Searching for the Sources of Productivity from Macro to Micro (and back)

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Overview

• Growth theory and empirics
  – Micro foundations of representative firm
  – Applied to macro/sectoral data
  – Limited role for policy
• Firm-level studies:
  – Single country applied micro analysis
• ‘Macro’ analysis with micro data
  – ICT (with Office of National Statistics, et al.)
  – Reallocation (with Haltiwanger, Scarpetta)
  – Labor Policy (with Perotti, Scarpetta; and with Gautier, de Wind)
### Results from EUKLEMS

<table>
<thead>
<tr>
<th>1995-2005</th>
<th>EU</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VA%</td>
<td>--Kict</td>
</tr>
<tr>
<td>Market</td>
<td>2.1</td>
<td>.4</td>
</tr>
<tr>
<td>EleCom</td>
<td>3.8</td>
<td>.8</td>
</tr>
<tr>
<td>MfgxElc</td>
<td>1.2</td>
<td>.2</td>
</tr>
<tr>
<td>DISTR</td>
<td>2.6</td>
<td>.3</td>
</tr>
<tr>
<td>FinBus</td>
<td>3.5</td>
<td>.9</td>
</tr>
</tbody>
</table>

Source: Timmer, O’Mahony, and van Ark (2007)
Results from EU KLEMS

Questions still needing answers

• Why is contribution from IT capital lower in EU
  Or… Why is ICT investment lower

• Why is growth in high-tech so much lower
  Or… Why is high-tech sector small, especially in fast growing parts

• Why is unexplained growth so high? Why is TFP growth so much lower in EU
  Or… Why is TFP growth especially low in ICT intensive sectors

• What, if anything, is the role of policy
  Or… If policy affects firms and market interactions, what can industry data tell us about policy
Growth Theory

- Effects of policy on growth:
  - Production Factors
  - Externalities

\[ y_i = A_i + \sum_{s \in \{klems\}} \alpha_s X_s \]

\[ \Delta A_i = G(I_i, A_i, \bar{A}) \]
Searching for the Sources of Productivity

• How do the following policies affect productivity?
  – Employment protection
  – Trade policy
  – Competition policy
  – Business conditions

• Difficult to identify with standard theory, even using micro data
Models of Firm Dynamics

• Heterogeneous agents at micro level
  Diversity in firm-level (innovation) strategies
  Frictions, uncertainty, expectations

• Market selection
  Sales and input growth, conditional on productivity
  and economic ‘environment’

• Combination of firm-level productivity impact
  and market share evolution gives total impact
  on industry productivity
Models of Firm Dynamics

Firm choices
- Entry/Exit
- Intangible investment
- Factor inputs
- Product output

Market Selection
- Competition
- Policy Environment

Aggregate Productivity
Models of Firm Dynamics

\[ S_i \in \{N, E, C\} \]
conditional on \( C \):

\[ y_i = A_i + \sum_{s \in \{klems\}} \alpha_s X_s, \text{ where } i \in C \]

\[ \Delta A_i = G(I_i, A_i, \bar{A}) \]

and aggregate productivity

\[ \bar{A} = \sum_{i \in C} A_i + \sum_{i \in C} (\phi_i - \bar{\phi})(A_i - \bar{A}) \]
Firm-level, cross-country comparisons

- Policy environment affects all firms in country (and industry) in the same manner
- Cross-country firm-level comparisons may provide means to observe/identify the impacts of policy changes
- Policy affects:
  - Externalities, production factors
  - Selection
  - Allocation
From firm data to macro indicators

Longitudinal Micro Data

Single country

Surveys, Business Registers

• SC LMD

National Accounts Industry Data

Multiple countries

N.A.

EUKLEMS

Linked Indicators
Distributed Micro Data Analysis

- Policy Question
- Research Design
- Program Code
- Publication
- Metadata
- Cross-country Tables
- Network members
- Provision of metadata.
- Approval of access.
- Disclosure analysis
## Selected Firm-level indicators

<table>
<thead>
<tr>
<th>(percent)</th>
<th>US</th>
<th>EU</th>
<th>US</th>
<th>EU</th>
<th>US</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrant Size rel. to incumbent</td>
<td>21.0</td>
<td>38.6</td>
<td>6.3</td>
<td>35.7</td>
<td>24.0</td>
<td>40.8</td>
</tr>
<tr>
<td>Productivity Gap of Exiters</td>
<td>10.0</td>
<td>15.4</td>
<td>1.2</td>
<td>9.1</td>
<td>7.9</td>
<td>17.7</td>
</tr>
<tr>
<td>Employment Share of Exiters*</td>
<td>18.9</td>
<td>23.1</td>
<td>20.2</td>
<td>31.8</td>
<td>19.8</td>
<td>22.3</td>
</tr>
<tr>
<td>Employment growth, top qrt.</td>
<td>68.6</td>
<td>50.1</td>
<td>91.8</td>
<td>65.1</td>
<td>70.8</td>
<td>45.0</td>
</tr>
</tbody>
</table>
Policy and productivity

• Allocation of resources across firms
  • Demand and supply conditions affect firm-level input decisions

• Selection
  • Entry and exit decisions

• Choice of innovation strategy
  • Intangible investments
  • Technology adoption
Covariance Between Size and Productivity?

