Title: Productivity, Job Creation and Entrepreneurship

Lecture Notes for NBER Entrepreneurship Bootcamp
July 2015
By John Haltiwanger
University of Maryland and NBER
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
Share of Employment by Firm Size, 2010

- Micro Firms (1-9 employees), 12,606,035
- Small-Medium (10-500 employees), 42,676,395
- Large Firms (500+ employees), 55,892,580
Job Destruction

Hires → Separations

Job Creation

Hires → Separations
Job Creation and Destruction, U.S. Private Sector, Annual Rates (Percent of Employment), 1980-2009

Job Creation

- Continuing Establishments: 10.6%
- New Establishments (Existing Firms): 3.2%
- New Firms: 3.1%
- Total = 16.9%

Job Destruction

- Continuing Establishments: 10%
- Exiting Establishments (Continuing Firms): 2.4%
- Exiting Firms: 2.9%
- Total = 15.3%

Source: BDS
Net Employment Growth by Base Year Firm Size

- 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 2499
- j) 2500 to 4999
- k) 5000 to 9999
- l) 10,000 +

- Base Year Size
- Base Year Size with Age Controls
Up or Out Dynamics of Young U.S. Firms

Firm Age

Net Employment Growth (Continuing Firms)  Job Destruction from Exit
Skewness of young continuing firms underlies high mean net growth of young firms.
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 (2022).
What accounts for cross sectional and dynamic patterns?

• Very skewed size distribution (often attributed to skewed productivity distribution)
• Very skewed distribution of *growth rates* of young firms
• These two findings presumably linked but complex:
  • One view is that entrants don’t know type but draw from same distribution (hence skewed distribution of growth rates).
  • A complementary view is that young businesses engage in experimentation/innovation activity. Some are successful while others are not (hence skewed distribution of growth rates as probability of success is low).
  • In either view, what is happening to older incumbents?
• Part of the open debate:
  • Is this ex ante heterogeneity (Hurst and Pugsley, 2012, 2014) or ex post heterogeneity (draws from a pareto distribution of productivity or success at innovations)?
  • Some evidence we will see below suggests that Hurst and Pugsley holds for some industries while skewness of firm growth rates holds in others.
  • Important to take into account ex ante heterogeneity.
Productivity Distribution Within Narrowly Defined Industries

Interquartile Range of TFP is 30 log points

Often hypothesized to be pareto to match skewed size distribution

Productivity of Businesses
Share of Reallocation Between and Within Detailed Industries

- Within Industry: 87%
- Between Industry: 13%
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

- **Total**: 5.13
- **Within**: 3.44
- **Reallocation Among Existing Establishments**: 0.35
- **Net Entry**: 1.35
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%

- Single Unit Establishment Firms
- All establishments
Some Disturbing Trends?
Declining Pace of Creation and Destruction in BED

Source: BLS BED DATA
Declining Business Dynamism is Evident from Multiple Data Sources

Job Reallocation Rate, U.S. Private Non-Farm (Quarterly)


Job Reallocation Rate, U.S. Private Non-Farm (Annual)

Source: BDS

Solid lines are Hodrick-Prescott Trends

Source: BED
Startup Rate in Nonfarm Private Sector, 1981-2012

Declining Entrepreneurship Accompanied “Accounts” for Substantial Fracturing of the Decline in Measures of Business Dynamism

Share of Employment for Young Firms, 1981-2012, Nonfarm Private Sector
Declining Dispersion (90-10 differential)

Employment-weighted Distribution of Firm Net Employment Growth

Source: Census LBD D®

33% Decline
25% Decline
Pre-2000, decline in 90-10 due to decline in 90-50 and 50-10. Post 2000, sharp decline in 90-50 relative to 50-10.
Decline in 90-50 is mimicked by decline in 90th percentile given 50th percentile is approximately zero – in other words, decline in 90-50 implies decline in high growth firms.
Decline in Overall Skewness is Both Composition Effect and Decline in Skewness Among Age Groups (Young < 5 years old).
Sectoral Differences in Decline in Dispersion (90-10)

Retail and Services dominated pre-2000 decline.

