Title: Productivity, Job Creation and Entrepreneurship

Lecture Notes for NBER Entrepreneurship Bootcamp
July 2013
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Share of Firms by Firm Size, 2010

- Micro Firms (1-9 employees), 3,825,610
- Small-Medium (10-500 employees), 1,172,026
- Large Firms (500+ employees), 18,573

Total: 5,120,169
Micro Firms (1-9 employees), 12,606,035

Small-Medium (10-500 employees), 42,676,395

Large Firms (500+ employees), 55,892,580

Share of Employment by Firm Size, 2010
Job Creation and Destruction, U.S. Private Sector, Annual Rates (Percent of Employment), 1980-2009

**Job Creation**
- Total = 16.9
  - Continuing Establishments: 10.6
  - New Establishments (Existing Firms): 3.2
  - New Firms: 3.1

**Job Destruction**
- Total = 15.3
  - Continuing Establishments: 10
  - Exiting Establishments (Continuing Firms): 2.4
  - Exiting Firms: 2.9

Source: BDS
Share of Employment in Startups by Firm Size Class

- Share: 0.2
- 0.15
- 0.1
- 0.05
- 0.0

Categories:
- a) 1 to 4
- b) 5 to 9
- c) 10 to 19
- d) 20 to 49
- e) 50 to 99
- f) 100 to 249
- g) 250 to 499
- h) 500 to 999
- i) 1000 to 24
- j) 2500 to 49
- k) 5000 to 99
- l) 10000+
Up or Out Dynamics of Young U.S. Firms

- Net Employment Growth (Continuing Firms)
- Job Destruction from Exit
90th and 10th Percentiles of Net Employment Growth Rates for Surviving U.S. Private Sector Firms by Firm Age

Source: Firm-level data used by Haltiwanger, Jarmin and Miranda (2011)
Startups and High Growth (Annual Growth > 25 percent) Existing Firms Disproportionately Create Jobs, U.S. Private Sector

Source: Tabulations from Firm-Level Data Used in Haltiwanger, Jarmin and Miranda (2011)
What accounts for cross sectional and dynamic patterns?

• Very skewed size distribution
• Constant state of churning
  • Wave of entering firms contributes substantially to job creation each year
  • Most exit
  • Conditional on survival, young businesses grow quickly
  • Even amongst large, mature businesses high pace of churning of jobs and businesses
Productivity Distribution Within Narrowly Defined Industries

Interquartile Range of TFP is 30 log points
Share of Reallocation Between and Within Detailed Industries

- Between Industry: 13%
- Within Industry: 87%
U.S. Labor Productivity: Comparison Between Actual and Random Allocation of Size of Businesses
Covariance Between Size and Productivity (within industries)
Change in Covariance (within industries)
Components of Total Factor Productivity Growth over Five-Year Horizons, 1977-1997, Selected Manufacturing Industries

<table>
<thead>
<tr>
<th>Component</th>
<th>Total</th>
<th>Within</th>
<th>Reallocation Among Existing Establishments</th>
<th>Net Entry</th>
</tr>
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<tr>
<td>Components of Total Factor Productivity Growth over Five-Year Horizons, 1977-1997, Selected Manufacturing Industries</td>
<td>5.13</td>
<td>3.44</td>
<td>0.35</td>
<td>1.35</td>
</tr>
</tbody>
</table>
Productivity of Young Businesses Relative to Mature Surviving Incumbents, U.S. Retail Trade

Young Exits
-31.60% -32%

Mature Exits
-26.20% -27%

Young Survivors
2.80% 3%

Young Survivors Five Years Later
1.20% 5%

Legend:
- Single Unit Establishment Firms
- All establishments
Ownership Change, Management, Financing...