- Olley and Pakes (1996) static decomposition:

\[
P_t = \frac{1}{N_t} \sum_i p_{it} + \sum_i (\theta_{it} - \bar{\theta}_t)(p_{it} - \bar{P}_t)
\]

where: \(N_t\): # of firms in a sector;

- The first term is the unweighted average of firm-level productivity
- The second term (OP cross term) reflects allocation of resources: do firms with higher productivity have greater market share.
Model-based analysis of OP-gap

- Idiosyncratic distortions to profit:
  - Opportunistic taxes, bureaucratic control of resources

- Lead to distortions in firm size
  - lowers correlation between productivity and size

- But also affect selection
  - Some good firms may not enter
  - Inefficient churn
Why does old EU lag in new technology’?

• Stylized facts from firm-level data
  – Indicators from EU differ from those in US, especially in ICT industries
    • Firm demographics (entry/exit)
    • Firm-level inputs
    • Productivity distribution
  – Points towards ‘safe’ behavior of firms in EU
Choice of Innovation Strategy

• Experimental
  – High payoff, \( \Pi \)
  – very low probability of success, \( p \).

• Follower
  – Low payoff, \( \pi \);
  – diversifiable risk for follower strategy.

• When experiment fails: reconfigure, try again
  – Partial exit costs \( P_{EX} \) (Firms continue to experiment)
  – Total exit cost \( T_{EX} \) (Firms give up experimentation)
Payoffs for Experimentation

\[\Pi(1-p)p(-Px)\]

\[\Pi(1-p)^2(-R_x-T_x)\]
FYI: ICT and variability of outcomes

Firm-growth Distribution vs Broadband Use
Testable implications

- With more experimentation average productivity is higher
- With higher exit costs, experimentation is lower, especially at frontier
- So:
  - Exit costs lower productivity more in those sectors where potential gain from experimentation is higher
  - Exit costs lower experimentation, and more so near frontier
## Data

<table>
<thead>
<tr>
<th>Source</th>
<th>Periods</th>
<th>Countries</th>
<th>Coverage</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>EUKLEMS</td>
<td>1970-04</td>
<td>EU+US</td>
<td>All industries</td>
<td>Output, factor inputs, prices</td>
</tr>
<tr>
<td>OECD-EPL</td>
<td>1985-03</td>
<td>OECD</td>
<td>---</td>
<td>EPL indicators</td>
</tr>
<tr>
<td>WB-CDB</td>
<td>2004-07</td>
<td>World</td>
<td>--</td>
<td>Entry costs, firing costs, rigidities</td>
</tr>
<tr>
<td>BHS</td>
<td>1990s</td>
<td>Selection of OECD, Asia, Lat. Am.</td>
<td>30 industries, mostly mfg</td>
<td>Moments and correlations from underlying firm-level business surveys</td>
</tr>
<tr>
<td>ONS/Eurostat</td>
<td>2001-04</td>
<td>13 EU countries</td>
<td>All industries</td>
<td>Moments and correlations from underlying linked firm-level datasets</td>
</tr>
</tbody>
</table>
Empirical specification

• Main regression: TFP effect of exit costs

\[ V_{c,i,t} = \alpha + \sum_{x \in \text{lkk}^{IT}} \beta_x X_{c,i,t} + I_{c,i} (\gamma_0 + \gamma_1 F)_i + \sum \delta_j D_j + \varepsilon_{c,i,t} \]

where \( I_{c,t} = EPL_{c,t} \) or \( CDB_c \)

• Frontier indicators (by industry for US or UK):
  – Top quartile productivity relative to mean
  – Standard deviation of productivity
  – Adoption of Broadband
Exit costs and productivity

<table>
<thead>
<tr>
<th></th>
<th>Log(VA)</th>
<th>Log(VA)</th>
<th>Log(VA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent var:</td>
<td>Log(VA)</td>
<td>Log(VA)</td>
<td>Log(VA)</td>
</tr>
<tr>
<td>Regressor:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log: Kit, Knit, Hours</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>EPL</td>
<td>.47</td>
<td>.34</td>
<td>.46</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.14)</td>
<td>(0.19)</td>
</tr>
<tr>
<td>EPL x Rank</td>
<td>---</td>
<td>-1.18</td>
<td>-1.13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.07)</td>
<td>(3.08)</td>
</tr>
<tr>
<td>Rank variable</td>
<td>---</td>
<td>Top prod/mean quartile</td>
<td>Broadband-use</td>
</tr>
<tr>
<td>Num. obs.</td>
<td>7032</td>
<td>6790</td>
<td>7031</td>
</tr>
<tr>
<td>R-sq</td>
<td>.97</td>
<td>.97</td>
<td>.97</td>
</tr>
</tbody>
</table>
Innovation strategy and employment

