Firm Performance and the Allocation of Resources

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Firm Heterogeneity, Allocation, and Misallocation

- 25 years of microdata-based research has made clear that firm heterogeneity is *large* and it is *everywhere*
  - Large: Huge differences in productivity and demand, even within narrowly defined industries/markets
  - Everywhere: Observed in every industry, time period, and country researchers have looked
- Two big areas of current work on heterogeneity
  - How does the market allocate activity (use of inputs and consumption of outputs) across heterogeneous producers?
  - Does some of the heterogeneity reflect a *misallocation* of activity?

Firm Heterogeneity, Allocation, and Misallocation

- Resource (mis-)allocation is one of the most fundamental questions in economics

- AEA website:

  What is Economics?

  Economics is the study of how people choose to use resources.

Firm Heterogeneity, Allocation, and Misallocation

- The allocation-across-heterogeneous-producer framework dominates one field (trade) and is growing fast in two others (macro and development)
- It is also very naturally connected to industrial organization (obviously!), though as much in concept as in practice
- It is a way—a very good way—that we IO researchers can inform the work of our colleagues in other fields
  - They're doing IO anyway; let's help them do it better

Firm Heterogeneity, Allocation, and Misallocation

- My talk today
  1. Overview a simple heterogeneous-producer market framework
  2. Summarize some of my recent and ongoing work in this area
  3. Talk briefly about how this framework (and through it, IO) has influenced other fields and discuss more generally how IO can extend its reach

A Simple Heterogeneous-Producer Framework

- A grossly simplified version in the style of, e.g.,
  - Hopenhayn (1992)
  - Ericson and Pakes (1995)
  - Melitz (2003)
  - Asplund and Nocke (2006)
  - Sutton (2007)

A Simple Heterogeneous-Producer Framework: Costs

- Each market producer has a variable cost function with an idiosyncratic component: $C(q_i; \omega_i)$
  - Idiosyncratic component ω_i can reflect differences in productivity and/or factor prices

A Simple Heterogeneous-Producer Framework: Demand

- Each producer faces a residual demand curve with an idiosyncratic component that also depends on the number of producers in the market: $D(p_i; \delta_i, N)$
  - δ_i can reflect vertical or horizontal differentiation or even market power differences
  - *N,* the number of producers, can be a discrete count or measure of a continuum
    - *N* is a stand-in for a broader set of measures that might affect the intensity of competition in the market

A Simple Heterogeneous-Producer Framework: Profit

- The producer chooses its optimal quantity/price given cost and demand primitives, yielding a profit value function $\pi(\omega_i, \delta_i, N)$
- Note:
  - Profits depend on the equilibrium level of competition in the market (captured by N)
  - Profits generally depend on both idiosyncratic cost and demand components ω_i and δ_i
    - This combination is the producer's "capability" in Sutton (2007); forms "profitability index" in Foster, Haltiwanger, and Syverson (2008)

A Simple Heterogeneous-Producer Framework: Equilibrium

- Two conditions pin down equilibrium

1. Zero-marginal-profit: No producer with a capability (ω_i and δ_i combination) that yields negative profits operates
2. Free entry: Ex-ante identical producers pay a sunk cost to take ω_i and δ_i draws from a known distribution $G(\omega_i,\delta_i)$; the expected value of taking a draw is zero

A Simple Heterogeneous-Producer Framework: Equilibrium

- Characteristics of equilibrium
  - Pins down market structure *N*
  - There is dispersion in both costs and demand
  - Observed distribution of idiosyncratic cost and demand is a truncation of $G(\omega_i,\delta_i)$
  - For any "standard" cost and demand functions, higher capability producers have larger market shares
  - Conditional on ω_i and δ_i, resources are allocated efficiently
  - Dynamic extensions imply shocks to ω_i and δ_i lead to reallocations that "follow" good draws

Testing the Framework (1): Do M&As Reallocate Resources to Better Producers?

- In a recent paper, Serguey Braguinsky, Atsushi Ohyama, Tetsuji Okazaki, and I use unusually detailed data on the Japanese cotton spinning industry at the opening of the 20th century to study acquisitions
- In principle M&A can reallocate productive assets to firms able to apply them more efficiently
- But a prominent alternative view is that M&A are driven by inefficient motives
- Previous research has not been fully conclusive, partly due to several data problems

Do M&As Reallocate Resources to Better Producers?

- Our data has a lot of other stuff one usually can't observe. We can measure…
  - …profitability separately from productivity (i.e., a richer measure of capabilities)
  - …the production process virtually at an engineering level
  - …productivity conditional on operation as well as capacity utilization
  - …firms' inventory holdings and past due accounts
  - …firms' product-market connections

Do M&As Reallocate Resources to Better Producers?

