Innovation and firm dynamics – sources of differential productivity growth between countries, industries and firm groups

Mika Maliranta (Research Institute of the Finnish Economy ETLA and University of Jyväskylä)
Aggregate productivity and innovations

- In the long run, economic growth is based on aggregate productivity growth
- Innovations are the driving force of aggregate productivity growth
- Different innovations translate into higher aggregate productivity through different firm-level mechanisms
- Distinction between “incremental” and “radical” innovations is crucial when considering the roles of
  - R&D
  - Entrepreneurship
  - Differential aggregate productivity development between countries
Incremental innovations and productivity growth

• Achieved with low R&D efforts, low risks, low firm heterogeneity and productivity dispersion, and low "churn" of firms
• "Disembodied" technological change
• Important in low tech industries and countries/regions far away from international productivity frontiers
• Productivity gains are materialized "within firms", i.e. by average productivity growth of a "representative firm"
Radical innovations and productivity growth

- Achieved by risky R&D efforts, involve high productivity heterogeneity and high productivity dispersion, high "churning" of firms
- Technological change "bodied" into organization, plants/firms
- Important in high tech industries and among firms devoting to innovative efforts
- Productivity gains are achieved through market experimentation, selection and reallocation between lucky succesful and unlucky unsuccess firms, i.e. "creative destruction" components of aggregate productivity growth
Some theoretical background and motivations

• Innovation-based growth theories
  – Product variety model (Romer 1990)
    • No role for simultaneous entry, exit and reallocation
  – Schumpeterian model
    • Struggle for profits, with winners and losers
    • Development involves simultaneous entry, exit and reallocation

• (Re)allocation of resources between firms and productivity growth

• R&D and the role of allocation of innovators (Acemoglu, Akcigit, Bloom and Kerr 2013)

• Entrepreneurship and experimentation in the markets (Kerr, Nanda, Rhodes-Kropf 2014)
Two forms of productivity growth

- **Productivity growth within firms**, i.e. (weighted average) productivity growth rate of the firms (WH)

- **Productivity-enhancing firm-level restructuring**, i.e. "creative destruction" (STR)
  - Entry and exit
  - Reallocation between incumbents (bw)

\[
AGG = WH + STR
\]

\[
STR = \text{entry} + \text{exit} + \text{bw}
\]
Measurement of two forms of aggregate productivity growth

• Popular methods:
  – It is possible that WH $\neq$ AGG when no heterogeneity and entries and exits totally random
  – Within effect does not indicate the growth rate of the firms

• Alternative methods draw a shard distinction between productivity growth of firms and aggregate productivity:
  – Links with index theory
  – Within component measured by an Bennet-type chain-index
  – Structural component = AGG – WH
Measurement of two forms of aggregate productivity growth

• "Log-version" (e.g. Hyytinen-Maliranta 2013)

\[
\Delta \bar{\Phi}_1 = \sum_{i \in \Omega_s} \bar{s}_{i}^{\text{stayer}} \cdot \Delta \bar{\phi}_i + \sum_{i \in \Omega_s} \bar{\phi}_i \cdot \Delta s_{i}^{\text{stayer}} + S_{1}^{\text{entrant}} \left( \bar{\Phi}_{1}^{\text{entrant}} - \bar{\Phi}_{1}^{\text{stayer}} \right) + S_{0}^{\text{exit}} \left( \bar{\Phi}_{0}^{\text{stayer}} - \bar{\Phi}_{0}^{\text{exit}} \right)
\]

\[
\bar{\phi}_{i1} = \ln \frac{Y_{i1}}{L_{i1}} \quad s_{i1} = \frac{L_{i1}}{L_{i1}} \quad \bar{\Phi} = \sum s_{i} \bar{\phi}_i
\]