Information increased pre-2000 and then sharply declined post 2000.

Showing HP Trends
Large Sectoral Differences in Skewness in the Cross Section and Over Time

Retail low skewness in all periods but decline in dispersion throughout. “Mom and Pops” don’t generate skewness.


90-50 Solid, 50-10 Dashed
Differences for Information Sector Striking. But High Tech is Spread Across Numerous Broad Sectors including Information, Services and Manufac:

<table>
<thead>
<tr>
<th>NAICS Code</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Information and Communications Technology (ICT) High-Tech</strong></td>
</tr>
<tr>
<td>3341</td>
<td>Computer and peripheral equipment manufacturing</td>
</tr>
<tr>
<td>3342</td>
<td>Communications equipment manufacturing</td>
</tr>
<tr>
<td>3344</td>
<td>Semiconductor and other electronic component manufacturing</td>
</tr>
<tr>
<td>3345</td>
<td>Navigational, measuring, electromedical, and control instruments manufacturing</td>
</tr>
<tr>
<td>5112</td>
<td>Software publishers</td>
</tr>
<tr>
<td>5161</td>
<td>Internet publishing and broadcasting</td>
</tr>
<tr>
<td>5179</td>
<td>Other telecommunications</td>
</tr>
<tr>
<td>5181</td>
<td>Internet service providers and Web search portals</td>
</tr>
<tr>
<td>5182</td>
<td>Data processing, hosting, and related services</td>
</tr>
<tr>
<td>5415</td>
<td>Computer systems design and related services</td>
</tr>
<tr>
<td></td>
<td><strong>Miscellaneous High-Tech</strong></td>
</tr>
<tr>
<td>3254</td>
<td>Pharmaceutical and medicine manufacturing</td>
</tr>
<tr>
<td>3364</td>
<td>Aerospace product and parts manufacturing</td>
</tr>
<tr>
<td>5413</td>
<td>Architectural, engineering, and related services</td>
</tr>
<tr>
<td>5417</td>
<td>Scientific research-and-development services</td>
</tr>
</tbody>
</table>
90-10 Gap for High Tech shows sharp decline post 2000

High Tech Sector Exhibits Rising Dispersion and Skewness in 1990s and then Sharp Declines Post 2000.
Decline in shocks or decline in responsiveness to shocks?

• Canonical firm dynamic models (e.g., Hopenhayn (1992), Hopenhayn and Rogerson (1993), Ericson and Pakes (1995)) imply decline should be from either:
  • A decline in the volatility of idiosyncratic shocks.
  • A decline in the response to such shocks.

• For high tech (manufacturing sector):
  • We find no evidence of a decline in the volatility of idiosyncratic shocks but a notable decline in the response to such shocks in the post 2000
  • This implies declining contribution of reallocation to productivity growth post 2000.
Within Industry Dispersion in TFP over time in High Tech Mfg vs. All Mfg (3-year MA, 90-10)
Analysis of Changing Response to Shocks

Estimating simple specifications such as:

\[ Y_{e,t+1} = \lambda_{t+1} + \beta \times TFP_{et} + \delta \times TFP_{et} \times Trend_{t+1} + X'_{et} \Theta + \varepsilon_{e,t+1} \]

\( e = \text{establishment}, \)  
\( Y (\text{outcome}) = \text{overall growth (or components) from} \ t \ \text{to} \ t+1 \) \text{from} \ t \ \text{to} \ t+1

\( Trend = \text{simple time trend with breaks allowed by decade} \ (\text{arbitrary}). \)

\( TFP = \log \text{TFPR at the establishment level} \ (\text{deviated from industry*year mean}) \)

\( X \) \text{includes establishment and firm level controls, cyclical controls including interactions with TFP} \ (\text{FGH} \ (2013))\)
Marginal Response of Plant-Level Growth to TFP Shock in High Tech Manufacturing
Employment shares by Cohorts of Publicly Traded Firms

