariffs propagate through production networks, and impact:**

- Vertical Specialization
- Input Sourcing Strategy
- Employment and Economic Performance

# Motivation

- **Policy Maker:** *Let's boost domestic EV industry!*
- **0% tariffs on direct inputs:** Lithium, Steel, and Aluminum
- **Increase tariffs on material used to produce Battery Casings from 20% to 35% (indirect inputs)**

# Motivation

- **Policy Maker:** *Let's boost domestic EV industry!*
- **0% tariffs on direct inputs:** Lithium, Steel, and Aluminum
- **Increase tariffs on material used to produce Battery Casings from 20% to 35% (indirect inputs)**

- Establishments usually report directly bought inputs and final output(s) produced
- This misses crucial element of production process, in-house produced goods, or **unobserved intermediate goods (UIGS)** – Battery Casings

# Motivation

- **Policy Maker:** *Let's boost domestic EV industry!*
- **0% tariffs on direct inputs:** Lithium, Steel, and Aluminum
- **Increase tariffs on material used to produce Battery Casings from 20% to 35% (indirect inputs)**

- Establishments usually report directly bought inputs and final output(s) produced
- This misses crucial element of production process, in-house produced goods, or **unobserved intermediate goods (UIGS) – Battery Casings**
- **Ignoring tariffs on UIGS can lead to biased estimates of impact of trade policy** since plants adjust their production processes in response to changes in input tariffs

# Main Contribution

1. Design an algorithm to construct Unobserved Intermediate Goods Set (UIGS)

2. Develop a new measure for examining impact of trade policy

**Main Takeaway:**

- By not considering tariffs on UIGS, estimated impact of trade policy is underestimated
- Decline in tariffs on UIGS increases:
  (a) Vertical Specialization
  (b) Sourcing of Imported Inputs
  (c) Employment
  (d) Sales, Profits, Labor Productivity
  (e) Total Factor Productivity

# **Data I:** Annual Survey of Industries India

- **Plant-level panel** of formal manufacturing industry from 2001-2010, including:
  - All plants with $>$ 100 employees
  - 1/5 of plants with $20 - 100$ employees

- Information on product code, quantity, and unit value for **inputs** and **outputs**, at 5-digit level

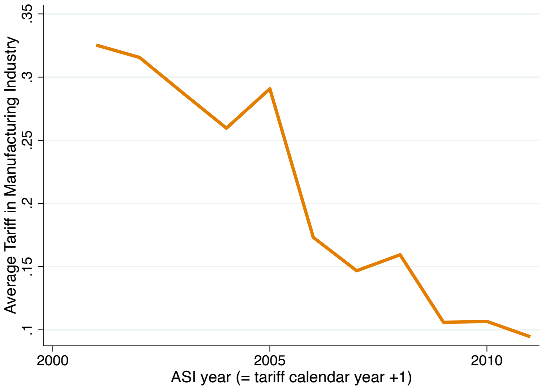
- Restrict to single-output plants ($\approx$ 60% of all plants)

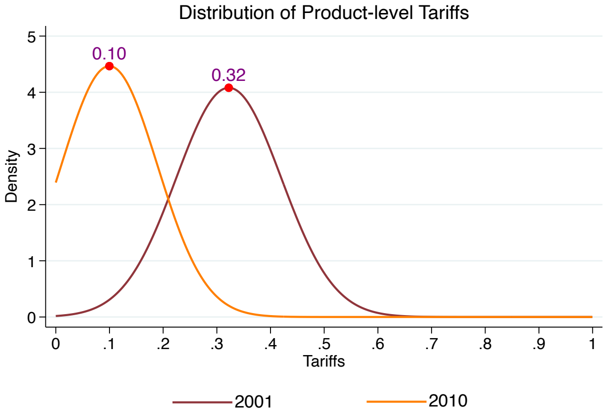
- Using input and output information for 5236 products at HS-6 level (27 million product pairs), construct **Product-level Input-Output Table for India**

# **Data II:** Trade Analysis Information System (TRAINS)

- **Import-Weighted Tariff Rates (in %)**
  - Average tariff rates of HS 6-digit products weighted by India's imports from world in same year as tariff.
  - Construct concordance from HS-6 to CPC to NPCMS to ASIC-2008 classification
  - Merge with ASI plant-level panel data for **2001-10**

# Trade Policy: Indian Manufacturing Sector



# Unobserved Intermediate Goods Set (UIGS)

- Establishments report directly bought inputs and final output(s) produced

- This misses crucial element of production process, **in-house produced goods**, or **unobserved intermediate goods (UIGS)** **– Battery Casings for EV's**

