Firm Dynamics and Aggregate Fluctuations: (Some) Open Questions

By

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Core Question

What is the link between differences in productivity across countries and differences in productivity across firms within countries?

- Both exhibit substantial dispersion and persistence.
- Theory suggests these are potentially linked.
- Empirical evidence offers support.
- But the details matter…
1. Why is there so much dispersion in productivity across businesses in narrowly defined sectors?

- Syverson (2004) documents interquartile range of plant-level productivity in U.S. is around 0.30 within narrowly defined industries.
- Hsieh and Klenow (2009) document that dispersion in productivity is higher in China and India than in the U.S.
- World Development Report (2013) documents tendency for higher dispersion in productivity in emerging economies relative to U.S.
- At first glance, suggests substantial improvements in aggregate productivity could be achieved by reallocation of resources away from less productive to more productive businesses within industries.
  - Apparently more possible gains in emerging economies.
- But key open questions:
  - What are we measuring?
  - What underlies this dispersion?
TFPR vs. TFPQ

- Conceptually, TFP a proxy for technical efficiency
- But in firm/plant-level data important to distinguish between TFPR and TFPQ
- We don’t typically have direct measures of TFPQ but rather TFPR at firm/plant level because we don’t observe prices at the firm/plant level.
Canonical, Frictionless Model

\[ Y = AK^\alpha L^{1-\alpha} \]

\[ Y = \frac{D^{\varepsilon-1}}{P^\varepsilon} \]

\[ \frac{rK}{wL} = \frac{\alpha}{1-\alpha} \]

\[ APK = \frac{PY}{K} = \frac{\varepsilon \ r}{\varepsilon - 1 - \alpha} \]

\[ APL = \frac{PY}{L} = \frac{\varepsilon \ w}{\varepsilon - 1 - \alpha} \]

\[ TFPQ = PA = \frac{\varepsilon (\frac{W}{r})^{1-\alpha}}{\varepsilon - 1 (1-\alpha)} \]

\[ TFPQ = A \]

Cobb-Douglas Technology, CRS
Isoelastic Demand, No Frictions, No Distortions,
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
Evidence on TFPQ vs. TFPR for U.S.

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 vs. Distortions?

- Costs of Entry (and exit)
  - Including costs of entering new markets
- 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
Important for Trade/Productivity Literature

Core findings from firm-level trade literature:

- Trade is “rare” – most firms don’t engage in trade.
- More “productive” and larger firms engage in trade.
- Amongst trading firms, trade is concentrated – most trade accounted for by the largest firms.
- Causality between trade and productivity?
  - While still an open question, evidence is all about TFPR and NOT TFPQ!
2. What is the relative importance of demand vs. supply factors in dispersion across firms (including in TFPR)?

- Canonical models focus on firm-level productivity as primary source of firm heterogeneity
  - Many interpret TFPR variation as TFPQ variation
    - Firm heterogeneity and trade literature especially even if demand structure is considered
- Evidence suggests demand side factors are important and are endogenous over firm life-cycle
Supply-side vs. Demand-side

Regression of fundamentals and plant age dummies (and industry-year effects).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Entrant</th>
<th>Young</th>
<th>Medium</th>
<th>Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFPQ</td>
<td>0.013</td>
<td>0.004</td>
<td>-0.004</td>
<td>-0.018</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Demand</td>
<td>-0.550</td>
<td>-0.397</td>
<td>-0.316</td>
<td>-0.339</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
<td>(0.024)</td>
<td>(0.026)</td>
<td>(0.021)</td>
</tr>
</tbody>
</table>
Demand Side

Dynamic demand-side forces take time to play out.
- Growth of a customer base
- Building a reputation
- Uncertainty about demand may create option value of waiting to expand

Customer Learning
- Details of product attributes
- Quality and quantity of bundled services
- Consistency of operations
- Longevity
Dynamic Model

Production Function: \( q_t = A_t x_t \)

Demand Curve: \( q_t = \theta_t A_t g_t Z_t^\gamma p_t^{\eta} \)

Evolution: \( Z_t = (1 - \delta) Z_{t-1} + (1 - \delta) R_{t-1} \)

Initialization: \( Z_{0e} = (K_{0e})^{\hat{\lambda}_1} \left( \frac{K_{0s(e)} + K_{0e}}{K_{0e}} \right)^{\hat{\lambda}_2} \)

Profits: \( \pi_t = p_t A_t x_t - c_t x_t - f \)
Estimating Model

Demand Equation:
\[
\ln q_{t+1} = \rho \ln q_t + \phi \ln AgE_{t+1} - \rho \phi \ln AgE_t \\
+ \gamma \ln Z_{t+1} - \rho \gamma \ln Z_t - \eta \ln p_{t+1} + \rho \eta \ln p_t + \nu_{t+1}
\]

