Productivity and Efficiency Analysis

8) Structural change

a) Entry and exit

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Backgroung and motivation

- Traditionally productivity growth seen as a synonym for technical progress (e.g., Solow, 1957)
- Malmquist index recognizes efficiency improvement as another source of productivity growth
- In the 1990s, structural change emerged as a source of productivity growth at the industry level:
  - Baily, Hulten, Campbell (1992), Griliches and Regev (1995)
  - Olley and Pakes (1996)

Olley and Pakes (1996)

- Empirical motivation: deregulation of the US telecommunications industry
- Entry of new firms to the industry
- Balanced vs unbalanced panel?

INDUSTRY PRODUCTIVITY GROWTH RATES[a]

Time Period	(1) Full Sample	(2) Balanced Panel
1974–1975	−.279	−.174
1975–1977	.020	−.015
1978–1980	.146	.102
1981–1983	−.087	−.038
1984–1987	.041	.069
1974–1987	.008	.020
1975–1987	.032	.036
1978–1987	.034	.047

[a] The numbers in Table IX are annual averages over the various subperiods.

Olley and Pakes (1996)

- Decomposition of industry-level productivity

industry productivity is a weighted average of plant-level productivity, with shares of industry output as weights,

$$p_t = \sum_{i=1}^{N_t} s_{it} p_{it},$$

where p_t is industry productivity at time t, p_{it} is plant level productivity, and s_{it} is plant i's share of output at time t. Now decompose p_t into two terms as follows:

$$(16) \qquad p_t = \sum_{i=1}^{N_t} (\bar{s}_t + \Delta s_{it})(\bar{p}_t + \Delta p_{it})$$

$$= N_t \bar{s}_t \bar{p}_t + \sum_{i=1}^{N_t} \Delta s_{it} \, \Delta p_{it}$$

$$= \bar{p}_t + \sum_{i=1}^{N_t} \Delta s_{it} \, \Delta p_{it}$$

where

$$\Delta s_{it} = s_{it} - \bar{s}_t \quad \text{and} \quad \Delta p_{it} = p_{it} - \bar{p}_t,$$

and $\bar{p}_t$ and $\bar{s}_t$ represent unweighted mean productivity and unweighted mean share, respectively.

Olley and Pakes (1996)

- Decomposition expressed in terms of **productivity level**, not productivity growth $p_{it} = \exp(y_{it} - b_l l_{it} - b_k k_{it} - b_a a_{it})$

$$P_t = \overline{p}_t + \sum_{i=1}^{N_t} \Delta s_{it} \Delta p_{it} \ .$$

- Industry productivity = average firm productivity + reallocation term

- The reallocation term does not draw a distinction between reallocation of resources across existing firms and the contribution of entry and exit

Baily, Hulten, Campbell (1992)

- Three groups of firms: survivors (S), entrants (E), exiting firms (X)

- Decomposition of industry *productivity change* (%): φ denotes the logarithm of productivity

$$
\begin{aligned}
\Delta\Phi &= \sum_{i\in S}(s_{i2}\varphi_{i2} - s_{i1}\varphi_{i1}) + \sum_{i\in E} s_{i2}\varphi_{i2} - \sum_{i\in X} s_{i1}\varphi_{i1} \\
&= \sum_{i\in S} s_{i1}(\varphi_{i2} - \varphi_{i1}) + \sum_{i\in S}(s_{i2} - s_{i1})\varphi_{i2} + \sum_{i\in E} s_{i2}\varphi_{i2} - \sum_{i\in X} s_{i1}\varphi_{i1},
\end{aligned}
$$

$$
\begin{aligned}
&\Delta\Phi = \Phi_t - \Phi_{t-1} \\
&= \ln P_t - \ln P_{t-1} \\
&\cong (P_t - P_{t-1}) / P_{t-1}
\end{aligned}
$$

Alternative decompositions with entry and exit

- Melitz and Polanec (2015) *Rand J Econ*

TABLE 1 Productivity Contributions of Surviving, Entering, and Exiting Firms

Group	GR	FHK	DOPD
Surviving firms	$s_{S2}(\Phi_{S2} - \bar{\Phi}) - s_{S1}(\Phi_{S1} - \bar{\Phi})$	$s_{S2}(\Phi_{S2} - \Phi_1) - s_{S1}(\Phi_{S1} - \Phi_1)$	$\Phi_{S2} - \Phi_{S1}$
Entering firms	$s_{E2}(\Phi_{E2} - \bar{\Phi})$	$s_{E2}(\Phi_{E2} - \Phi_1)$	$s_{E2}(\Phi_{E2} - \Phi_{S2})$
Exiting firms	$s_{X1}(\bar{\Phi} - \Phi_{X1})$	$s_{X1}(\Phi_1 - \Phi_{X1})$	$s_{X1}(\Phi_{S1} - \Phi_{X1})$

GR = Griliches and Regev (1995)
FHK = Foster, Haltiwanger, Krizan (2001)
DOPD = Dynamic Olley-Pakes Decomposition by Melitz and Polanec (2015)

Combining Olley-Pakes with entry and exit

- Several studies: Maliranta (2003), Böckerman and Maliranta (2007), Diewert and Fox (2009), Hyytinen and Maliranta (2013), and Maliranta and Määttänen (2015)

- DOPD by Melitz and Polanec (2015) *Rand J Econ*

$$P_t - P_{t-1} = \left(\bar{p}_{S,t} - \bar{p}_{S,t-1}\right) + \left[\sum_{i \in S} \mathrm{cov}\left(s_{it}, p_{it}\right) - \sum_{i \in S} \mathrm{cov}\left(s_{i,t-1}, p_{i,t-1}\right)\right]$$

$$+ s_{Et}\left(P_{Et} - P_{St}\right) + s_{X,t-1}\left(P_{S,t-1} - P_{X,t-1}\right)$$

Combining Olley-Pakes with entry and exit

- DOPD by Melitz and Polanec (2015) *Rand J Econ*

$$P_t - P_{t-1} = \left(\bar{p}_{S,t} - \bar{p}_{S,t-1}\right) + \left[\sum_{i \in S} \operatorname{cov}\left(s_{it}, p_{it}\right) - \sum_{i \in S} \operatorname{cov}\left(s_{i,t-1}, p_{i,t-1}\right)\right]$$

$$+ s_{Et}\left(P_{Et} - P_{St}\right) + s_{X,t-1}\left(P_{S,t-1} - P_{X,t-1}\right)$$

- *Error*: OP decomposition stated in *levels* of productivity, MP assume them to be in *logs*
- DOPD is correct for the difference of productivity indices, but it is incorrect to interpret as a percentage change of productivity

Next lesson

8b) Share weights