# Unobserved Intermediate Goods Set (UIGS)

- Establishments report directly bought inputs and final output(s) produced

- This misses crucial element of production process, **in-house produced goods**, or **unobserved intermediate goods (UIGS)** – Battery Casings for EV's

- **Ignoring tariffs on UIGS can lead to biased estimates of impact of trade policy** since plants adjust their production processes in response to changes in input tariffs

# Unobserved Intermediate Goods Set (UIGS)

- Establishments report directly bought inputs and final output(s) produced

- This misses crucial element of production process, **in-house produced goods**, or **unobserved intermediate goods (UIGS)** – Battery Casings for EV's

- Ignoring tariffs on UIGS can lead to biased estimates of impact of trade policy since plants adjust their production processes in response to changes in input tariffs

- **How can we know intermediate goods a plant is using if it is not reported?**

# **Unobserved Intermediate Goods Set:** Theory I

- **Using product-level input-output table: (27 million $\omega - \omega'$ product pairs)**

# Unobserved Intermediate Goods Set: Theory I

- **Using product-level input-output table: (27 million $\omega - \omega'$ product pairs)**
- Expenditure on input $\omega$ to produce output $\omega'$: $e_{\omega\omega'}$
- Let $\mathcal{D}(\omega)$ be set of products that are downstream to $\omega$, i.e.,

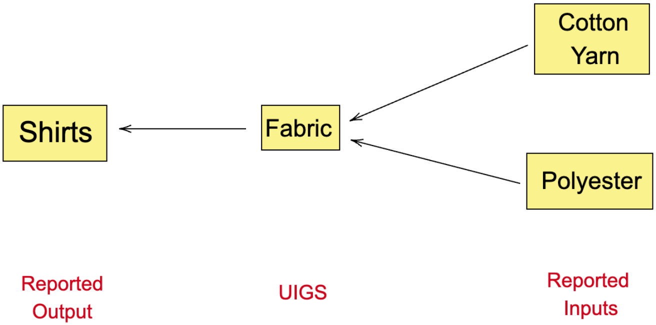
$$\mathcal{D}(\omega) := \{\omega' \mid e_{\omega\omega'} > 0\}$$

- Let $\mathcal{U}(\omega')$ be set of products that are upstream to $\omega'$ , i.e.,

$$\mathcal{U}(\omega') := \{\omega \mid e_{\omega\omega'} > 0\}$$

- Then, $\omega' \in \mathcal{D}(\omega)$, and $\omega \in \mathcal{U}(\omega')$

# Unobserved Intermediate Goods Set: Illustration I



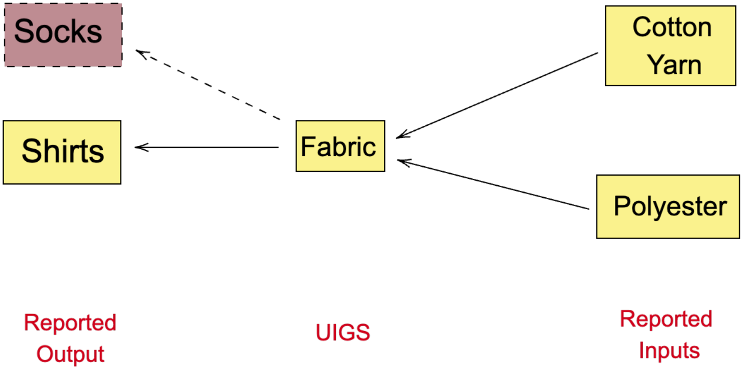

In this production chain,

$$Inputs = \{Cotton\ Yarn\ ,\ \ Polyester\}$$

$$Output = \{Shirts\}$$

- From I-O table:
- $\mathcal{D}(Cotton\ Yarn) = \{Fabric\ ,\ Shirts\,,\ Socks\ ,\ Pillowcases\}\,,$
  $\mathcal{D}(Polyester) = \{Fabric\ ,\ Shirts\,,\ Socks\ ,\ Car\ Seat\ Covers\}\,,$
- $[\mathcal{D}(Cotton\ Yarn) \bigcap \mathcal{D}(Polyester)] \setminus \{Shirts\} = \mathcal{I}_j = \{Fabric\,,\ Socks\}\,.$