• Many factors underlie the ongoing restructuring and reallocation of businesses
• For allocative efficiency, financial markets need to be facilitating the reallocation of resources to the most productive businesses
• Ownership/management practices and changes are part of these dynamics.
• Example: Private Equity
Impact of Private Equity on Net and Job Reallocation

- Excess Within Firm Reallocation
- Excess Reallocation
- Job Reallocation
- Net
- Job Destruction
- Job Creation

[Bar chart showing the comparison between Organic and All categories for each category mentioned above.]
Exit Probability of Targets and Controls by Terciles of Within Industry Productivity Distribution

Entry Probability of Targets and Controls by Terciles of Within Industry Productivity Distribution
Two Year Productivity Growth Impact From Private Equity

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Total Productivity Growth Differential</td>
<td>2.09</td>
</tr>
<tr>
<td>Excluding Acquisition/Divestiture</td>
<td>1.96</td>
</tr>
<tr>
<td>Share of Total from:</td>
<td></td>
</tr>
<tr>
<td>Continuing Establishments</td>
<td>0.20</td>
</tr>
<tr>
<td>Net Entry</td>
<td>0.74</td>
</tr>
<tr>
<td>Net Acquisition</td>
<td>0.06</td>
</tr>
</tbody>
</table>
Some Disturbing Trends?
Declining Pace of Creation and Destruction in BED

Source: BLS BED DATA
Figure 1: Annual job creation and destruction rates, 1980-2011

Notes: Author calculations from the U.S. Census Bureau’s Business Dynamics Statistics. Filter is Hodrick-Prescott with multiplier 400. Vertical axis does not begin at zero.
Figure 2: Annual startup rate and average startup size, 1980-2011

Notes: Author calculations from the U.S. Census Bureau’s Business Dynamics Statistics. Left vertical axis does not begin at zero.
Figure 3: Declining share of activity from young firms (firm age five or less)

Notes: Author calculations from the U.S. Census Bureau’s Business Dynamics Statistics. Employment shares in each period based on the average of employment in period t-1 and t (the denominator of the DHS growth rate).
Figure 4: Average flows by firm age, 1982-2011

Notes: Author calculations from the U.S. Census Bureau’s Business Dynamics Statistics.
Figure 5: Sector share of employment, 1980-2011

Notes: Author calculations from the U.S. Census Bureau’s Business Dynamics Statistics. Broad sectors are on SIC basis. AGR= Agricultural Services, MIN=Mining, CON=Construction, MAN=Manufacturing, TCU=Transportation, Communication and Utilities, WHO=Wholesale Trade, RET=Retail Trade, FIRE = Finance, Insurance and Real Estate, and SRV=Services.
Figure 6: Average job flows by sector, 1980-2011

Notes: Author calculations from the U.S. Census Bureau’s Business Dynamics Statistics. Sector definitions from SIC. See notes from Figure 5 for details on sectoral abbreviations.
Figure 9: Percent of decline in job flows from 1987/89 to 2004/06 (averages) accounted for by composition effects

Notes: Author calculations from the U.S. Census Bureau’s Longitudinal Business Database. See text for details of the decomposition used to generate these calculations.
NUTS AND BOLTS of PRODUCTIVITY MEASUREMENT
Measurement of Plant-level Productivity

$$t fp_i = y_i - \alpha_l l_i - \alpha_k k_i - \alpha_m m_i - \alpha_e e_t$$

All variables in logs, difficult measurement. Issues on outputs and inputs and factor elasticities.

Typical to assume Cobb-Douglass or to have Divisia index approach approximation.
Measurement issues

• Factor inputs:
  • Labor quality
  • Capital stock (book value vs. perpetual inventory)

• Factor elasticities:
  • Cost shares, estimated elasticities using OLS, IV, proxy methods
  • All typically estimate factor elasticities at the industry level
    • Time invariant with estimated approach typically given Cobb-Douglass assumptions
    • Estimates vary in literature but measures of TFP highly correlated across these methods. Other issues (below) appear to matter more.