Source: COMPUSTAT – LBD shows similar patterns post 1980
Employment shares by Cohorts of Publicly Traded Firms

Source: COMPUSTAT – LBD shows similar patterns post 1980
Employment volatility of Cohorts

- 1950s
- 1960s
- 1970s
- 1980s
- 1990s
- 2000s
NUTS AND BOLTS of PRODUCTIVITY MEASUREMENT
Measurement of Plant-level Productivity

\[ tfp_i = y_i - \alpha_l l_i - \alpha_k k_i - \alpha_m m_i - \alpha_e e_t \]

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). Typically do not have by asset class. Very different from aggregate measurement. Open question as to how problematic.

• 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
Details matter

• For cost share approach, two different methods:
  • Shares of revenue vs. shares of total costs.
  • Shares of revenue requires profit maximization, first order conditions hold, perfect competition, CRS
  • Shares of total costs requires cost minimization, first order conditions hold, CRS.
    • Advantage of this method is that even with imperfect competition this method yields production elasticities. Can also be used without CRS but need to pin down RTS with some other method.
  • Often take averages across plants over time or within industry, so first order conditions hold on average.

• Estimation methods don’t require so many assumptions but are limited by two key issues:
  • Typically do not observe y but rather \( p^*y \) (revenue). Deflate by industry deflator. So estimating revenue function. NOT factor elasticities if prices are endogenous with firms facing downward sloping demand curve. Difficult to recover production elasticities without much more structure.
  • Proxy methods use high order polynomial approximations. These are sensitive to measurement error.
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{1cm} (24)

\[ i_{jt} = i(k_{jt}, a_{jt}, \omega_{jt}, \Delta_t) = i_t(k_{jt}, a_{jt}, \omega_{jt}). \]  \hspace{1cm} (27)

\[ \omega_{jt} = h_t(k_{jt}, a_{jt}, i_{jt}). \]  \hspace{1cm} (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{1cm} (29)

\[ y_{jt} - \beta_l l_{jt} = \beta_0 + \beta_k k_{jt} + \beta_a a_{jt} + \omega_{jt} + \eta_{jt}. \]  \hspace{1cm} (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{1cm} (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{1cm} (34b)

Depends critically on the invertibility amongst other assumptions.
Factor Elasticity of Capital

kernel = epanechnikov, bandwidth = 0.0315
Factor Elasticity of Labor

kernel = epanechnikov, bandwidth = 0.0512
TFPR Dispersion (IQR)

The diagram shows the dispersion of TFPR across different industries. The 50 largest industries are represented by black bars, and the 10 largest industries are represented by gray bars. The industries are labeled as OLS, OP, LPVA, LPNL, LPGR, LPGSS, WLPE, WLPM, and GA. The x-axis represents the industries, and the y-axis represents the TFPR dispersion (IQR) ranging from 0 to 0.7.
Marginal effect of Productivity on Exit

Is the devil in the details? No (and yes).

Legend:
- 4-digit
- 3-digit
- 3-digit, select
Contribution of Reallocation to Productivity Growth – Structural Decomposition
More Basic Measures of Productivity Are Often Used

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

\[ RLP_{et} = \frac{VA_{et}}{TE_{et}} = \frac{Y_{et} - M_{et}}{TE_{et}} \]

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
Dispersion in Productivity – How should we think about this?

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, Haltiwanger 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) vs. Firm Productivity

Distorted Economy

Healthy Economy
Differences in Overall Growth Rates Over the Business Cycle: High and Low Productivity Establishments

Normal is Zero Change in Unemployment, Mild is 0.01 Change, Sharp is 0.03 Change. High Productivity is 1 std dev above mean, Low Productivity is 1 std dev below mean.