# Unobserved Intermediate Goods Set: Illustration I



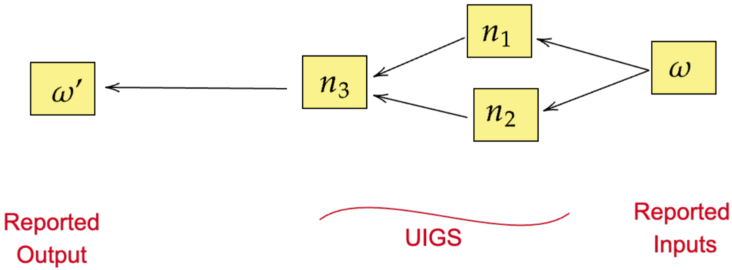

In this production chain,

$Inputs = \{Cotton\ Yarn\,,\ Polyester\}$

$Output = \{Shirts\}$

- $[\mathcal{D}(\text{Cotton Yarn}) \cap \mathcal{D}(Polyester)] \setminus \{Shirts\} = \mathcal{I}_j = \{Fabric\,,\ Socks\}$
- $[[\mathcal{D}(\text{Cotton Yarn}) \cap \mathcal{D}(Polyester)] \setminus \{Shirts\}] \cap \mathcal{U}(Shirts) = \mathcal{I}_j = \{Fabric\}$

# Unobserved Intermediate Goods Set: Illustration II

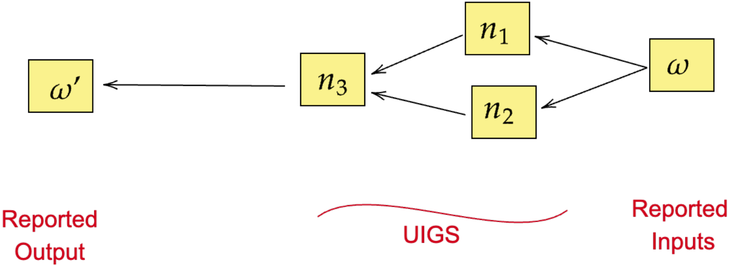



In this production chain, plant uses $\omega$ (reported input) to produce $\omega'$ (reported output) :

$$\textit{Inputs} = \{\omega\}$$

$$\textit{Output} = \{\omega'\}$$

# Unobserved Intermediate Goods Set: Illustration II




In this production chain, plant uses $\omega$ (reported input) to produce $\omega'$ (reported output) :

$$\textit{Inputs} = \{\omega\}$$

$$\textit{Output} = \{\omega'\}$$

- For $m = 1$ (reported inputs), $\mathcal{I}_j^1 = \{n_1\ ,\ n_2\}$
- For $m = 2$, $\mathcal{D}(n_1) = \{n_3\ ,\omega'\}$ and $\mathcal{D}(n_2) = \{n_3\ ,\omega'\}$, and so, $\mathcal{I}_j^2 = \{n_3\}$
- Since, $\mathcal{I}_j^3 = \emptyset$, $\textbf{\textit{UIGS}}_j$ is: $\mathcal{I}_j^1 \cup \mathcal{I}_j^2 = \{n_1,\ n_2,\ n_3\}$

# Unobserved Intermediate Goods Set: Theory II

- **For a plant $j$ : (in year $t$)**

# Unobserved Intermediate Goods Set: Theory II

- **For a plant *j* : (in year *t*)**

- If it uses inputs $\omega^1, \omega^2, ..., \omega^k$ to produce output $\omega'$, then,

$$\omega' \in \mathcal{D}(\omega^1), \omega' \in \mathcal{D}(\omega^2), ..., \omega' \in \mathcal{D}(\omega^k)$$

$$\omega^1, \omega^2, ..., \omega^k \in \mathcal{U}(\omega')$$

- And,

$$\underbrace{\bigcap_{i=1}^{k} \mathcal{D}(\omega^i)}_{\text{Goods that can be produced using this particular set of inputs}}$$

# Unobserved Intermediate Goods Set: Theory III

- For a plant $j$, if it uses inputs $\omega^1, \omega^2, \ldots, \omega^k$ to produce output $\omega'$, then,

$$\omega' \in \mathcal{D}(\omega^1), \omega' \in \mathcal{D}(\omega^2), \ldots, \omega' \in \mathcal{D}(\omega^k)$$

$$\omega^1, \omega^2, \ldots, \omega^k \in \mathcal{U}(\omega')$$

- And,

$$\underbrace{\bigcap_{i=1}^{k} \mathcal{D}(\omega^i) \setminus [\{\omega'\} \cup \mathcal{D}(\omega')]}$$