• Plant-level heterogeneity in output and input prices
• Plant-level heterogeneity in factor elasticities
More Basic Measures of Productivity Are Often Used

• Labor productivity Measures at the Establishment (or Firm level)
  • Real Value Added Per Worker

\[ RLP_{et} = \left( \frac{VA_{et}}{TE_{et}} \right) = \left( \frac{Y_{et} - M_{et}}{TE_{et}} \right) \]

Where
- \( Y_{et} = \) Real Gross Output
- \( M_{et} = \) Real Materials (including energy)
- \( Te_{et} = \) Total Employment

Use detailed industry output and material price deflators

Often best available measure is real gross output per worker – comparable within industries
Example of proxy method

\[ y_{jt} = \beta_0 + \beta_k k_{jt} + \beta_a a_{jt} + \beta_l l_{jt} + \omega_{jt} + \eta_{jt} \]  \hspace{2cm} (24)

\[ i_{jt} = i(k_{jt}, a_{jt}, \omega_{jt}, \Delta_t) = i_t(k_{jt}, a_{jt}, \omega_{jt}). \]  \hspace{2cm} (27)

\[ \omega_{jt} = h_t(k_{jt}, a_{jt}, i_{jt}). \]  \hspace{2cm} (28)

\[ y_{jt} = \beta_0 + \beta_k k_{jt} + \beta_a a_{jt} + \beta_l l_{jt} + h_t(k_{jt}, a_{jt}, i_{jt}) + \eta_{jt}. \]  \hspace{2cm} (29)

\[ y_{jt} - \beta_l l_{jt} = \beta_0 + \beta_k k_{jt} + \beta_a a_{jt} + \omega_{jt} + \eta_{jt}. \]  \hspace{2cm} (33)

\[ y_{jt} - \beta_l l_{jt} \]
\[ = \beta_0 + \beta_k k_{jt} + \beta_a a_{jt} + g(\omega_{jt-1}) + \xi_{jt} + \eta_{jt} \]  \hspace{2cm} (34a)
\[ = \beta_0 + \beta_k k_{jt} + \beta_a a_{jt} + g(\phi_{jt-1} - \beta_0 - \beta_k k_{jt-1} - \beta_a a_{jt-1}) + \xi_{jt} + \eta_{jt} \]
\[ = \beta_k k_{jt} + \beta_a a_{jt} + \tilde{g}(\phi_{jt-1} - \beta_k k_{jt-1} - \beta_a a_{jt-1}) + \xi_{jt} + \eta_{jt}, \]  \hspace{2cm} (34b)

Depends critically on the invertibility amongst other assumptions
Cobb-Douglas Technology, CRS
Isoelastic Demand, No Frictions,
Price takers in factor markets

No dispersion in factor cost
share ratio, Revenue average
product of capital, revenue average
product of labor, TFPR

Even though there is dispersion
In TFPQ
Why is there so much dispersion in productivity across businesses in narrowly defined sectors?

**Background facts:**
- Interquartile range of log of Revenue TFP (TFPR) is 0.29
- Interquartile range of log of Revenue Labor Productivity (RLP) is 0.65
- Dispersion in TFPQ, TFPR, and output price within narrow product classes (7-digit) in U.S. (Source: FHS (2008)):
  - Std. Dev of log(TFPQ) is: 0.26
  - Std. Dev of log(TFPR) is: 0.22
  - Std. Dev of log(RLP) is: 0.65
  - Std. Dev of log(P) is: 0.18
  - Std. Dev of log(Q) is: 1.05
  - Corr(log(TFPQ),log(P)) is: -0.54
  - Corr(log(TFPQ),log(Q)) is: 0.28
  - Corr(log(TFPQ),log(TFPR)) is: 0.75
  - Corr(log(TFPQ),log(RLP)) is: 0.56
Frictions + Distortions

- Costs of Entry (and exit)
  - Including costs of entering new markets
  - Hopenhayn (1992), Melitz (2003), Melitz and Ottaviano (2005)
- Learning (initial conditions and after changing products/processes)
  - Experimentation
- Adjustment costs for factors of production (capital, labor, intangible capital)
  - Convex vs. Nonconvex
- Economies of scope and control
- Product Differentiation:
  - Horizontal (e.g., spatial) vs. Vertical
- Output and input price dispersion and determination
- Imperfections in product, labor, capital, credit markets
- Distortions to all of the above + market institutions
  - Idiosyncratic distortions as in Banerjee and Duflo (2003), Restuccia and Rogerson (2008), Hsieh and Klenow (2009), Bartelsman, Halliwanger and Scarpetta (2013)
What frictions matter the most?

• Many studies showing evidence of entry costs, labor adjustment costs, capital adjustment costs, trade costs, product differentiation, and so on.