Foster, Grim and Haltiwanger (2013)
Differences in Overall Growth Rates Over the Business Cycle: High and Low Productivity Establishments

**Young Firms**
(Less than 5 years old)

- Normal
- Mild Contraction
- Sharp
- GR, Mild
- GR, Sharp

**Mature Firms**
(5 or more years old)

- Normal
- Mild Contraction
- Sharp
- GR, Mild
- GR, Sharp

Normal is Zero Change in Unemployment, Mild is 0.01 Change, Sharp is 0.03 Change. High Productivity is 1 std dev above mean, Low Productivity is 1 std dev below mean.
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)
Firm Productivity Shock (Profitability)

Firm Employment Changes

Range of Inaction

Job Destruction

Job Creation
Job Creation

Healthy Economy

Range of inaction (increases with uncertainty and distortions)

Distorted, Uncertain Economy

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

$$\Omega_t = \sum_i s_{it} \omega_{it}$$

$$= (1/N_t) \sum_i \omega_{it} + \sum_i (s_{it} - (1/N_t) \sum_i s_{it}) (\omega_{it} - (1/N_t) \sum_i \omega_{it})$$

Olley and Pakes (1996) decomposition

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

$$= \sum_{i \in C} s_{it} \Delta \omega_{it} + \sum_{i \in C} \Delta s_{it} (\omega_{it} - \bar{\Omega}_t) + \sum_{i \in N} s_{it} (\omega_{it} - \bar{\Omega}_t) - \sum_{i \in X} s_{it-1} (\omega_{it-1} - \bar{\Omega}_t)$$

$$= within + reallocation + entry - exit$$

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
- These decompositions can be used as moments to match in a calibration or indirect inference approach (see, e.g., Bartelsman, Haltiwanger and Scarpetta (2009))
- These decompositions even with crude measures of productivity (like labor or capital productivity) may be more robustly measured than more structural decompositions.
Comments on Decomposition in Literature

• Decompositions more closely tied to aggregate welfare and productivity have been developed (Petrin and Levinsohn (2008), Basu and Fernald (2002))
  • These decompositions highlight that at any instant of time marginal revenue products have not been equalized to factor prices because of adjustment frictions.
  • Reallocation is constantly moving resources that push towards such equalization. Shocks each period continually yield gaps/wedged in marginal revenue products.
  • This approach has considerable potential but implementation is complicated by measurement. Requires measuring marginal revenue products. Accurate estimation of factor elasticities and relevant factor prices critical.
  • For example, variation across plants in factor prices may reflect quality differences in factors.
Olley and Pakes (1996) results for Telecommunications equipment

**TABLE XI**

DECOMPOSITION OF PRODUCTIVITY

(EQUATION (16))

<table>
<thead>
<tr>
<th>Year</th>
<th>$p_t$</th>
<th>$\bar{p}_t$</th>
<th>$\Sigma_i \Delta s_{it} \Delta p_{it}$</th>
<th>$\rho(p_{it}, k_t)$</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>
</tr>
<tr>
<td>1983</td>
<td>0.84</td>
<td>0.76</td>
<td>0.08</td>
<td>-0.07</td>
</tr>
<tr>
<td>1984</td>
<td>0.90</td>
<td>0.83</td>
<td>0.07</td>
<td>-0.09</td>
</tr>
<tr>
<td>1985</td>
<td>0.99</td>
<td>0.72</td>
<td>0.26</td>
<td>0.02</td>
</tr>
<tr>
<td>1986</td>
<td>0.92</td>
<td>0.72</td>
<td>0.20</td>
<td>0.03</td>
</tr>
<tr>
<td>1987</td>
<td>0.97</td>
<td>0.66</td>
<td>0.32</td>
<td>0.10</td>
</tr>
</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)

