What Determines Firm Performance?

Chad Syverson

University of Chicago Booth School of Business and NBER

Presentation at REU
July 5, 2013
An Explosion of Data

- The past 20 years have seen a massive infusion of detailed data on firms’ production activities
  - Statistical agencies’ microdata
    - E.g., U.S. Economic Census
    - U.K., Denmark, France, Colombia, Chile, Turkey, Ghana, China, India, Indonesia...
  - Firms’ own data distributed via agreement
A Key Focus: Firm Performance as Measured through Productivity

- Much of the research using this data has focused on businesses’ productivity

- Productivity: How much output (physical units, quality adjusted units, or dollars) a producer obtains from each unit of inputs

\[
\text{Productivity} = \frac{Output}{Inputs}
\]

- Efficiency in production
Productivity Dispersion is Everywhere

- There are very large productivity differences across producers, even within narrowly defined industries.
- Researchers (including me) have found this in every country, industry, and time period they’ve looked.
Productivity Dispersion is Everywhere

- What does “narrowly defined” mean?
  - Saw blade manufacturing
  - White pan bread bakeries
  - Ready-mixed concrete
  - Bookstores
  - Manufactured ice
Productivity Dispersion is Everywhere

- What do “large productivity differences” mean?
  - Typical 90-10 percentile total factor productivity ratio within 4-digit industries in U.S. mfg. is 2-to-1 or higher

- What this implies:
  - Line up industry producers from least to most productive; the 90th percentile producer obtains twice as much output from the same measured inputs (capital, labor, energy, materials) as the 10th percentile producer

- China: 3-to-1 ratio
- India: 5-to-1
Productivity Is Persistent

- High-productivity businesses this year are likely to be next year as well
  - Even after 5 years, 1/3 of businesses in top 20 percent are still there
  - Those that aren’t are more likely to be in second 20 percent than anywhere else
  - Etc.

- Low-productivity businesses are likely to stay that way, too…unless they shut down (which they do, a lot)
Productivity Is Literally a Matter of Survival for Businesses

- Higher productivity is tied to “good news” about business prospects
  - More likely to survive
    - Lowest 20 percent of manufacturers 2.5X more likely to go out of business within five years than those in highest 20 percent
- Faster future growth
- Productivity is good for workers (higher wages) and consumers (lower prices) too
Examples of Productivity Research across Fields

- Macro
  - Dissect aggregate productivity growth
  - Build models of productivity-driven fluctuations
  - Test models of growth, convergence, and technology spillovers

- Industrial Organization
  - Effects of competition
  - Size of sunk entry costs
  - Role of organizational structure
Examples of Productivity Research across Fields

- Development
  - Effects of shifts from informal to formal sector
  - Entrepreneurship decisions
  - Input cost shocks in crises

- Labor
  - Role of human capital in productivity growth
  - Effects of incentive pay and other HR practices
  - Test models of social interactions among workers
Examples of Productivity Research across Fields

- **Finance**
  - Effects of mergers and acquisitions
  - Span-of-control issues (e.g., diversification discount)

- **Trade**
  - Heterogeneous-productivity frameworks have become dominant paradigm
  - Productivity effects of openness
Measurement of Productivity

- Typical measure is total factor productivity (TFP)
- Standard treatment of TFP as shifter of PF
  - E.g., Cobb-Douglas PF:
    \[ TFP_t = A_t = \frac{Y_t}{K_t^{\alpha_k} L_t^{\alpha_l} M_t^{\alpha_m}} \]
- Remember: TFP is, at its heart, a residual—sort of a measure of our ignorance. The literature is trying to put faces on that residual
Measurement of Productivity

- Standard ways to measure productivity
  1. Index number (a la Solow residual)
  2. Residual of production function estimation

- Every method requires assumptions; some are more comfortable in certain settings

- Fortunately, productivity patterns usually quite robust to particulars of measurement
So What Determines Productivity?

Two broad sets of factors:
1. Things that, at least in concept, are within a businesses’ control—“levers”
2. Aspects of the operating environment—“external factors”
“Levers”

1. Managerial practices/talent
2. Higher-quality labor and capital
3. IT and R&D
4. Learning-by-doing
5. Product innovation
6. Firm structure decisions
Managerial Practices/Talent

- Until recently, as a source of productivity differences, management held the highest ratio of speculation to actual evidence.