• and "non-log-version" (e.g. Böckerman-Maliranta 2012)

\[
\frac{\Phi_{1} - \Phi_{0}}{\Phi} = \sum_{i \in \Omega_s} \bar{s}_{i}^{\text{stayer}} \frac{\Delta \phi_i}{\bar{\phi}_i} + \sum_{i \in \Omega_s} \bar{s}_{i}^{\text{stayer}} \left( \frac{\bar{\phi}_i}{\Phi} - 1 \right) + \sum_{i \in \Omega_s} \frac{\bar{\phi}_i}{\Phi} \cdot \Delta s_{i}^{\text{stayer}} + S_{1}^{\text{entrant}} \left( \frac{\Phi_{1}^{\text{entrant}} - \Phi_{1}^{\text{stayer}}}{\Phi} \right) + S_{0}^{\text{exit}} \left( \frac{\Phi_{0}^{\text{stayer}} - \Phi_{0}^{\text{exit}}}{\Phi} \right)
\]

\[
\phi_{i1} = \frac{Y_{i1}}{L_{i1}} \quad s_{i1} = \frac{L_{i1}}{L_{i1}} \quad \Phi = \sum s_{i} \phi_i
\]

• Note that \( \ln \frac{\Phi_{1}}{\Phi_{0}} \approx \frac{\Phi_{1} - \Phi_{0}}{\Phi} \)

• But \( \ln \frac{\Phi_{1}}{\Phi_{0}} \neq \bar{\Phi}_1 - \bar{\Phi}_0 \)
DIFFERENCES BETWEEN COUNTRIES
Labor productivity within business sector industries, normalized industry structures, index 2000 = 100

Within firms

"Creative destruction"

 Computations made in collaboration with Karsten Albæk and Fredrik Heyman in the NORWELL-project
Labor productivity within manufacturing industries excl. electr/electronics, normalized industry structures, index 2000 = 100

Computations made in collaboration with Karsten Albæk, Erling Barth and Fredrik Heyman in the NORWELL-project
Labor productivity within private service industries, normalized industry structures, index 2000 = 100

Computations made in collaboration with Karsten Albæk and Fredrik Heyman in the NORWELL-project
INNOVATION ACTIVITY AND CREATIVE DESTRUCTION
“Creative destruction” among innovative and less innovative firms (within industries)

Low innovation

High innovation

Low risk & low productivity gain

High risk & high productivity gain

productivity

FIRM

INDUSTRY

t

t+5
Innovative firms and creative destruction

• Analysis with Finnish linked employer-employee data
• All firms in each 1-2 digit industry are classified into three groups
  – High intensity: employment share of ”innovators” 20%-100%
  – Medium intensity: employment share of ”innovators” 10-20%
  – Low intensity: employment share of ”innovators” 0–10%
   ”Innovators” = managers and professionals
• Aggregate productivity growth of each firm group is decomposed into micro-level sources
• Hypothesis: firms with high innovation intensity have
  – Large productivity dispersion
  – Large ”creative destruction” component
Productivity dispersion between firms (std. of log Y/L), normalized industry structures

a) Business sector industries

b) Manufacturing industries

- Innovation activity
- High
- Medium
- Low

c) Service industries

d) Manufacturing industries without electronics

- Innovation activity
- High
- Medium
- Low
Productivity growth within firms, normalized industry-structures, index 2004 = 1

- **a) Business sector**
  - Innovation intensity
    - low
    - medium
    - high

- **b) Manufacturing**
  - Innovation intensity
    - low
    - medium
    - high

- **c) Services**
  - Innovation intensity
    - low
    - medium
    - high

- **d) Manufacturing without electronics**
  - Innovation intensity
    - low
    - medium
    - high
Creative destruction, normalized industry-structures, index 2004 = 1

**a) Business sector**

Innovation intensity
- low
- medium
- high

**b) Manufacturing**

Innovation intensity
- low
- medium
- high

**c) Services**

Innovation intensity
- low
- medium
- high

**d) Manufacturing without electr.**

Innovation intensity
- low
- medium
- high