Overall, Unweighted average over time for China.
Key equations

\[
\sum_{i} \sum_{k} \left( P_{i} \frac{\partial Q_{i}}{\partial X_{ik}} - W_{ik} \right) dX_{ik} + \sum_{i} \sum_{j} \left( P_{i} \frac{\partial Q_{i}}{\partial M_{ij}} - P_{j} \right) dM_{ij} - \sum_{i} P_{i} dF_{i} + \sum_{i} P_{i} d\omega_{i},
\]

\[
\sum_{i} D_{i} \sum_{k} \left( \varepsilon_{ik} - c_{ik} \right) d\ln X_{ik} + \sum_{i} D_{i} \sum_{j} \left( \varepsilon_{ij} - c_{ij} \right) d\ln M_{ij} - \sum_{i} D_{i} d\ln F_{i} + \sum_{i} D_{i} d\ln \omega_{i},
\]

\[ c_{ik} = \frac{W_{ik} X_{ik}}{P_{i} Q_{i}}. \]

\[ \varepsilon_{ik} \] is estimated at the 4-digit level from production function

• **Key point:** In practice gaps are based on difference between industry-specific, time invariant estimated factor elasticities and plant-specific, time varying cost shares
  • As a rough approximation they are exploiting within industry dispersion in cost shares
What do such gaps capture?

• **Frictions and distortions?**
  • Gaps are similar in spirit to measures from factor adjustment literature
    • But even here difficulties:
      • Best fitting structural models to plant-level data have proportional nonconvex costs of adjustment (disruption effects) so not additively separable
      • Can’t separately estimate production/profit function from adjustment costs

• **Unobserved heterogeneity in factor elasticities?**
  • Much evidence that K/L ratios, skill mixes exhibit persistent differences across plants in the same industry
    • Matched employer-employee data show persistence of 0.92 of idiosyncratic (within 4-digit industry) in fraction of highly educated workers at establishments
    • At the core of the labor literature on skill biased technical change using micro data
What do such gaps capture?

• Unobserved differences in input quality
  • Model assumes factors of type i are homogenous.
  • Large within and between plant wage dispersion
    • In 1992, within plant C.V. for Production Workers 0.21, between plant C.V. for Nonproduction workers 0.47
    • Much due to differences in skill mixes within and across plants

• Differences in factor prices across plants for same quality input
  • Efficiency wages, rent sharing (so not exogenous differences)
    • Abowd et. al. findings suggest about 50 percent of variation is person effects and about 50 percent firm effects
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
- Job Destruction
- Job Creation

Legend:
- Organic
- All
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></th>
<th>Value</th>
</tr>
</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>
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
Small Businesses With and Without Paid Employees Differ in Fundamental Ways

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

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

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

\[\alpha > 0, \quad \eta > 0, \quad \text{and} \quad \gamma \geq 0.\]

\(y\) = numeraire good
\(\delta_i\) = variety-specific, mean-zero taste shifter
\(q_i\) = quantity of good \(i\) consumed
\(\bar{q} = \frac{1}{N} \int_{i \in I} q_i di\)

The implied demand curve:

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

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

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

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

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.

$$V^e = \int \int \int_{\omega_i, \phi^* + \frac{w}{\omega}} \frac{1}{4\gamma} (\phi_i - \phi^*)^2 f(\delta, \omega, w) d\delta d\omega dw - s = 0$$
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:
\[
TFPQ_i = \frac{q_i}{x_i} \cdot \frac{x_i}{x_i} = \omega_i
\]

Revenue-based productivity (literature standard):
\[
TFPR_i = \frac{p_i q_i}{x_i} = p_i \omega_i = \frac{1}{2} \frac{\gamma \alpha}{\eta N + \gamma} \omega_i + \frac{1}{2} \frac{\eta N}{\eta N + \gamma} \left( \bar{p} - \bar{\delta} \right) \omega_i + \frac{1}{2} \delta_i \omega_i + \frac{1}{2} w_i
\]

Plant price deviation from industry deflator depends on both demand (enters positively into profits) and costs (enter negatively):
\[
p_i - \bar{p} = \frac{1}{2} \left( \delta_i - \bar{\delta} \right) + \frac{1}{2} \left( \frac{w_i}{\omega_i} - \bar{w} \right)
\]