• Mortensons-Pissarides type model with 2 sectors
  – 1: safe sector, known technology
  – 2: risky sector, draw from prod. distribution

• With firing costs, option of closing down conditional on bad draw is more expensive
  – So, fewer jobs created in risky sector
## Exit costs and employment

<table>
<thead>
<tr>
<th>Regressor:</th>
<th>Labor share in sector</th>
<th>Labor share in sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPL</td>
<td>.02</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>(0.74)</td>
<td>(0.74)</td>
</tr>
<tr>
<td>EPL x Rank</td>
<td>-0.82</td>
<td>-0.84</td>
</tr>
<tr>
<td></td>
<td>(10.30)</td>
<td>(10.55)</td>
</tr>
<tr>
<td>Rank variable</td>
<td>Top quartile prod/mean</td>
<td>Broadband-use</td>
</tr>
<tr>
<td>Num. obs.</td>
<td>5518</td>
<td>5518</td>
</tr>
<tr>
<td>R-sq</td>
<td>.84</td>
<td>.84</td>
</tr>
</tbody>
</table>
Value added per hour EU relative to US
(source: EU KLEMS, market sector, EU15)
Exit costs and productivity

- Productivity is reduced in industries that have potential gain from experimentation
- Employment share in innovative industries is reduced
- => High exit costs lower aggregate productivity
ICT Adoption

• Carrot and Stick:
  Profits to be gained if successful (taking into account market share gains)
  Competitive pressure: Market share/profit losses when others adopt successfully

• Costs and benefits:
  Readiness: skilled workers, high wages, complementary inputs
  Profits from being successful and scaling up business
Broadband Adoption and Impact

\[ a: v_{ijt} = a_0 + a_1 DSL\% + a_2 k^{IT} + a_3 k^N + a_4 hrs + \text{dummies} \]

\[ b: DSL\%_{ijt} = b_0 + b_1 w_{-1} + b_2 Cap\%_{-1} + b_3 HiSkl_{-1} + b_4 Churn + \text{dummies} \]

<table>
<thead>
<tr>
<th>v</th>
<th>(log) real value added</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kit</td>
<td>ICT capital service</td>
</tr>
<tr>
<td>Kn</td>
<td>Non-IT capital service</td>
</tr>
<tr>
<td>Hrs</td>
<td>hours</td>
</tr>
<tr>
<td>w</td>
<td>Average wage</td>
</tr>
<tr>
<td>Cap%it</td>
<td>ICT-capital as share of cap.</td>
</tr>
<tr>
<td>HiSkl</td>
<td>High skilled worker share</td>
</tr>
<tr>
<td>DSL%</td>
<td>Broadband penetration</td>
</tr>
<tr>
<td>Churn</td>
<td>Interquartile range of firm-level growth rate distribution</td>
</tr>
</tbody>
</table>
## Broadband Adoption and Impact

\[ a: v_{ijt} = a_0 + a_1 DSL\% + a_2 k^{IT} + a_3 k^N + a_4 hrs + \text{dummies} \]

\[ b: DSL\%_{ijt} = b_0 + b_1 w_{t-1} + b_2 Cap\%_{t-1} + b_3 HiSkl_{t-1} + b_4 Churn + \text{dummies} \]

<table>
<thead>
<tr>
<th>Variable</th>
<th>a: Log (value added); b: DSL%</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1 Broadband Penetration (DSL%):</td>
<td><strong>1.24</strong> 0.90</td>
</tr>
<tr>
<td>a2 Non-ICT Capital</td>
<td>0.35 0.27</td>
</tr>
<tr>
<td>a3 ICT Capital</td>
<td>-0.07 0.05</td>
</tr>
<tr>
<td>a4 Labor Hours</td>
<td>0.72 0.68</td>
</tr>
<tr>
<td>b1 Wage(t-1)</td>
<td>0.24 0.02</td>
</tr>
<tr>
<td>b2 ICT capital share(t-1)</td>
<td>0.31 0.20</td>
</tr>
<tr>
<td>b3 High-skill labor share(t-1)</td>
<td>0.18 0.38</td>
</tr>
<tr>
<td>b4 Churn</td>
<td><strong>0.30</strong> 0.15</td>
</tr>
<tr>
<td>Fixed effects</td>
<td>c,t i,t</td>
</tr>
<tr>
<td>Num. Obs.</td>
<td>659 646</td>
</tr>
</tbody>
</table>
Conclusions

• Country/Industry/Time panel regressions are useful to assess role of policy
• Expanding modelling framework to include selection and allocation increases understanding/identification of policy-productivity link
• Frictions in resource reallocation reduce intangible investment (ICT)