Goods that can be produced using this particular set of inputs, except for output $\omega'$ and its downstream products

# Unobserved Intermediate Goods Set: Theory IV

- For a plant $j$, if it uses inputs $\omega^1, \omega^2, ..., \omega^k$ to produce output $\omega'$, then,

$$\omega' \in \mathcal{D}(\omega^1), \omega' \in \mathcal{D}(\omega^2), ..., \omega' \in \mathcal{D}(\omega^k)$$

$$\omega^1, \omega^2, ..., \omega^k \in \mathcal{U}(\omega')$$

- And,

$$\underbrace{\left[\bigcap_{i=1}^{k} \mathcal{D}(\omega^i) \setminus [\{\omega'\} \cup \mathcal{D}(\omega')]\right] \bigcap \mathcal{U}(\omega')}$$

Goods that can be produced using this particular set of inputs, except output $\omega'$ and downstream products, that are used in production of $\omega'$

# Unobserved Intermediate Goods Set: Theory V

- For a plant $j$, if it uses inputs $\omega^1, \omega^2, ..., \omega^k$ to produce output $\omega'$, then,

$$UIGS_j := \mathcal{I}_j = \bigcup_{m=1}^{M} \left(\mathcal{I}_j^m\right) = \bigcup_{m=1}^{M} \left( \left[ \bigcap_{i=1}^{k^{(m-1)}} \mathcal{D}(\omega^i) \setminus [\{\omega'\} \cup \mathcal{D}(\omega')] \right] \bigcap \mathcal{U}(\omega') \right)$$

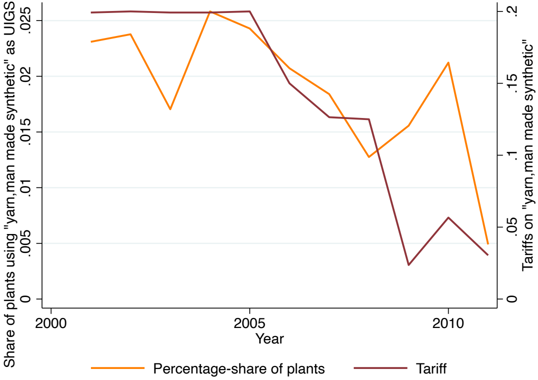
- Where $k^{(0)} = k$, $\left|\mathcal{I}_j^1\right| = k^{(1)}$, and $\left|\mathcal{I}_j^m\right| = k^{(m)}$
- Start with reported inputs, $\omega^1, \omega^2, ..., \omega^k$, for $m = 1$ and get $\mathcal{I}_j^1$, then, for $m = 2$, consider products in $\mathcal{I}_j^1$ as inputs, and get $\mathcal{I}_j^2$, ...
- Continue this iterative process till $m = M$, if $\mathcal{I}_j^{M+1} = \emptyset$

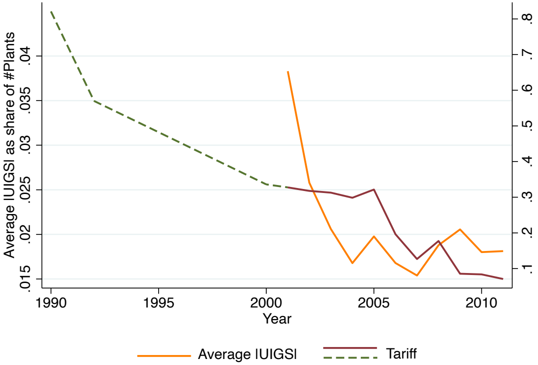
# **UIGS Example:** India-Made Petrol Car Manufacturing Plant in Panch Mahal District (Gujarat) in 2010

| Reported Inputs |
|---|
| colour, ink, artist ink, paint, n.e.c |
| tyre/tube, others |
| seat cushion, rubber |
| rubber & rubber product, n.e.c |
| iron/steel primary forms, n.e.c |
| frame, steel - not for doors/windows |
| engine |
| general purpose machinery/tools, components, n.e.c |
| converter |
| batteries |
| modules |
| motor vehicle, others & parts, n.e.c |

| UIGS |
|---|
| air conditioner |
| body for motor car |
| clutch |
| compressors |
| cylinder head & block |
| electronic controller |
| engine assembly |
| gear |
| gear boxes |
| m.s. bars & rods, angles/-plates/square |
| meter assembly |
| wheels |