• Many open questions and issues:
  • Not practical to include all frictions in all models – but caution about identification since we are all using same data
  • How do frictions vary across advanced vs. emerging vs. transition?

• Important to distinguish between those frictions that yield some plants persistently higher productivity than others as opposed to adjustment dynamics
Lots of margins for distortions...

- Cross sectional misallocation
- Dynamic distortions:
  - Startups
  - Post-entry up or out dynamic
  - Creative Destruction
- Secular vs. Cyclical Distortions
Prob Of Exit (firm)

Firm Productivity

Healthy Economy

Distorted Economy
Impact of Trade Reform on Plant Exit Hazard in Colombia

Diff in Diff approach to identification using industry-specific changes in tariffs

Source: Eslava, Haltiwanger, Kugler and Kugler (2012)
Healthy Economy

Distorted, Uncertain Economy

Range of inaction (increases with uncertainty and distortions)

Firm Productivity Shock
Impact of Trade Reform on TFP(Q) in Colombia

Source: Eslava, Haltiwanger, Kugler and Kugler (2012)
Taking Stock

• High pace of churning of businesses within narrowly defined industries
• Startups and young businesses play an important role in these dynamics
• Up or out dynamics
• These dynamics connected to productivity (and demand) dynamics at the micro level
• Identifying the frictions and how they vary across industry, time, and country ongoing activity
• But what about before entry?
How Do We measure the CONTRIBUTION OF REALLOCATION?
Size/productivity relationship within industries

\[
\Omega_t = \sum_i s_{it} \omega_{it}
\]

\[
= \left(1/ \ N_t \right) \sum_i \omega_{it} + \sum_i \left( s_{it} - \left(1/ \ N_t \right) \sum_i s_{it} \right) \left( \omega_{it} - \left(1/ \ N_t \right) \sum_i \omega_{it} \right)
\]

Olley and Pakes (1996) decomposition

\[
\Delta \Omega_t = \sum_i s_{it} \omega_{it} - \sum_i s_{it-1} \omega_{it-1}
\]

\[
= \sum_{i \in C} s_{it} \Delta \omega_{it} + \sum_{i \in C} \Delta s_{it} \left( \overline{\omega_{it}} - \overline{\Omega_t} \right) + \sum_{i \in N} s_{it} \left( \omega_{it} - \overline{\Omega_t} \right) - \sum_{i \in X} s_{it-1} \left( \omega_{it-1} - \overline{\Omega_t} \right)
\]

\[
= within + reallocation + entry - exit
\]

Modified Baily, Hulten and Campbell (1992) and Griliches and Regev (1995) decomposition
Comments on Decomposition in Literature

• Some questions about how to interpret industry-level index defined in this manner
  • Typical check (e.g., BHC and FHK) to see how this index performs relative to standard aggregate *industry* measures
    • Common result – magnitudes very similar and correlations high in most studies
  • Cautions:
    • These measures very sensitive to measurement error since depend on measuring within industry productivity (log) level dispersion accurately
    • Not appropriate for decompositions that exploit between industry variation (measurement and index problems)

• Standard decomposition summarizes changes in activity weighted micro distribution

• Decompositions more closely tied to aggregate welfare and productivity have been developed (Petrin and Levinsohn (2008), Basu and Fernald (2002))

• Alternatively, these decompositions can be used as moments to match in a calibration or indirect inference approach (see, e.g., Bartelsman, Haltiwanger and Scarpetta (2009))
Olley and Pakes (1996) results for Telecommunications equipment

