Notes on Young (2015) "Structural Transformation, the Mismeasurement of Productivity Growth, and the Cost Disease of Services"
- Industries’ productivities grow at different rates
  - Relative price of services vs. goods increased by 0.8pp each year.
  - If goods and services are complements in consumption→ labor demand for services increases
- As expanding sectors’ hire additional workers, average worker quality declines
  - Causes measured TFP to decline..

Papers like Ngai and Pissarides focus on the first bullet point. Young focuses on the second.
Proof of concept

Negative Correlation between Industry Growth & Change in Observed Worker Quality

What about unobserved worker characteristics?
Outline

- Measuring productivity growth
  - Motivating model for why worker quality might decline with industry size.
  - Implications for productivity growth between goods & services.

- Estimating $\xi$
Workers choose sectors according to their comparative advantage

- Each worker has efficiency levels $z_G$ and $z_S$ in producing goods/services.
  - Let $u$ index workers
- Each sector offers $w_i$ as the wage per efficiency unit.
- The set of workers working in $G$ are

$$\text{Set}_G = \{ u | w_G z_G (u) > w_S z_S (u) \}$$

- Let $\pi_G$ denote $G$'s share of workers
- Average efficiency in sector $G$ is

$$\bar{z}_G = \frac{\int_{u \in \text{Set}_G} z_G (u) \, du}{\int_{u \in \text{Set}_G} \, du} = \frac{\int_{u \in \text{Set}_G} z_G (u) \, du}{L \pi_i}$$
Measured productivity

- Key parameter, elasticity of worker efficiency with industry size:

\[ \xi \equiv \frac{d\bar{z}_i}{d\pi_i} \frac{\pi_i}{\bar{z}_i} \]

- Each industry \( i \) produces using capital and (effective) labor

\[ Q_i = A_i F_i (K_i, L_i \bar{z}_i) \]

- Effective labor is the product of hours \( L_i \) and (unobserved) average worker efficacy \( \bar{z}_i \)

- Taking a log-linear approximation (then using the definition of \( \xi \))

\[ \hat{A}_i = \hat{Q}_i - \Theta_{K_i} \hat{K}_i - \Theta_{L_i} \hat{L}_i - \Theta_{L_i} \bar{z}_i \]

\[ = \hat{Q}_i - \Theta_{K_i} \hat{K}_i - \Theta_{L_i} \hat{L}_i - \xi \Theta_{L_i} \hat{\pi}_i \]

None of what is on this slide depends on why \( \bar{z} \) responds to \( \pi \).
Measured productivity growth

- Difference in TFP growth: 0.94 pp, 0.85 pp when accounting for workers’ observable characteristics (sex, age group, education category).
Implications for productivity growth

\[ \hat{A}_i \text{ (true)} - \hat{A}_i \text{ (est)} = -\xi \sum_j \Theta^j_{Li} \times \hat{\pi}^j_i \]

- Cost share of type j workers
- Change in industry i share of type j

<table>
<thead>
<tr>
<th>$\xi$</th>
<th>Goods</th>
<th>Services</th>
<th>Aggregate</th>
</tr>
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<tbody>
<tr>
<td>0.00</td>
<td>1.57</td>
<td>0.73</td>
<td>0.97</td>
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<tr>
<td>-0.25</td>
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<td>0.94</td>
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<td>-0.50</td>
<td>1.10</td>
<td>0.84</td>
<td>0.91</td>
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<td>-0.75</td>
<td>0.87</td>
<td>0.90</td>
<td>0.88</td>
</tr>
<tr>
<td>-1.00</td>
<td>0.64</td>
<td>0.95</td>
<td>0.85</td>
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</table>

Task for the rest of the paper: estimate $\xi$. 
Empirical specification

\[ Y_{ict} = \alpha_{ic} + \delta_{ct} + \gamma_{ic} \hat{U}_{ct} + \xi \cdot X_{ict} + \varepsilon_{ict} \]

\[ X_{ict} = \alpha_{ic}^X + \delta_{ct}^X + \gamma_{ic}^X \hat{U}_{ct} + \beta_{ic} \hat{Z}_{ct} + \eta_{ict} \]

Idea: Wars (or other events that shift military spending)

1. Affect labor demand, differentially across industries
2. Do not directly impact tfp growth
Industries’ exposure to federal spending differs greatly

<table>
<thead>
<tr>
<th>Industry</th>
<th>Sales Share</th>
<th>Industry</th>
<th>Sales Share</th>
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</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>0.0%</td>
<td>Other transport</td>
<td>13.9%</td>
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<tr>
<td>Textiles</td>
<td>0.0%</td>
<td>Motor vehicles</td>
<td>2.9%</td>
</tr>
<tr>
<td>Chemicals</td>
<td>0.0%</td>
<td>F.I.R.E.</td>
<td>2.4%</td>
</tr>
<tr>
<td>Lumber</td>
<td>0.0%</td>
<td>Construction</td>
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<tr>
<td>Paper</td>
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<td>Electrical machinery</td>
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</tr>
</tbody>
</table>