- Recent efforts to collect broad and consistent data on management practices.
  - E.g., World Management Survey—detailed discussions with plant managers from around the world, codified into management practice scores.
Management Scores across Countries

Management Scores across Firms

- United States
- Brazil
- China
- India

Management Scores across Ownership

5+ Shareholders  Family, family CEO  Government  Private Equity

Family, external CEO  Founder  Managers  Private Individuals

Managerial Practices/Talent

- Managerial practice scores are correlated with firms’ productivity levels (& growth, survival, etc.)
  - What is correlated with management scores?
    - Competition
    - Primogeniture
  - Does management cause productivity to go up?
  - Gold standard: randomized trial
Management Practices in Indian Textiles

- Experiment run on 20 cotton fabric plants (average 300 employees and $7m sales) in Mumbai
- Randomized “treatment” group plants—5 months of management consulting intervention
- Control group—received 1 month (need to set up data collection)
- Consulting offered on 38 specific practices tied to factory operations, quality and inventory control
- Collect weekly data on all plants from 2008 to 2010
Adoption of 38 Mgmt. Practices

Months after the start of the diagnostic phase

Share of 38 practices adopted

Treatment plants

Control plants

Non-experimental plants in treatment firms

Months after the start of the diagnostic phase
• Quality improved significantly in treatment plants

•Weeks after the start of the experiment

•Note: solid lines are point estimates, dashed lines are 95% confidence intervals
• TFP rose in treatment plants vs controls

- Weeks after the start of the experiment
- Note: solid lines are point estimates, dashed lines are 95% confidence intervals
Management Practices in Indian Textiles

- All totaled, the average plant should save about $200-300K per year due to the changes
- This includes ongoing costs of data collection and monitoring
Learning-by-Doing

- Learning-by-doing (LBD): the efficiency gains achieved via the very act of producing

- Study the mechanisms behind LBD in an auto assembly plant during a production year
  - About 200,000 cars
  - See each of the several hundred processes
  - Know when defects happen
<table>
<thead>
<tr>
<th>Vin</th>
<th>Model</th>
<th>Dcode</th>
<th>Descr</th>
<th>Dept</th>
<th>Zone</th>
<th>Teamop</th>
<th>Day</th>
<th>Month</th>
<th>Hr</th>
<th>Min</th>
<th>Defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>100017</td>
<td>XXXP41</td>
<td>VS--QBUY01</td>
<td>QBUY-VIN SCRIBE REQUIRED</td>
<td>9150</td>
<td>T5</td>
<td>VS01</td>
<td>18</td>
<td>4</td>
<td>10</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>100017</td>
<td>XXXP41</td>
<td>BS99999968</td>
<td>AC LINE TO SHOCK TOWER LOOSE</td>
<td>9150</td>
<td>T5</td>
<td>T4M4</td>
<td>18</td>
<td>4</td>
<td>10</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>100017</td>
<td>XXXP41</td>
<td>EN99998139</td>
<td>AC LINE SHY</td>
<td>9150</td>
<td>T5</td>
<td>T4M4</td>
<td>18</td>
<td>4</td>
<td>10</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>100017</td>
<td>XXXP41</td>
<td>EN99999994</td>
<td>AC LINE NOT SEATED TO BLOCK</td>
<td>9150</td>
<td>T5</td>
<td>T4M4</td>
<td>18</td>
<td>4</td>
<td>10</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>100017</td>
<td>XXXP41</td>
<td>QVST9QVL12</td>
<td>LT A-POST PLUG-SHY (L10) @YEL</td>
<td>9150</td>
<td>TQV1</td>
<td>18</td>
<td>4</td>
<td>11</td>
<td>31</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>100017</td>
<td>XXXP41</td>
<td>CPTS-F0-T1</td>
<td>CPTS-FUEL TANK ASSY TRACE @SCANT1 F0 ATT1BUG,BRR</td>
<td>9170</td>
<td>C3</td>
<td>C317</td>
<td>18</td>
<td>4</td>
<td>11</td>
<td>48</td>
<td>0</td>
</tr>
<tr>
<td>100017</td>
<td>XXXP41</td>
<td>TE99998983</td>
<td>HEATER HOSE TO FIREWALL N/C</td>
<td>9170</td>
<td>C3</td>
<td>C323</td>
<td>18</td>
<td>4</td>
<td>11</td>
<td>52</td>
<td>1</td>
</tr>
<tr>
<td>100017</td>
<td>XXXP41</td>
<td>STJ8RESULT</td>
<td>ROLL MOUNT/MASS DAMPER SECURE</td>
<td>9170</td>
<td>C1</td>
<td>STJ8</td>
<td>18</td>
<td>4</td>
<td>11</td>
<td>59</td>
<td>0</td>
</tr>
<tr>
<td>100017</td>
<td>XXXP41</td>
<td>STJ8QBUY01</td>
<td>QBUY-ROLL MOUNT/MASS DAMPER BOLT #1 TORQ</td>
<td>9170</td>
<td>C1</td>
<td>STJ8</td>
<td>18</td>
<td>4</td>
<td>11</td>
<td>59</td>
<td>0</td>
</tr>
<tr>
<td>100017</td>
<td>XXXP41</td>
<td>STJ8QBUY02</td>
<td>QBUY-ROLL MOUNT/MASS DAMPER BOLT #2 TORQ</td>
<td>9170</td>
<td>C1</td>
<td>STJ8</td>
<td>18</td>
<td>4</td>
<td>11</td>
<td>59</td>
<td>0</td>
</tr>
<tr>
<td>100017</td>
<td>XXXP41</td>
<td>SCANQBUY03</td>
<td>SCAN-SCAN FRONT SUSPENSION VIN @RED@BN</td>
<td>9170</td>
<td>C1</td>
<td>C134</td>
<td>18</td>
<td>4</td>
<td>12</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>100017</td>
<td>XXXP41</td>
<td>CPTS-21-P2</td>
<td>CPTS - ROLL MOUNT PART# REQUIRED</td>
<td>9170</td>
<td>C1</td>
<td>C135</td>
<td>18</td>
<td>4</td>
<td>12</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>
Overall LBD Patterns
Starting a New Shift