<table>
<thead>
<tr>
<th>Year</th>
<th>$p_t$</th>
<th>$\bar{p}_t$</th>
<th>$\Sigma_t \Delta s_{it} \Delta p_{it}$</th>
<th>$\rho(p_{it}, k_{it})$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1974</td>
<td>1.00</td>
<td>0.90</td>
<td>0.01</td>
<td>-0.07</td>
</tr>
<tr>
<td>1975</td>
<td>0.72</td>
<td>0.66</td>
<td>0.06</td>
<td>-0.11</td>
</tr>
<tr>
<td>1976</td>
<td>0.77</td>
<td>0.69</td>
<td>0.07</td>
<td>-0.12</td>
</tr>
<tr>
<td>1977</td>
<td>0.75</td>
<td>0.72</td>
<td>0.03</td>
<td>-0.09</td>
</tr>
<tr>
<td>1978</td>
<td>0.92</td>
<td>0.80</td>
<td>0.12</td>
<td>-0.05</td>
</tr>
<tr>
<td>1979</td>
<td>0.95</td>
<td>0.84</td>
<td>0.12</td>
<td>-0.05</td>
</tr>
<tr>
<td>1980</td>
<td>1.12</td>
<td>0.84</td>
<td>0.28</td>
<td>-0.02</td>
</tr>
<tr>
<td>1981</td>
<td>1.11</td>
<td>0.76</td>
<td>0.35</td>
<td>0.02</td>
</tr>
<tr>
<td>1982</td>
<td>1.08</td>
<td>0.77</td>
<td>0.31</td>
<td>-0.01</td>
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<tr>
<td>1983</td>
<td>0.84</td>
<td>0.76</td>
<td>0.08</td>
<td>-0.07</td>
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<tr>
<td>1984</td>
<td>0.90</td>
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<td>1986</td>
<td>0.92</td>
<td>0.72</td>
<td>0.20</td>
<td>0.03</td>
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<tr>
<td>1987</td>
<td>0.97</td>
<td>0.66</td>
<td>0.32</td>
<td>0.10</td>
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</tbody>
</table>

*See text for details.*
Olley-Pakes Decomposition for Colombian Manufacturing

Source: Eslava et al. (2005)
Olley Pakes Decomposition of Labor Productivity
(Average Industry)

China

Overall, Unweighted average

Year

Unweighted Average
Overall
OP_gap
Pre-Entry History of entrepreneurs
“Before” Entry....

• Entrepreneurial dynamics starts at micro business level

• Entrepreneurs start with an idea – often while employed elsewhere

• New longitudinal databases at U.S. Census Bureau tracking this process
  • ILBD: Nonemployers (e.g., sole props without employees) + Employers
  • LEHD/SED: Tracking transitions from W&S jobs to self-employed jobs
Micro Businesses constitute a large share of businesses and a small share of revenue…

Source: Davis et. al. (2008)
Shares of New Employer Businesses in 1997 with Pre-History as Nonemployer Businesses

Source: Davis et al. (2008)
Propensity to Diversify in Labor Market Varies in Important Ways Across Worker Life Cycle

Percent of 1992 Wage and Salary Earners moving to Partial Self-Employment by 1997: By Age Category
Propensity to Diversify in Labor Market Varies in Important Ways Across Worker Life Cycle

Percent of 1992 Partially Self-Employed moving to Full Self-Employment by 1997: By Age Category

<table>
<thead>
<tr>
<th>Age Category</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>u25</td>
<td>6</td>
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<tr>
<td>25 to 34</td>
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<tr>
<td>35 to 54</td>
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<td>55 to 64</td>
<td>15</td>
</tr>
<tr>
<td>65p</td>
<td>18</td>
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Small Businesses With and Without Paid Employees Differ in Fundamental Ways

**Job Stability -- Likelihood of Staying in Same Labor Market State**

- W&S only
- Sole Proprietor (N) only
- Sole Proprietor (E) only
Data

• Tracking U.S. Business Dynamics
  • The Longitudinal Business Database
    • 1975-2005 (08) – long time series permits analysis by firm age
    • Private Non Farm Economy
    • Establishment level with Firm identifiers
    • High quality establishment links to identify entry/exit
      • Need both firm and establishment level data to get dynamics right
    • Firm Size: constructed by aggregating employment up to firm
    • Firm Age: constructed from age of oldest establishment at time of firm birth
  • Other: Payroll, Industry, Location (Lat/Lon possible)
  • Can be integrated with data from Economic Censuses and Annual Surveys as well as external data (COMPUSTAT, Venture Capital, Private Equity)
Micro Productivity Data in U.S.