# UIGS and Tariffs




- Correlation: **0.69**
- Correlation: **0.5**

# Empirical Strategy I:

- Total expenditure on product $\omega$ to produce output $\omega'$, aggregating for all plants $j'$ in all years $t$

$$\sum_t \sum_{j'} e^{j'}_{\omega\omega' t}$$

- Total expenditure on all input-mix used to produce output $\omega'$, aggregating for all plants $j'$ in all years $t$

$$\sum_t \sum_{j'} \sum_{\omega} e^{j'}_{\omega\omega' t}$$

- Then, relative importance of product $\omega$ in production of output $\omega'$ is given by:

$$z_{\omega\omega'} := \frac{\sum_t \sum_{j'} e^{j'}_{\omega\omega' t}}{\sum_t \sum_{j'} \sum_{\omega} e^{j'}_{\omega\omega' t}}$$

# Empirical Strategy II:

$$\Delta_5 Y_{j\omega' t} = \beta_0 + \beta_1 . \sum_{\omega \in \mathcal{I}_{j\,(t-5)}} z_{\omega\omega'} . \Delta_5 \log\left(1 + \tau_{\mathcal{I}\ \omega\ t}\right) + \xi_t + \varepsilon_{\ j\omega' t}$$

- $Y_{j\omega' t}$ is variable of interest for plant $j$, producing $\omega'$, in year $t$
- $\tau_{\mathcal{I}\ \omega\ t}$ is tariff on product $\omega \in \mathcal{I}$ in the year $t$;
- $\xi_t$ is year fixed effect.
- $z_{\omega\omega'}$ relative importance share depends on input-output pair (and is time invariant)
- Set $\mathcal{I}$ of UIGS varies at plant-year level

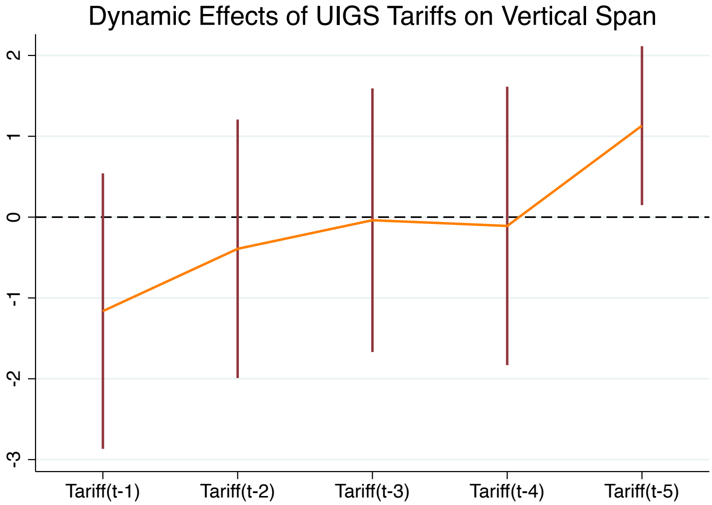
# Results I: Vertical Specialization I

*[Construct Vertical Span, à la Boehm and Oberfield (2023) approach]* ▸ Construction ▸ Robustness checks

| | (1) | (2) | (3) |
|---|---|---|---|
| Dependent Variable $\rightarrow$ | $\Delta_5$ Vertical Span | $\Delta_5$ Vertical Span | $\Delta_5$ Vertical Span |
| $\sum_{\omega \in \mathcal{I}_{j\,(t-5)}} z_{\omega\omega'} .\, \Delta_5 \log\left(1 + \tau_{\mathcal{I}\ \omega\ t}\right)$ | 0.765*** | 0.935*** | 0.955*** |
| | (0.256) | (0.278) | (0.344) |
| Year FE | ✓ | ✓ | ✓ |
| UIGS Goods | ALL | Share $>$ 1% | Share $>$ 5% |
| R-squared | 0.002 | 0.002 | 0.003 |
| Observations | 14,362 | 10,842 | 5,784 |

Robust standard errors in parentheses, clustered at the plant level.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

# Results I: Vertical Specialization II
(Adjustments take time)



# Results I: Vertical Specialization III
## (Small v/s Large Plants)

| | (1) | (2) |
|---|---|---|
| Dependent Variable $\rightarrow$ | $\Delta_5$ Vertical Span | $\Delta_5$ Vertical Span |
| $\sum_{\omega \in \mathcal{I}_{j\,(t-5)}} z_{\omega\omega'} . \Delta_5 \log\left(1 + \tau_{\mathcal{I}\ \omega\ t}\right)$ | 1.134** | 0.788** |
| | (0.509) | (0.323) |
| Year FE | ✓ | ✓ |
| UIGS Goods | Share $>$ 1% | Share $>$ 1% |
| Plant Size | Small | Large |
| R-squared | 0.003 | 0.003 |
| Observations | 4,983 | 5,859 |