![Chart showing average defects per car by production week/year for Shift 1 and Shift 2. The chart shows a significant decrease in defects for both shifts over time, with Shift 1 generally having fewer defects than Shift 2.]
Starting a New Model
Station-Level Defect Rates Are Persistent

The diagram shows the distribution of station-level defect rates across different quantiles. Each bar represents a quantile, with the fraction of total defects indicated on the y-axis. The colors signify different quantiles:
- Quantile 1: Blue
- Quantile 2: Red
- Quantile 3: Green
- Quantile 4: Orange
- Quantile 5: Gray

The bars are divided among the quantiles, illustrating the persistent nature of defect rates across stations.
Absenteeism

- Higher absenteeism rates are related to defects, but the effect is small
- Cutting absences altogether (from about 14% to zero) would only reduce defect rates by 5%
Warranty Payments

- Each defect tied to an average warranty cost of 41¢ over the first 9 months of car’s life
- Applied to 65 defect-per-car drop in average defect rates over production year: ~$26.50 per car savings
- Applied to the 200K cars: $5 million in warranty claims savings
- Clearly lower bound: only early warranty claims, doesn’t measure effect on consumers’ willingness to pay for quality
Bottom Line on Mechanism

- No relearning with new shift
- Absences have small effects
- Station-level defect rates are correlated across shifts
- LBD is embodied in physical or organizational capital rather than individual workers
Firm Structure

- Plants in vertically structured firms have higher productivity than those in other firm structures (single-industry horizontal, conglomerate)
  - This is also true if we just compare new plants
- Plants that *will become* part of vertically structured firms *already* have higher productivity than their peers
- So does vertical integration lead to higher productivity?
Firm Size Distributions by Firm Structure

1997 Firm Size Distributions by Organizational Form

- Single-industry horizontal
- Conglomerate
- Vertically integrated
Firm Structure

- If we compare productivity levels of plants in vertically integrated firms to those in firms that have a different structure \textit{but are the same size}, most of the productivity gap disappears.
- Good firms get big and have good plants.
  - Sometimes, they get big vertically, but that may be incidental to their productivity.
External Factors

1. Productivity spillovers
2. Competition—both intra-market and through trade
3. Regulatory environment
4. Input market flexibility
Competition and Productivity