• Manufacturing:
  • Annual Survey of Manufactures and Census of Manufactures
    • Nominal revenue and expenditures
    • Can construct measures of real outputs and inputs
    • Five year panel rotation so longitudinal analysis possible (but requires careful treatment of data)
    • Selected products have physical quantities

• Retail Trade
  • Census of Retail Trade
    • Nominal revenue so a gross output per store measure feasible
New data on micro businesses

- **ILBD:**
  - Tracks all nonemployer and employer businesses including transitions
- **LEHD:**
  - Tracks all employer-employee matches in U.S.
  - Can be integrated with ILBD
  - Enables tracking of transitions between W&S, an owner of nonemployer business and owner of employer business
Availability of data

• Public domain tabulations available at:
http://www.ces.census.gov/index.php/bds/bds_home

• Census NSF/RDC access at:
http://www.ces.census.gov/index.php/ces/researchguidelines

• Sensitive data:
  • Must work in enclave (NBER, NYCRDC, Washington, D.C., Chicago Fed, Duke, UCLA, UC-Berkeley, Univ. of Michigan, Cornell, Stanford, Univ. of Minn., Atlanta, …)
  • Predominant purpose must benefit U.S. Census
Extra Slides on Firm Dynamics model
Standard Heterogeneous-Producer Industry Models

The Workhorse:

- Producers $i$ differ in a profitability component $\omega_i$, usually taken to represent costs/productivity.

- Profits depend on $\omega_i$ and industry state $S$: $\pi_i = \pi_i(\omega_i, S)$  $\omega_i \sim G(\omega)$

- There is some critical $\omega^*$ such that producers with $\omega_i < \omega^*$ have NPVs below outside option and therefore exit the industry.

- Industry state $S$ typically depends on endogenously determined distribution of $\omega_i$ among producers (add’l free entry assumption).

Closely Related Issue – Size Distribution of Activity

- $\pi_i = \pi_i(\omega_i, S)$ has curvature either from decreasing returns (e.g., Lucas (1978)) or product differentiation (e.g., Melitz (2003))
- Curvature pins down the size distribution of activity and permits studying the evolution of the size distribution of activity
- In healthy market economies, most productive plants are the largest – allocative efficiency
- Active literature attempting to explain cross country differences in productivity (e.g., Hsieh and Klenow (2009)) using distortions on this margin

Industry is comprised of a continuum of producers of measure \( N \). Each produces a single variety (indexed by \( i \)) of industry product. Representative consumer’s utility function

\[
U = y + \int \left( \alpha + \delta_i \right) q_i di - \frac{1}{2} \eta \left( \int q_i di \right)^2 - \frac{1}{2} \gamma \int q_i^2 di
\]

\[
= y + \alpha \int q_i di - \frac{1}{2} \left( \eta + \frac{\gamma}{N} \right) \left( \int q_i di \right)^2 + \int \delta_i q_i di - \frac{1}{2} \gamma \int (q_i - \bar{q})^2 di
\]

\( \alpha > 0, \, \eta > 0, \, \text{and} \, \gamma \geq 0. \)

\( y \) = numeraire good

\( \delta_i \) = variety-specific, mean-zero taste shifter

\( q_i \) = quantity of good \( i \) consumed

\( \bar{q} = \frac{1}{N} \int q_i di \)

The implied demand curve:

\[
q_i = \frac{1}{\eta N + \gamma} \alpha - \frac{1}{\gamma} \frac{\eta N}{\gamma N + \gamma} \bar{p} + \frac{1}{\gamma} \frac{\eta N}{\gamma N + \gamma} \bar{N} + \frac{1}{\gamma} \delta_i - \frac{1}{\gamma} p_i
\]
Model: Supply

Production Function: $q_i = \omega_i x_i$

Producers face (potentially idiosyncratic) factor price $w_i$

$\Rightarrow$ marginal cost = $w_i / \omega_i$

Profits:

$$\pi_i = \left( \frac{1}{\eta N + \gamma} \alpha - \frac{1}{\gamma} \frac{\eta N}{\eta N + \gamma} \bar{\delta} + \frac{1}{\gamma} \frac{\eta N}{\eta N + \gamma} \bar{p} + \frac{1}{\gamma} \delta_i - \frac{1}{\gamma} p_i \right) \left( p_i - \frac{w_i}{\omega_i} \right)$$