Robust standard errors in parentheses, clustered at the plant level.
*** p<0.01, ** p<0.05, * p<0.1

# Results II: Input Sourcing Decisions

▸ Substitution between Inputs

| Dependent Variable → | (1) Log Inputs | (2) Log $\frac{\text{Domestic Inputs}}{\text{Output}}$ |
|---|---|---|
| $\sum_{\omega \in \mathcal{I}_{j\,(t-5)}} z_{\omega\omega'} \cdot \Delta_5 \log\left(1 + \tau_{\mathcal{I}\ \omega\ t}\right)$ | -1.767*** | 0.240*** |
| | (0.476) | (0.069) |
| Year FE | ✓ | ✓ |
| UIGS Goods | Share > 1% | Share > 1% |
| R-squared | 0.004 | 0.006 |
| Observations | 11,322 | 10,536 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

# Results III: Employment

| | (1) | (2) |
|---|---|---|
| Dependent Variable $\rightarrow$ | $\Delta_5$ Log Managerial Staff | $\Delta_5$ Log Factory Workers |
| $\sum_{\omega \in \mathcal{I}_{j\,(t-5)}} z_{\omega\omega'} . \Delta_5 \log\left(1 + \tau_{\mathcal{I}\ \omega\ t}\right)$ | -2.195*** | -1.583*** |
| | (0.575) | (0.523) |
| Year FE | ✓ | ✓ |
| UIGS Goods | Share $>$ 1% | Share $>$ 1% |
| R-squared | 0.528 | 0.034 |
| Observations | 10,806 | 11,249 |

Robust standard errors in parentheses, clustered at the plant level.
*** p$<$0.01, ** p$<$0.05, * p$<$0.1

# Results IV: Economic Performance I

| | (1) | (2) | (3) |
|---|---|---|---|
| Dependent Variable $\rightarrow$ | $\Delta_5$ Log Sales | $\Delta_5$ Log Profits | $\Delta_5$ Log Labor Productivity |
| $\sum_{\omega \in \mathcal{I}_{j\,(t-5)}} z_{\omega\omega'} . \Delta_5 \log\left(1 + \tau_{\mathcal{I}\ \omega\ t}\right)$ | -2.181*** | -3.849*** | -1.503*** |
| | (0.499) | (0.899) | (0.457) |
| Year FE | ✓ | ✓ | ✓ |
| UIGS Goods | Share $>$ 1% | Share $>$ 1% | Share $>$ 1% |
| R-squared | 0.008 | 0.006 | 0.004 |
| Observations | 11,322 | 7,285 | 11,309 |

Robust standard errors in parentheses, clustered at the plant level.
*** p<0.01, ** p<0.05, * p<0.1

# Results IV: Economic Performance II

| | (1) | (2) |
|---|---|---|
| Dependent Variable $\rightarrow$ | $\Delta_5$ Log Sales | $\Delta_5$ Log Sales |
| $\sum_{\omega \in \mathcal{I}_{j\,(t-5)}} z_{\omega\omega'} \cdot \Delta_5 \log\left(1 + \tau_{\mathcal{I}\ \omega\ t}\right)$ | | -2.242*** |
| | | (0.508) |
| $\Delta_5$ Log Inputs Weighted Lagged Tariff | -1.034** | -0.999** |
| | (0.496) | (0.497) |
| Year FE | ✓ | ✓ |
| UIGS Goods | – | Share $> 1\%$ |
| R-squared | 0.003 | 0.005 |
| Observations | 9,871 | 9,871 |

Robust standard errors in parentheses, clustered at the plant level.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

# Results IV: Economic Performance III

[ *Estimate Production Function using Levinsohn and Petrin (2003) method, with ACF (2015) correction* ]

▸ Methodology

| Dependent Variable → | $\Delta_5\ \widehat{TFP}$ |
|---|---|
| $\sum_{\omega \in \mathcal{I}_{j\,(t-5)}} z_{\omega\omega'} . \Delta_5 \log\left(1 + \tau_{\mathcal{I}\ \omega\ t}\right)$ | -0.116*** |
| | (0.034) |
| Year FE | ✓ |
| UIGS Goods | Share $> 1\%$ |
| R-squared | 0.002 |
| Observations | 10,967 |