Euler Equation:
\[
E[\varepsilon_{t+1}] = \frac{C_t}{R_t} - \left(1 - \frac{1}{\eta}\right) \beta (1-\delta) \gamma \frac{R_{t+1}}{Z_{t+1}} - \beta (1-\delta) \left(\frac{C_{t+1}}{R_{t+1}} - \left(1 - \frac{1}{\eta}\right)\right) = 0
\]
Learning with Depreciation Model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Coefficient</th>
<th>S E</th>
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</thead>
<tbody>
<tr>
<td>$\gamma$</td>
<td>0.795</td>
<td>(0.014)</td>
</tr>
<tr>
<td>Young dummy</td>
<td>-0.066</td>
<td>(0.031)</td>
</tr>
<tr>
<td>Medium dummy</td>
<td>-0.025</td>
<td>(0.026)</td>
</tr>
<tr>
<td>$\rho$</td>
<td>0.366</td>
<td>(0.085)</td>
</tr>
<tr>
<td>$\lambda_1$</td>
<td>0.651</td>
<td>(0.051)</td>
</tr>
<tr>
<td>$\lambda_2$</td>
<td>0.548</td>
<td>(0.063)</td>
</tr>
<tr>
<td>$\eta$</td>
<td>-1.808</td>
<td>(0.082)</td>
</tr>
<tr>
<td>Competitors Price</td>
<td>0.338</td>
<td>(0.073)</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.893</td>
<td>(0.026)</td>
</tr>
<tr>
<td>Inverse Mills Ratio, Demand</td>
<td>-0.022</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Inverse Mills Ratio, EE</td>
<td>0.026</td>
<td>(0.005)</td>
</tr>
</tbody>
</table>
## Decomposing Demand Shocks

<table>
<thead>
<tr>
<th>Variable</th>
<th>Young</th>
<th>Medium</th>
<th>Old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand Shock</td>
<td>-0.575</td>
<td>-0.287</td>
<td>Excl.</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.029)</td>
<td></td>
</tr>
<tr>
<td>Active Accumulation</td>
<td>-0.617</td>
<td>-0.271</td>
<td>Excl.</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.025)</td>
<td></td>
</tr>
<tr>
<td>Passive Accumulation</td>
<td>-0.066</td>
<td>-0.025</td>
<td>Excl.</td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.026)</td>
<td></td>
</tr>
</tbody>
</table>
Quick summary and questions

- It takes a long time for entering plants to grow to the size of incumbents.
- The demand side plays a larger part in the persistence of the size gap than does the supply side.
- Evidence suggests young firms actively invest in active demand accumulation by cutting prices when young.
- Frictions relevant for new firms and new activity in a new location (trade activity).
3. Do we need a high pace of reallocation including entry/exit to achieve allocative efficiency?

U.S. in particular has a high pace of output and input reallocation
- Very costly
- Possible distortions – cyclically and secularly

In “Long Run”, appears to payoff – reallocation and productivity closely connected
- Caution: Might be demand side factors driving reallocation as well – okay but perhaps different frictions are important.
Job Creation and Destruction, U.S. Private Sector, Annual Rates (Percent of Employment), 1980-2009

Job Creation

- New Firms: 3.1
- New Establishments (Existing Firms): 3.2
- Continuing Establishments: 10.6

Total = 16.9

Job Destruction

- Exiting Firms: 2.9
- Exiting Establishments (Continuing Firms): 2.4
- Continuing Establishments: 10

Total = 15.3
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%
- Mature Exits: -26.20%
- Young Survivors: 2.80%
- Young Survivors Five Years Later: 3%
- All establishments: 1.20%
- Single Unit Establishment Firms: 5%
Declining Pace of Creation and Destruction in BED

Source: BLS BED DATA, Davis, Faberman and Haltiwanger (2011)
4. What firm level moments should we use to identify distortions and quantify the extent of misallocation?
Hsieh and Klenow (2009) approach

- All TFPR dispersion is due to distortions.
- Countries “distortion” index can be estimated directly from TFPR dispersion
  - Higher TFPR dispersion countries are more distorted.
  - Hsieh and Klenow find that TFPR dispersion is much higher in China and India than U.S.
- They estimate the degree of distortions in China and India and calculate the gains in aggregate productivity that will be realized if China/India converge to U.S. TFPR dispersion.

Is this a reasonable identification approach?
Table 1: Within Industry Productivity Dispersion and OP Covariance Term

(weighted averages of industry-level data, U.S. Industry Weights)

<table>
<thead>
<tr>
<th></th>
<th>Revenue Labor Productivity Std Dev.</th>
<th>Revenue TFP Std Dev.</th>
<th>OP covariance term</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>0.58</td>
<td>0.38</td>
<td>0.51</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.57</td>
<td>0.41</td>
<td>0.16</td>
</tr>
<tr>
<td>Germany</td>
<td>0.72</td>
<td>NA</td>
<td>0.28</td>
</tr>
<tr>
<td>France</td>
<td>0.53</td>
<td>0.22</td>
<td>0.24</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.56</td>
<td>0.15</td>
<td>0.30</td>
</tr>
<tr>
<td>Hungary</td>
<td>1.03</td>
<td>0.91</td>
<td>0.18</td>
</tr>
<tr>
<td>Romania</td>
<td>1.05</td>
<td>0.56</td>
<td>-0.03</td>
</tr>
<tr>
<td>Slovenia</td>
<td>0.80</td>
<td>0.22</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Notes: Averages over 1992-2001 data. Industry-level firm based TFP measures not available for Germany.
More than 5200 country/industry/year observations of some of the key moments -- virtually all show STD(LPR)>STD(TFPR)
A Model of “Mis”-Allocation (Based on Rogerson and Restuccia (2008) (and similar to Hsieh and Klenow (2009))