Profit-maximizing price (constant marginal cost $c_i$):

$$p_i = \frac{1}{2} \frac{\gamma}{\eta N + \gamma} \alpha - \frac{1}{2} \frac{\eta N}{\eta N + \gamma} \bar{\delta} + \frac{1}{2} \frac{\eta N}{\eta N + \gamma} \bar{p} + \frac{1}{2} \delta_i + \frac{1}{2} \frac{w_i}{\omega_i}$$

Deviation from industry-average price:

$$p_i - \bar{p} = \frac{1}{2} (\delta_i - \bar{\delta}) + \frac{1}{2} \left( \frac{w_i}{\omega_i} - \frac{\bar{w}}{\bar{\omega}} \right)$$

Maximized profits:

$$\pi_i = \frac{1}{4\gamma} \left( \frac{\gamma}{\eta N + \gamma} \alpha - \frac{\eta N}{\eta N + \gamma} \bar{\delta} + \frac{\eta N}{\eta N + \gamma} \bar{p} + \delta_i - \frac{w_i}{\omega_i} \right)^2$$
Model: Equilibrium

Equilibrium Condition 1: The marginal producer in the industry makes zero profits

Define “profitability index” \( \phi_i \equiv \delta_i - \frac{w_i}{\omega_i} \). Then marginal producer has index equal to:

\[
\phi^* = -\frac{\gamma}{\eta N + \gamma} \alpha + \frac{\eta N}{\eta N + \gamma} \bar{\delta} - \frac{\eta N}{\eta N + \gamma} \bar{p}
\]

Profits can be rewritten in terms of this marginal profitability level

\[
\pi_i = \frac{1}{4 \gamma} (\phi_i - \phi^*)^2
\]

Profits increase in demand (\( \delta_i \)) and efficiency (\( \omega_i \)), decrease in factor price (\( w_i \)).

Equilibrium Condition 2: Potential entrants decide whether to pay sunk entry cost \( s \) to learn \( \delta_i, \omega_i, w_i \). Expected value of entry is 0.

\[
V^e = \int_{0}^{w_i} \int_{0}^{\omega_i} \int_{0}^{\delta_i} \int_{\phi_i}^{} \frac{1}{4 \gamma} (\phi_i - \phi^*)^2 f(\delta, \omega, w) d\delta d\omega dw - s = 0
\]
Selection effect:
- Only high-profitability producers operate in equilibrium
- Low types exit

Sunk costs, market power and dispersion:
- Sunk costs make entry costly
- Curvature yields equilibrium size distribution

Many models of selection also include fixed costs of operating each period
Model: Empirical Implications

Output-based productivity:

\[ TFPQ_i = \frac{q_i}{x_i} = \frac{\omega_i x_i}{x_i} = \omega_i \]

Revenue-based productivity (literature standard):

\[ TFPR_i = \frac{p_i q_i}{x_i} = p_i \omega_i = \frac{1}{2} \frac{\gamma \alpha}{\eta N + \gamma} \omega_i + \frac{1}{2} \frac{\eta N}{\eta N + \gamma} (\bar{p} - \bar{\delta}) \omega_i + \frac{1}{2} \delta_i \omega_i + \frac{1}{2} w_i \]

Plant price deviation from industry deflator depends on both demand (enters positively into profits) and costs (enter negatively):

\[ p_i - \bar{p} = \frac{1}{2} \left( \delta_i - \bar{\delta} \right) + \frac{1}{2} \left( \frac{w_i}{\omega_i} - \left[ \frac{w}{\omega} \right] \right) \]

Comparative Statics:

- \( \frac{d\phi^*}{d\gamma} < 0 \): Lower substitutability (higher \( \gamma \)) lowers \( \phi^* \)
- \( \frac{d\phi^*}{ds} < 0 \): Higher sunk entry cost lowers \( \phi^* \)
Start with Foster, Haltiwanger and Syverson (2008)