Robust standard errors in parentheses, clustered at the plant level.
*** p<0.01, ** p<0.05, * p<0.1

# Conclusion

1. Designed an algorithm to construct Unobserved Intermediate Goods Set (UIGS)

2. Developed a new measure for examining impact of trade policy

   - **Main Result I:**
     Decline in tariffs on UIGS increases vertical specialization, sourcing of imported inputs, employment, sales, profits, labor productivity, and TFP of manufacturing plants

   - **Main Result II:**
     By not considering tariffs on UIGS, impact of trade policy is underestimated

# Thanks!

For comments: smalik9@uh.edu

# **Vertical Span:** Measure of Vertical Specialization

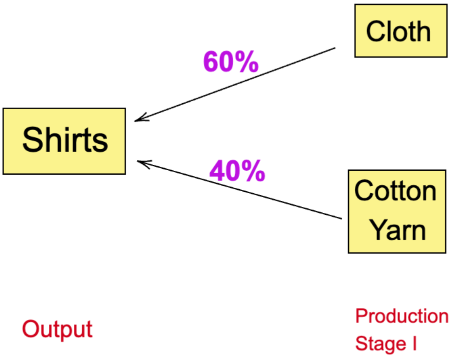
- Constructed at plant-level, *à la* *Boehm and Oberfield (2023)* approach:

1. For each output-input pair $(\omega,\ \hat{\omega})$, construct **vertical distance:** $\boldsymbol{d_{\omega\hat{\omega}}}$
   - Using information from **all plants producing** $\omega$ from $\hat{\omega}$, $\forall\ \hat{\omega}$
2. For each plant *j*, construct **vertical span:**
   **No. of stages b/w inputs coming outside of plant to output going outside of plant**

# **Vertical Span:** Intuition for vertical distance $\boldsymbol{d}_{\omega\hat{\omega}}$


1. Consider **shirts** ($\omega$)

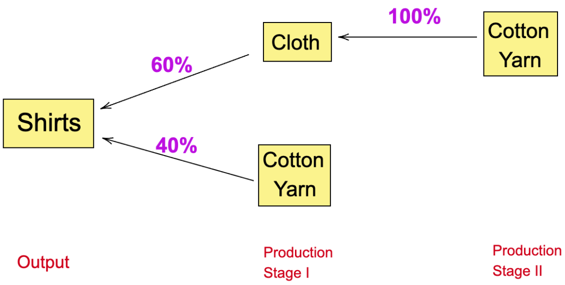
# Vertical Span: Intuition for vertical distance $d_{\omega\hat{\omega}}$




1. Consider **shirts** ($\omega$)

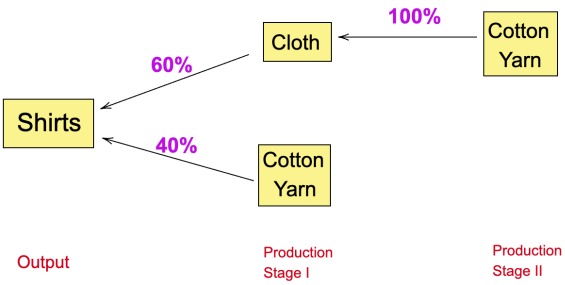
2. Construct materials cost shares of $\omega$ for each input ($\hat{\omega}$)

# Vertical Span: Intuition for vertical distance $d_{\omega\hat{\omega}}$




1. Consider **shirts** ($\omega$)
2. Construct materials cost shares of $\omega$ for each input ($\hat{\omega}$)
3. Recursively construct cost shares of input, inputs' inputs, ...

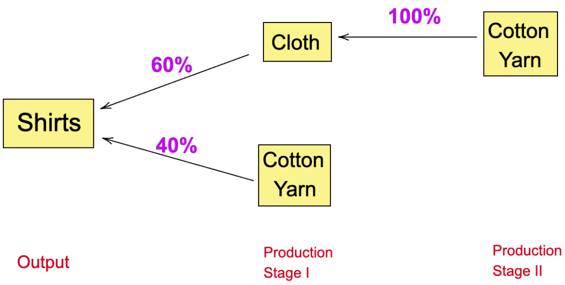
# **Vertical Span:** Intuition for vertical distance $\boldsymbol{d}_{\omega\hat{\omega}}$




