What Determines Productivity?

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

- 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 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

Management Scores across Ownership

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
• 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
### Raw Factory Information System Data

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### Overall LBD Patterns

![Overall LBD Patterns](image-url)
Starting a New Shift

Average Defects per Car

Production Week/Year

Shift 1

Shift 2

Starting a New Model

Average Defects per Car

Production Week/Year

Model 1

Model 2

Model 3
Station-Level Defect Rates Are Persistent

Absenteeism

- Higher absenteeism rates are related to defects, but
  the effect is small
- Cutting absences by $\frac{1}{2}$ would only reduce defect rates by 0.5%
Warranty Payments

- Each defect tied to an average warranty cost of 42¢ over the first 9 months of car’s life
- Applied to 70 defect-per-car drop in average defect rates over production year: ~$28 per car savings
- Applied to the 200K cars: $5.5 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**

![Graph showing firm size distributions for Single-industry horizontal, Conglomerate, and Vertically integrated firms.](image)
**Firm Structure**

- If we compare productivity levels of plants in vertically integrated firms to those in firms that have a different structure *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

Market A

Market B

Competition and Productivity: Concrete
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

![Correlation between Productivity and Market Share](image)
Productivity and Market Flexibility

Correlation between Productivity and Market Share

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