• Source data: Census of Manufactures
  • High quality coverage
  • Limited number of products with physical quantity data
<table>
<thead>
<tr>
<th>Variables</th>
<th>Trad'l. Output</th>
<th>Revenue Output</th>
<th>Physical Output</th>
<th>Price</th>
<th>Trad'l. TFP</th>
<th>Revenue TFP</th>
<th>Physical TFP</th>
<th>Capital</th>
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<td><strong>1.14</strong></td>
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Measuring Plant-Level Demand

Estimate product demand curves; plant-specific residual is idio. demand

$$\ln q_{it} = \alpha_0 + \alpha_1 \ln p_{it} + \alpha_2 \ln (INCOME_{mt}) + \sum_t \alpha_t \cdot YEAR_t + \eta_{it}$$

$q_{it}$—physical output of plant $i$ in year $t$
$p_{it}$—plant unit price
$INCOME_{mt}$—average income in the plant’s local market $m$
$YEAR_t$—year dummy
$\eta_{it}$—plant-year disturbance term

Plant demand:

$$\hat{\delta}_{it} = \hat{\eta}_{it} + \hat{\alpha}_2 \ln (INCOME_{mt}) = \ln q_{it} - \hat{\alpha}_0 - \hat{\alpha}_1 \ln p_{it} - \sum_t \hat{\alpha}_t \cdot \text{YEAR}_t$$

I.e., residual is plant quantity sold that can’t be accounted for by unit price or local income differences

- Use $\text{TFPQ}_{it}$ to instrument for prices (captures production costs)
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<tr>
<th>Product</th>
<th>Price Coefficient ($\alpha_1$)</th>
<th>Income Coefficient ($\alpha_2$)</th>
<th>Price Coefficient ($\alpha_1$)</th>
<th>Income Coefficient ($\alpha_2$)</th>
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## Determinants of Market Selection

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Note: Much greater dispersion in demand shocks than physical TFP
Establishment-level Productivity
Empirical Patterns

- Dispersion (large), persistence (high) evolution (consistent with learning and selection)
- Selection
  - Lower productivity plants exit
  - Other determinants of productivity matter
  - Open questions: Impact of distortions on selection?
    - Models like Melitz (2003) and Restuccia and Rogerson (2007) imply reduced distortions will improve selection
    - Eslava et. al. (2009) find evidence that trade liberalization improves market selection
- These patterns both support basic models and can be used to test and estimate models
- One other approach has to been to explore the covariance between size and productivity within industries.
  - Basic prediction of virtually all models is positive correlation between size and profitability/productivity
Within Industry Dynamic Decomposition Applied to FHS (2008) data

<table>
<thead>
<tr>
<th>Component</th>
<th>Within</th>
<th>Between</th>
<th>Entry</th>
<th>Exit</th>
<th>Net Entry</th>
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<td>3.82</td>
<td>-0.05</td>
<td>1.04</td>
<td>0.32</td>
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</tbody>
</table>
Growth Identities: Establishment

g_{it} = \frac{(E_{it} - E_{it-1})}{X_{it}}

where

X_{it} = 0.5 \times (E_{it} + E_{it-1})

Then

JC_{it} = \max(g_{it}, 0)

JD_{it} = \max(-g_{it}, 0)

From Entry/Exit

JC_{it} = \max(g_{it}, 0) \times I\{g_{it} = 2\}

JD_{it} = \max(-g_{it}, 0) \times I\{-g_{it} = 2\}
Growth Identities: Aggregate Measures (any level)

\[ JC_t = \sum_i \left( \frac{X_{it}}{X_t} \right) \max\{g_{it}, 0\} \quad JD_t = \sum_i \left( \frac{X_{it}}{X_t} \right) \max\{-g_{it}, 0\} \]

\[ JC\_Entry_t = \sum_i \left( \frac{X_{it}}{X_t} \right) I\{g_{it} = 2\} \max(g_{it}, 0) \]

\[ JD\_Exit_t = \sum_i \left( \frac{X_{it}}{X_t} \right) I\{g_{it} = -2\} \max(-g_{it}, 0) \]

\[ g_t = JC_t - JD_t \]

\[ JC_t = JC\_Cont_t + JC\_Entry_t \]

\[ JD_t = JD\_Cont_t + JD\_Exit_t \]