Comparative Statics:
- \[\frac{d\phi^*}{d\gamma} < 0: \text{Lower substitutability (higher } \gamma \text{) lowers } \phi^*\]
- \[\frac{d\phi^*}{ds} < 0: \text{Higher sunk entry cost lowers } \phi^*\]
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>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Output</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue Output</td>
<td>0.99</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Output</td>
<td>0.98</td>
<td>0.99</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>-0.03</td>
<td>-0.03</td>
<td>-0.19</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional TFP</td>
<td>0.19</td>
<td>0.18</td>
<td>0.15</td>
<td>0.13</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue TFP</td>
<td>0.17</td>
<td>0.21</td>
<td>0.18</td>
<td>0.16</td>
<td>0.86</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical TFP</td>
<td>0.17</td>
<td>0.20</td>
<td>0.28</td>
<td>-0.54</td>
<td>0.64</td>
<td>0.75</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Capital</td>
<td>0.86</td>
<td>0.85</td>
<td>0.84</td>
<td>-0.04</td>
<td>0.00</td>
<td>-0.00</td>
<td>0.03</td>
<td>1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard Deviations</th>
<th>1.03</th>
<th>1.03</th>
<th>1.05</th>
<th>0.18</th>
<th>0.21</th>
<th>0.22</th>
<th>0.26</th>
<th>1.14</th>
</tr>
</thead>
</table>
Measuring Plant-Level Demand

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

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

$q_{it}$—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:

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

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

- Use TFPQ$_{it}$ to instrument for prices (captures production costs)
<table>
<thead>
<tr>
<th>Product</th>
<th>IV Estimation</th>
<th>OLS Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Price Coefficient ($\alpha_1$)</td>
<td>Income Coefficient ($\alpha_2$)</td>
</tr>
<tr>
<td>Boxes</td>
<td>-3.02</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>0.17 [0.61]</td>
<td>0.02</td>
</tr>
<tr>
<td>Bread</td>
<td>-3.09</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>0.42 [0.33]</td>
<td>0.05</td>
</tr>
<tr>
<td>Carbon Black</td>
<td>-0.52</td>
<td>-0.21</td>
</tr>
<tr>
<td></td>
<td>0.38 [0.50]</td>
<td>0.11</td>
</tr>
<tr>
<td>Coffee</td>
<td>-3.63</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>0.98 [0.41]</td>
<td>0.14</td>
</tr>
<tr>
<td>Concrete</td>
<td>-5.93</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>0.36 [0.10]</td>
<td>0.01</td>
</tr>
<tr>
<td>Hardwood Flooring</td>
<td>-1.67</td>
<td>-0.20</td>
</tr>
<tr>
<td></td>
<td>0.48 [0.61]</td>
<td>0.18</td>
</tr>
<tr>
<td>Gasoline</td>
<td>-1.42</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>2.72 [0.20]</td>
<td>0.07</td>
</tr>
<tr>
<td>Block Ice</td>
<td>-2.05</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>0.46 [0.32]</td>
<td>0.11</td>
</tr>
<tr>
<td>Processed Ice</td>
<td>-1.48</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>0.27 [0.37]</td>
<td>0.03</td>
</tr>
<tr>
<td>Plywood</td>
<td>-1.21</td>
<td>-0.23</td>
</tr>
<tr>
<td></td>
<td>0.14 [0.89]</td>
<td>0.10</td>
</tr>
<tr>
<td>Sugar</td>
<td>-2.52</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td>1.01 [0.15]</td>
<td>0.13</td>
</tr>
<tr>
<td>Dependent Variable</td>
<td>Five-Year Horizon</td>
<td>Implied One-Year Persistence Rates</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td></td>
<td>Unweighted</td>
<td>Weighted</td>
</tr>
<tr>
<td>Traditional TFP</td>
<td>0.249</td>
<td>0.316</td>
</tr>
<tr>
<td></td>
<td>0.017</td>
<td>0.042</td>
</tr>
<tr>
<td>Revenue TFP</td>
<td>0.277</td>
<td>0.316</td>
</tr>
<tr>
<td></td>
<td>0.021</td>
<td>0.042</td>
</tr>
<tr>
<td>Physical TFP</td>
<td>0.312</td>
<td>0.358</td>
</tr>
<tr>
<td></td>
<td>0.019</td>
<td>0.049</td>
</tr>
<tr>
<td>Price</td>
<td>0.365</td>
<td>0.384</td>
</tr>
<tr>
<td></td>
<td>0.025</td>
<td>0.066</td>
</tr>
<tr>
<td>Demand Shock</td>
<td>0.619</td>
<td>0.843</td>
</tr>
<tr>
<td></td>
<td>0.013</td>
<td>0.021</td>
</tr>
<tr>
<td>Variable</td>
<td>Exit</td>
<td>Entry</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------</td>
<td>--------</td>
</tr>
<tr>
<td>Traditional TFP</td>
<td>-0.0211</td>
<td>0.0044</td>
</tr>
<tr>
<td></td>
<td>0.0042</td>
<td>0.0044</td>
</tr>
<tr>
<td>Revenue TFP</td>
<td>-0.0220</td>
<td>0.0133</td>
</tr>
<tr>
<td></td>
<td>0.0044</td>
<td>0.0047</td>
</tr>
<tr>
<td>Physical TFP</td>
<td>-0.0186</td>
<td>0.0128</td>
</tr>
<tr>
<td></td>
<td>0.0050</td>
<td>0.0053</td>
</tr>
<tr>
<td>Price</td>
<td>-0.0034</td>
<td>0.0005</td>
</tr>
<tr>
<td></td>
<td>0.0031</td>
<td>0.0034</td>
</tr>
<tr>
<td>Demand Shock</td>
<td>-0.3466</td>
<td>-0.5557</td>
</tr>
<tr>
<td></td>
<td>0.0227</td>
<td>0.0264</td>
</tr>
</tbody>
</table>