Consumers supply labor inelastically and maximize utility:

$$\sum_{t=0}^{\infty} \beta^t U(C_t)$$

Firms maximize profits where:

$$\pi_{it} = (1 - \tau_i - \kappa_{it})P_{\theta_i} \bar{Y}_t \left[ A_i \varepsilon_{it} (n_{it} - f)^{\gamma} k_{it}^{\alpha} \right]^\rho - w_i n_{it} - Rk_{it}$$

$$Y_{it} = A_i \varepsilon_{it} (n_{it} - f)^{\gamma - \alpha} k_{it}^{\alpha}, \gamma < 1$$

$$Y_t = N_t^{(\rho - 1)/\rho} \left( \sum_i \theta_i Y_{it}^\rho \right)^{1/\rho} \quad P_{it} = P_i \theta_i (\bar{Y}_t / Y_{it})^{1-\rho}$$

Our innovations: Overhead labor, quasi-fixed capital and transitory shocks
Yields dispersion in TFPR and LPR even in absence of distortions
Entry/Selection

\[ W^e = \int_{A,\tau} \max(0, W(A, \tau) dG(A, \tau)) - c_e \]

\[ G (A, \tau) \]

Ex Ante Joint Distribution

\[ W(A_i, \tau_i) = E \left[ \pi(A_i, \tau_i, \kappa_{it}, \epsilon_{it}) \right] / (1 - \chi) \]

\[ \chi = (1 - \lambda) / (1 + r) \]

Exogenous probability of exiting in each period given by \(\lambda\)
Aggregate Relationships and Steady State Equilibrium

\[ C_t + E_t c_e + \delta K_t = Y_t \]

Resources expended on entry/exit impact consumption and welfare

\[ W^e = 0, \ N^d = N^s \]

Free entry condition and equilibrium in labor market
Consider briefly simpler model with no transitory shocks:

\[ \frac{\tilde{y}_t}{\tilde{y}_{t-1}} = (1 - \theta) \frac{\tilde{y}_t}{\tilde{y}_{t-1}}. \]

\[ \frac{\tilde{y}_t}{\tilde{y}_{t-1}} = \left( \frac{1}{1 - \frac{\theta}{\theta + \phi}} \right) \frac{\tilde{y}_t - \tilde{y}_t}{\tilde{y}_{t-1}} \left( \frac{\tilde{y}_{t-1}}{\tilde{y}_{t-1}} \right) \]

\[ \frac{\tilde{y}_t}{\tilde{y}_{t-1}} = \frac{1}{(1 - \frac{\theta}{\theta + \phi})} \frac{\tilde{y}_t}{\tilde{y}_{t-1}} - \frac{\tilde{y}_t}{\tilde{y}_{t-1}} \left( \frac{\tilde{y}_{t-1}}{\tilde{y}_{t-1}} \right) \]
Non distorted economy responsiveness to overhead labor

U.S. Benchmark
The Relationship Between OP Covariances and Distortion Dispersion

- COV(LPR)
- COV(TFPR)
- Cov(TFPQ)
The Relationship Between Productivity and Distortion Dispersion

STD(TFPR)  STD(LPR)
Using distortions to match OP-gap

<table>
<thead>
<tr>
<th>Country</th>
<th>COV_LPR</th>
<th>COV_LPR</th>
<th>STD_LPR</th>
<th>STD_LPR</th>
<th>STD_TFPR</th>
<th>STD_TFPR</th>
<th>Consumption Index (Model)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>(Data)</td>
<td>(Model)</td>
<td>(Data)</td>
<td>(Model)</td>
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<td>(Model)</td>
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</tr>
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<td>United States</td>
<td>0.51</td>
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<td>0.58</td>
<td>0.75</td>
<td>0.38</td>
<td>0.47</td>
<td>1.00</td>
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<tr>
<td>United Kingdom</td>
<td>0.16</td>
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<td>0.65</td>
<td>0.41</td>
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<td>0.28</td>
<td>0.72</td>
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<td>Romania</td>
<td>-0.03</td>
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<td>0.72</td>
<td>0.56</td>
<td>0.70</td>
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<td>Slovenia</td>
<td>0.05</td>
<td>0.05</td>
<td>0.80</td>
<td>0.71</td>
<td>0.22</td>
<td>0.71</td>
<td>0.90</td>
</tr>
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</table>
Robustness: Multiplicative Measurement Error in Output (additive in logs)
Concluding Remarks

Aggregate and Micro Productivity Dispersion inherently linked via allocative efficiency.

But many conceptual and measurement challenges:

- Much of the firm-level evidence is about TFPR and not TFPQ.
  - Some parts of the literature have not fully taken this into account.
- The recent misallocation literature builds on the distinction between TFPR and TFPQ.
  - But identification and measurement challenges remain.