- Even monopolist minimizes costs, so why does competition matter to productivity?
- Minimizing costs may not be—probably isn’t—free
- Ever-changing market conditions mean best-practice efficiency is a moving target
- Lack of competition dulls incentive to keep up with target
- Competition shifts activity away from less productive firms and toward more productive ones
Competition and Productivity: Two Mechanisms

- Competition can drive productivity improvements through a combination of two mechanisms
  - Existing businesses spurred to be more efficient
  - “Selection” / Darwinian survival: inefficient shrink or go out of business, efficient enter and grow
- Both mechanisms matter, but their relative importance varies across industries
  - Manufacturing: 50-60% of productivity growth among existing producers
  - Retail: Almost all growth through selection
Competition and Productivity: Ready-Mixed Concrete

- Concrete is concrete, so what limits competition?
  - Transport costs
- Markets where producers are located close together offer more options for customers
  - It’s harder to be inefficient and survive in such mkts
  - Competitiveness determined by construction density

![Diagram](attachment:diagram.png)
Competition and Productivity: Concrete
Competition and Productivity: U.S. Iron Ore

- Productivity doubles in 5 years.
- No productivity change in 12 years.
Competition and Productivity: U.S. Iron Ore

- Repair hours drop from 50% to 25% of total hours

**Fig. 10.**—Total hours and repair hours as a percentage of total hours: Minntac/USX pellet mine
Regulation and Productivity

- Regulatory policies may impose barriers to efficiency or affect incentives to change productivity
  - But—The Porter Hypothesis: regulation can force a reckoning that leads to new efficiencies

- Study of U.S. Clean Air Act Amendments
  - About 5% total TFP drop of polluting plants in nonattaining counties
    - $21 billion per year in lost manufacturing output
  - But there are benefits, too
Regulation and Productivity: U.S. Sugar Act

- Sugar Act—New Deal program lasted 1934-74
- Gave subsidies to farmers based on “sugar-in-beet”
- Paid for subsidies by taxing sugar companies on refined sugar
  - Let sugar companies collude in exchange
Regulation and Productivity: U.S. Sugar Act

- Incentives
  - Farmers: maximize “sugar-in-the-beet”
    - Grow giant, but low quality, beets
    - Little sugar per pound of beet, hard to refine
  - Sugar companies: because of collusive agreements, little incentive to get much sugar out of raw stock
- Expected outcome—low refining productivity (little sugar per ton of beets)
Productivity and Market Flexibility

- Productivity growth through Darwinian selection relies on the ability to reallocate resources to higher-productivity producers
  - Product market flexibility (i.e., competition)—consumers can easily switch suppliers
  - Labor mkt. flexibility—workers can move to more efficient operations
  - Capital mkt. flexibility—capital flows to efficiency
- Summary measure of reallocation at work is correlation between productivity and market share
Productivity and Market Flexibility

Correlation between Productivity and Market Share
Productivity and Market Flexibility

Correlation between Productivity and Market Share

- Hungary
  - 95-96
  - 00-01
- Slovenia
  - 92-93
  - 95-96
  - 00-01
- Romania
  - 95-96
  - 98-99
- Latvia
  - 95-96
  - 98-99
- Estonia
  - 95-96
  - 00-01
What Determines Firm Performance: Open Questions

- What is the importance of demand?
- What is the role of (or hope for) government policies that encourage productivity growth?
- Which productivity drivers matter most?
- What factors determine whether selection or within-producer growth is more important in a market/sector/industry?
What Determines Firm Performance: Open Questions

- What is the role of misallocation as a source of variation in emerging economies?
- What is the importance of higher variance in productivity outcomes?
- Can we predict innovation based on market conditions?
- What is the nature of intangible capital?
- Is it management or managers?
Finally—A Plea for Data

- Virtually everything discussed we now know because detailed data on production practices was available.
- Most of this data was originally collected by statistical agencies for the purpose of constructing aggregates.
- Their insights into productivity is in many ways a happy externality.
- Now that we know the value of such data, let’s make more directed efforts to measure business-level production practices.
Finally—A Plea for Data

- Examples of new data
  - Management practices (MOBS in ASM)
  - Micro-level prices
  - Input quality measures
  - Proxies for intangible capital
  - Non-R&D innovation spending

- Collecting such data is costly and will involve tradeoffs for statistical agencies or a willingness of researchers to pay private companies for the collection efforts

- Yet it’s clear there is much to gain