Evidence on Cross-Industry Input Allocation and Country-Level TFP Growth

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Evidence on Cross-industry Input Allocation and Country-level TFP Growth

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*The views expressed in this paper are solely those of the authors and not necessarily those of the U.S. Bureau of Economic Analysis, U.S. Department of Commerce.
Introduction

- Development accounting literature: input misallocation accounts for a significant portion of TFP differences across countries.

- Outstanding research questions:
  - “How much of the dispersion in productivity is real versus a by product of measurement error?”
  - “How large are misallocations across sectors?”

- This paper: input heterogeneity, reallocations across sectors.
Introduction

- Introduce TFP measurement framework into lit. on misallocation.
- Labor cross classified by worker characteristics.
- Capital classified by asset type.

Findings:
- Reallocation effects small on average.
- Sizable for subset of countries in certain industries.
Based on measured primary input prices.

If price of homogeneous input differs across sectors, potential misallocation.

Assumption: Price = marginal product.

Equalized pricing -> Reallocation effect.
  “efficient” in the terminology of Hsieh and Klenow.
Capital Reallocation Effects

- Different rental prices for same asset => marginal products differ by industry.

- Rental prices typically unobserved.

\[ P_{K,k,j,t} = (i_{j,t} - \pi_{k,t} + (1 + \pi_{k,t})\delta_k)P_{I,k,t-1} \]

- Reallocation effect if industry rates of return differ.

- Measurement question: bias from measuring capital service prices at aggregate level.
Different labor input price for same worker => marginal products differ by industry.

Labor input price:

\[ P_{L,j,i,t} = \left( \frac{\$}{hr} \right)_{j,i,t} \]

- \( j \): worker type by demographic group.
- Measurement question: bias from measuring labor service prices at aggregate level.
Equalized Pricing

- Equalized marginal products $\Rightarrow$ Equalized pricing.

\[ V_{K,k,agg,t} = \sum_j P_{K,k,j,t} Q_{K,k,j,t} \]

\[ V_{K,k,agg,t} = \sum_j P_{K,k,agg,t} Q_{K,k,j,t} \]

\[ P_{K,k,agg,t} = \frac{V_{K,k,agg,t}}{\sum_j Q_{K,k,j,t}} \]
Reallocation and TFP

- **Industry TFP growth:**
  \[
  \nu_{T,j} = \bar{\nu}_{K,j} \Delta \ln P_{K,j} + \bar{\nu}_{L,j} \Delta \ln P_{L,j} + \bar{\nu}_{X,j} \Delta \ln P_{X,j} - \Delta \ln P_{Y,j}
  \]

- **Aggregation over industries:**
  \[
  \Delta \ln P_V = \sum_j \bar{\omega}_j \frac{\bar{\nu}_{K,j}}{\bar{\nu}_{V,j}} \Delta \ln P_{K,j} + \bar{\omega}_j \frac{\bar{\nu}_{L,j}}{\bar{\nu}_{V,j}} \Delta \ln P_{L,j} - \bar{\omega}_j \frac{1}{\bar{\nu}_{V,j}} \nu_{T,j}
  \]

- **Bottom up TFP:**
  \[
  \nu_{TD} = \sum_j \bar{\omega}_j \frac{1}{\bar{\nu}_{V,j}} \nu_{T,j}
  \]

- **Aggregate TFP:**
  \[
  \Delta \ln P_V = \bar{\nu}_K \Delta \ln P_K + \bar{\nu}_L \Delta \ln P_L - \nu_T
  \]
Reallocation and TFP

- **Difference:**

\[ v_T - v_{TD} = \left( \bar{v}_K \Delta \ln P_K - \sum_j \bar{w}_j \frac{\bar{v}_{K,j}}{\bar{v}_{V,j}} \Delta \ln P_{K,j} \right) + \left( \bar{v}_L \Delta \ln P_L - \sum_j \bar{w}_j \frac{\bar{v}_{L,j}}{\bar{v}_{V,j}} \Delta \ln P_{L,j} \right) \]

- **Definitions:**

\[ R_K \equiv \bar{v}_K \Delta \ln P_K - \sum_j \bar{w}_j \frac{\bar{v}_{K,j}}{\bar{v}_{V,j}} \Delta \ln P_{K,j} \]

\[ R_L \equiv \bar{v}_L \Delta \ln P_L - \sum_j \bar{w}_j \frac{\bar{v}_{L,j}}{\bar{v}_{V,j}} \Delta \ln P_{L,j} \]