1. Consider **shirts** ($\omega$)
2. Construct materials cost shares of $\omega$ for each input ($\hat{\omega}$)
3. Recursively construct cost shares of input, inputs' inputs, ...
4. $\boldsymbol{d}_{\omega\hat{\omega}}$ is avg. no. of steps between $\omega$ and $\hat{\omega}$, weighted by product of cost shares

- $\boldsymbol{d}_{Shirts \leftarrow Cloth} = 1$,
- $\boldsymbol{d}_{Shirts \leftarrow Yarn} = (0.4)1 + (0.6)(1.0)2 = 1.6$

# Vertical Span: Intuition for vertical distance $d_{\omega\hat{\omega}}$




1. Consider **shirts** ($\omega$)
2. Construct materials cost shares of $\omega$ for each input ($\hat{\omega}$)
3. Recursively construct cost shares of input, inputs' inputs, ...
4. $d_{\omega\hat{\omega}}$ is avg. no. of steps between $\omega$ and $\hat{\omega}$, weighted by product of cost shares

- $d_{Shirts \leftarrow Cloth} = 1$,
- $d_{Shirts \leftarrow Yarn} = (0.4)1 + (0.6)(1.0)2 = 1.6$

5. **Repeat for 5236 products...**

# **Vertical Span:** How far are plant's inputs from output

back to results

- For each plant $j$, construct **vertical span:**

$$\text{span}_j = \sum_{\hat{\omega}} \frac{X_{j\hat{\omega}}}{\sum_{\tilde{\omega}} X_{j\tilde{\omega}}} d_{\omega\hat{\omega}} \tag{1}$$

whereby,

- $X_{j\hat{\omega}}$ is input expenditure of plant $j$ on product $\hat{\omega}$,
- $\sum_{\tilde{\omega}} X_{j\tilde{\omega}}$ is total input expenditure of plant $j$
- **Weighted average of distance of output from inputs**

# **Vertical Span:** How far are plant's inputs from output

back to results

- For each plant $j$, construct **vertical span:**

$$\text{span}_j = \sum_{\hat{\omega}} \frac{X_{j\hat{\omega}}}{\sum_{\tilde{\omega}} X_{j\tilde{\omega}}} d_{\omega\hat{\omega}} \tag{1}$$

  whereby,
  - $X_{j\hat{\omega}}$ is input expenditure of plant $j$ on product $\hat{\omega}$,
  - $\sum_{\tilde{\omega}} X_{j\tilde{\omega}}$ is total input expenditure of plant $j$
  - **Weighted average of distance of output from inputs**

- **Eg:** If plant $j$ (prod. shirts) spends 70% and 30% of input exp. on cloth and yarn resp.

  $\boldsymbol{span_j = (0.7)(d_{Shirts \leftarrow Cloth}) + (0.3)(d_{Shirts \leftarrow Yarn}) = (0.7)(1) + (0.3)(1.6) = 1.18}$

# Substitution between Imported and Domestic Inputs

$$Log\left(\frac{Domestic\ Inputs}{Imported\ Inputs}\right)_{j\hat{\omega}t} = \beta_0 + \beta_1\left(Log\ Input\ Tariffs\right)_{\hat{\omega}t} + \zeta_j + \xi_t + \varepsilon_{j\hat{\omega}t}$$

$$Log\left(\frac{Domestic\ Inputs}{Imported\ Inputs}\right)_{j\hat{\omega}t} = \beta_0 + \beta_1\left(Log\ Input\ Tariffs\right)_{\hat{\omega}(t-1)} + \zeta_j + \xi_t + \varepsilon_{j\hat{\omega}t}$$

- Plant $j$ (producing output $\omega$), using inputs $\hat{\omega}$ , in year $t$

# Substitution between Imported and Domestic Inputs

back to results

| | (1) | (2) |
|---|---|---|
| Dependent Variable $\rightarrow$ | Log ( $\frac{\textit{Domestic Inputs}}{\textit{Imported Inputs}}$ ) | Log ( $\frac{\textit{Domestic Inputs}}{\textit{Imported Inputs}}$ ) |
| Log Input Tariffs | 1.107*** | |
| | (0.232) | |
| Log Input Tariffs$_{(t-1)}$ | | 1.107*** |
| | | (0.263) |
| Observations | 35,622 | 33,196 |
| R-squared | 0.398 | 0.401 |
| Plant FE | ✓ | ✓ |
| Year FE | ✓ | ✓ |

Robust standard errors in parentheses, clustered at the plant level.
*** p<0.01, ** p<0.05, * p<0.1