Note: These figures are taken from the 1997 IO Table, using a slightly different industry classification from what is given in Young (2015).
Changes in military spending

![Graph showing percent change in military expenditures as a share of GDP from 1950 to 2010. The graph displays fluctuations over time, with notable peaks and troughs.](image-url)
Changes in military spending
First-stage estimates

\[ X_{ict} = \alpha_{ic}^X + \delta_{ct}^X + \gamma_{ic}^X \hat{U}_{ct} + \beta_{ic} \cdot \hat{Z}_{ct} + \eta_{ict} \]

- Smallest Coeffs:  
  - Legal
  - Apparel
  - Comp Systems
  - Social Assistance
  - Data Processing

- Largest Coeffs:  
  - Mining Support
  - Rail Support
  - Warehousing
  - Federal Reserve
  - Mining

\( \Delta \) lab. share

\( \Delta \) military spending
First-stage and second stage estimates

\[ X_{ict} = \alpha_{ic}^X + \delta_{ct}^X + \gamma_{ic}^X \hat{U}_{ct} + \beta_{ic} \cdot \hat{Z}_{ct} + \eta_{ict} \]

\[ Y_{ict} = \alpha_{ic} + \delta_{ct} + \gamma_{ic} \hat{U}_{ct} + \gamma_{ic} \cdot \hat{Z}_{ct} + \varepsilon_{ict} \]
Hamilton (2003) Instrument:

$$\max \left\{ 0, \log \frac{\max \text{oil price in quarter } t}{\max \text{oil price in quarters } t-12 \text{ to } t-1} \right\}$$
First-stage estimates

\[
\Delta \text{lab. share} = \alpha_{ic} X + \delta_{ct} X + \gamma_{ic} \hat{U}_{ct} + \beta_{ic} \cdot \hat{Z}_{ct} + \eta_{ict}
\]

Smallest Coeffs:
- Legal
- Motion Pictures
- Data Processing
- Health
- Computer Systems

Largest Coeffs:
- Mining Support
- Water Transport
- Computers
- Management
- Air Transport

\(\beta_{ic}\)
First-stage and second stage estimates

1\textsuperscript{st} stage: \(X_{ict} = \alpha_{ic}^X + \delta^X_{ct} + \gamma_{ic}^X \hat{U}_{ct} + \beta_{ic} \cdot \hat{Z}_{ct} + \eta_{ict}\)

2\textsuperscript{nd} stage: \(Y_{ict} = \alpha_{ic} + \delta_{ct} + \gamma_{ic} \hat{U}_{ct} + \gamma_{ic} \cdot \hat{Z}_{ct} + \varepsilon_{ict}\)
OLS & IV Industry estimates vary quite a bit

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>OLS</th>
<th>Δ Defense Spending</th>
<th>Δ Metals Prices</th>
<th>Oil Price Maximum</th>
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</thead>
<tbody>
<tr>
<td>ξ</td>
<td>-0.22</td>
<td>-0.92</td>
<td>-0.55</td>
<td>0.37</td>
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<tr>
<td>(s.e)</td>
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<td>0.27</td>
<td>0.32</td>
<td>0.38</td>
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<tr>
<td>F-test p.val</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Dropping the $\hat{U}_{ct}$ terms

<table>
<thead>
<tr>
<th></th>
<th>OLS</th>
<th>Δ Defense Spending</th>
<th>Δ Metals Prices</th>
<th>Oil Price Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>ξ</td>
<td>-0.17</td>
<td>-0.36</td>
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<td>0.36</td>
</tr>
<tr>
<td>(s.e)</td>
<td>0.10</td>
<td>0.22</td>
<td>0.45</td>
<td>0.40</td>
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<tr>
<td>F-test p.val</td>
<td>0.00</td>
<td>0.44</td>
<td>0.03</td>
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</table>
Lessons

1. Productivity is, many times, taken to be an exogeneous process.
   Example: Basu (1996)
   1.1 (Conventionally measured) productivity is highly procyclical and volatile (perhaps implausibly so).
   1.2 Is this (partly) due to procyclical utilization?
   1.3 How to measure changes in utilization?

2. (Industry-specific) factor supply curves slope up.
   2.1 Physical capital (Scientists' labor) supply is not perfectly elastic
   2.2 Subsidies to investment (R&D) lead to higher investment prices (scientists' wages)
   2.3 Conventional measures of societal value investment (R&D) subsidies may be too high