- **Thus,**

\[ v_T - v_{TD} = R_K + R_L \]
Reallocation Intuition

- Zero if prices for the same input are equal across industries.
- Can be positive or negative.
- Positive if fast growing assets are employed in industries with relatively higher prices.
  - I.e.: 1) reallocation imposes fast growing assets have lower marginal products, and 2) output is fixed, 3) aggregate TFP is measured to be higher than industry TFP.
Data

- Industry-level production account ~30 indus.
- World KLEMS and EUKLEMS.
  - Gender
  - Skill (3): high, medium, low
  - Age (3): under 29, 29-49, 50+
- 8 assets (1995-2006): computing equipment, communications equipment, software, transportation equipment, other machinery, construction, residential structures, and other assets.
- 13 Countries: Australia, Austria, Czech Republic, Denmark, Finland, Germany, Italy, Japan, Netherlands, Slovenia, Spain, United Kingdom, and the United States
Industry Origins of the Reallocation Effects

- If reallocation is zero, aggregate TFP equals industry TFP computed under equalized prices:

  \[ v_T = \sum_j \bar{w}_j \frac{1}{\bar{u}_{V,j}} v_{TP,j} \]

- Thus:

  \[ v_T - v_{TD} = \sum_j \bar{w}_j \frac{1}{\bar{u}_{V,j}} v_{TP,j} - \sum_j \bar{w}_j \frac{1}{\bar{u}_{V,j}} v_{T,j} = R_K + R_L \]
Industry Effects

United States

Agriculture, Hunting, Forestry And Fishing
Mining And Quarrying
Food, Beverages And Tobacco
Textiles, Textile, Leather And Footwear
Wood And Of Wood And Cork
Pulp, Paper, Paper, Printing And Publishing
Chemical, Rubber, Plastics And Fuel
Other Non-Metallic Mineral
Basic Metals And Fabricated Metal
Machinery, Nec
Electrical And Optical Equipment
Transport Equipment
Manufacturing Nec; Recycling
Electricity, Gas And Water Supply
Construction
Wholesale And Retail Trade
Hotels And Restaurants
Transport And Storage
Post And Telecommunications
Financial Intermediation
Real Estate, Renting And Business Activities
Community Social And Personal Services
Public Admin And Defence; Compulsory Social Security
Education
Health And Social Work

Percentage Points

Capital
Labor
Industry Effects

Slovenia

Agriculture, Hunting, Forestry And Fishing
Mining And Quarrying
Food, Beverages And Tobacco
Textiles, Textile, Leather And Footwear
Wood And Of Wood And Cork
Pulp, Paper, Paper, Printing And Publishing
Chemical, Rubber, Plastics And Fuel
Other Non-Metallic Mineral
Basic Metals And Fabricated Metal
Machinery, Nec
Electrical And Optical Equipment
Transport Equipment
Manufacturing Nec; Recycling
Electricity, Gas And Water Supply
Construction
Wholesale And Retail Trade
Hotels And Restaurants
Transport And Storage
Post And Telecommunications
Financial Intermediation
Real Estate, Renting And Business Activities
Community Social And Personal Services
Public Admin And Defence; Compulsory Social Security
Education
Health And Social Work

Percentage Points

Capital Labor
Industry Effects

Czech Republic

Agriculture, Hunting, Forestry And Fishing
Mining And Quarrying
Food, Beverages And Tobacco
Textiles, Textile, Leather And Footwear
Wood And Of Wood And Cork
Pulp, Paper, Paper, Printing And Publishing
Chemical, Rubber, Plastics And Fuel
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Real Estate, Renting And Business Activities
Community Social And Personal Services
Public Admin And Defence; Compulsory Social Security
Education
Health And Social Work
Industry Effects

Japan

Agriculture, Hunting, Forestry And Fishing
Mining And Quarrying
Food, Beverages And Tobacco
Textiles, Textile, Leather And Footwear
Wood And Of Wood And Cork
Pulp, Paper, Paper, Printing And Publishing
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Real Estate, Renting And Business Activities
Community Social And Personal Services
Public Admin And Defence; Compulsory Social Security
Education
Health And Social Work

Percentage Points

-0.30
-0.20
-0.10
0.00
0.10
0.20

Capital  Labor
Industry Effects

- Broad based across industries.
- Counter balance positive and negative effects within countries.
- Capital and labor effects (mostly) positively correlated across industries.
- Real estate and renting stands out.
- Variance of labor reallocation effect across industries is higher than the variance of the capital reallocation effect.
Conclusions

- Input allocation potentially important in TFP differences across countries.

- This paper: small on average, sizable in instances (for this set of countries).

- Industry-level KLEMS accounts useful.
  - Work underway to expand.
  - Need underlying detail.

- Applying aggregate prices inconsistent with the industry data.