Unweighted Regressions
## Determinants of Market Selection

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional TFP</td>
<td>-0.073</td>
<td>0.015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue TFP</td>
<td>-0.063</td>
<td>0.014</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical TFP</td>
<td>-0.040</td>
<td>0.012</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prices</td>
<td>-0.021</td>
<td>0.018</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demand Shock</td>
<td>-0.047</td>
<td>0.003</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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>Components of Decomposition (GR)</th>
<th>Within</th>
<th>Between</th>
<th>Entry</th>
<th>Exit</th>
<th>Net Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>2.30</td>
<td>1.40</td>
<td>0.18</td>
<td>0.44</td>
<td>0.72</td>
</tr>
<tr>
<td>Revenue</td>
<td>5.13</td>
<td>4.03</td>
<td>0.16</td>
<td>0.55</td>
<td>0.94</td>
</tr>
<tr>
<td>Physical</td>
<td>5.13</td>
<td>3.82</td>
<td>-0.05</td>
<td>1.04</td>
<td>1.36</td>
</tr>
</tbody>
</table>
Extra Slides
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)

$$JC_t = \sum_i \left( \frac{X_{it}}{X_t} \right) \max\{g_{it}, 0\}$$

$$JD_t = \sum_i \left( \frac{X_{it}}{X_t} \right) \max\{-g_{it}, 0\}$$

$$JD \_ Exit_t = \sum_i \left( \frac{X_{it}}{X_t} \right) I\{g_{it} = -2\} \max(-g_{it}, 0)$$

$$JC \_ Entry_t = \sum_i \left( \frac{X_{it}}{X_t} \right) I\{g_{it} = 2\} \max(g_{it}, 0)$$

$$g_t = JC_t - JD_t$$

$$JC_t = JC \_ Cont_t + JC \_ Entry_t$$

$$JD_t = JD \_ Cont_t + JD \_ Exit_t$$