- Main findings (1): More nuanced picture than the straightforward "higher productivity buys lower productivity" story of the theoretical literature
  - Acquired firms' plants *not* on average any less physically productive than plants of the acquiring firms
  - Acquired firms had newer, better capital
  - But acquired firms much less *profitable* than acquirers
  - Profitability gap not from output price differences
  - Acquisitions raised *both* productivity and profitability; prices didn't change

Future Acquiring, Acquired and Exiting Plants *before* Acquisitions, 1896-97

		Acquiring plants	Acquired plants		Exiting plants
			First cohort	Second cohort	
TFPQ	Mean	0.066	0.034	0.156	-0.211
	(SD)	(0.156)	(0.225)	(0.229)	(0.552)
Profit per paid-in share	Mean	0.274	0.185	0.159	0.159
	(SD)	(0.205)	(0.074)	(0.149)	(0.101)
Price (yen/400lb)	Mean	93.8	92.4	92.8	91.7
	(SD)	(4.9)	(3.8)	(7.4)	(7.0)
Logged price residual	Mean	-0.017	0.008	0.005	0.015
	(SD)	(0.055)	(0.041)	(0.040)	(0.062)
Main count of yarn produced	Mean	21.5	17.5	17.2	14.0
	(SD)	(11.5)	(2.6)	(4.7)	(5.6)
Days in operation	Mean	323.7	315.9	300.6	278.6
	(SD)	(29.8)	(29.5)	(55.6)	(56.8)
Equipment age	Mean	5.28	5.88	2.79	11.77
	(SD)	(3.49)	(2.76)	(1.00)	(6.69)
Firm age	Mean	9.13	11.06	3.31	12.54
	(SD)	(5.08)	(3.81)	(2.05)	(7.86)
Observations		32	33	32	24

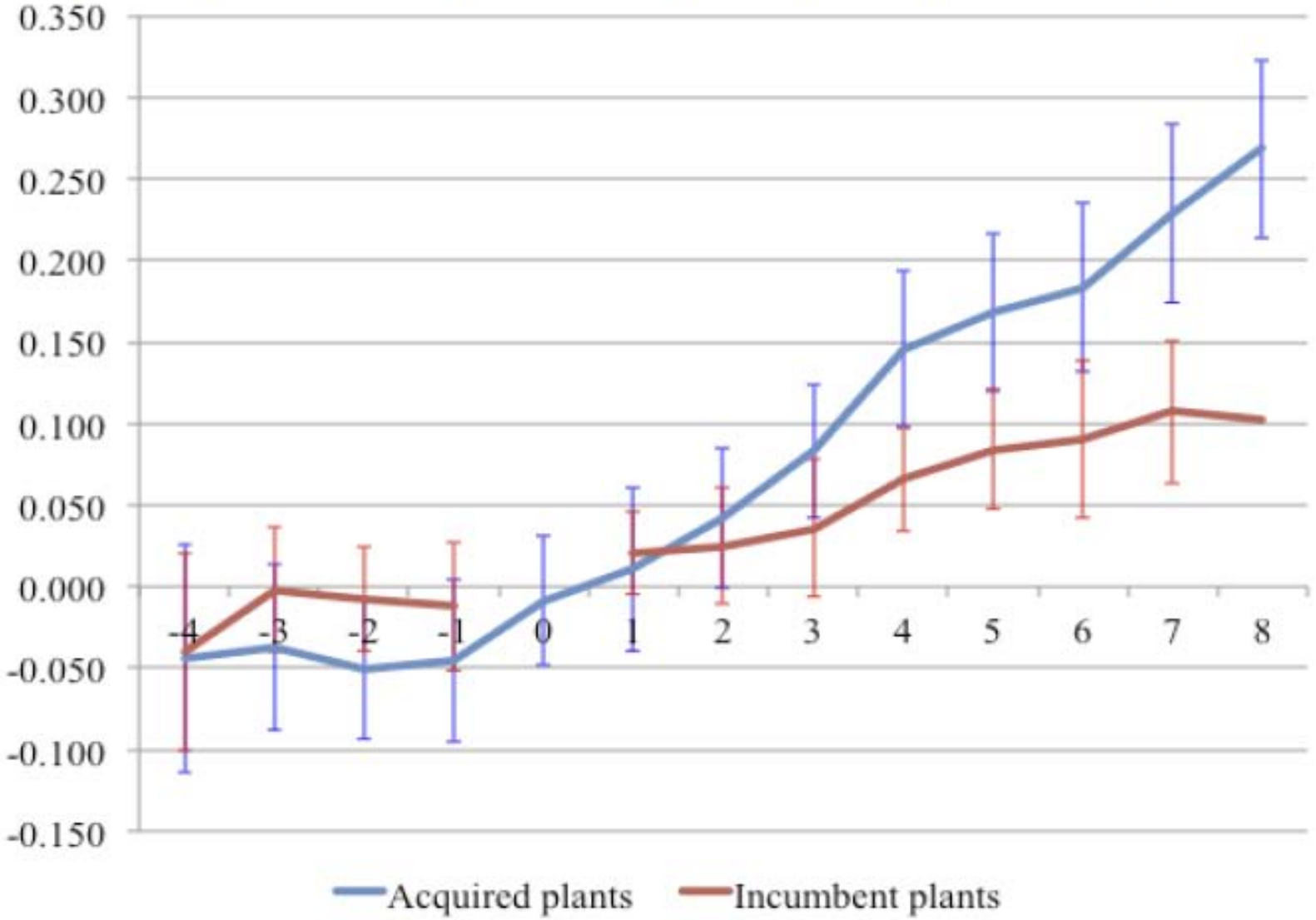
Comparisons of Machine Vintages

	Pre-1892 vintage	1892-97 vintage
Spindle rotation speed (RPM x 1000)	7.10	7.71
Cotton yarn count designed for	17.53	19.96
Number of spindles per ring frame	332.25	377.71
Number of cotton types designed for	1.06	2.47
Designed for Indian cotton	0.00	0.56
Designed for US cotton	0.04	0.44

Within-Acquired-Plant Estimates

	All acquisitions		
Dependent variable	TFPQ	Plant ROCE	Log price res.
Late pre-acquisition dummy	-0.003	0.020	0.011
	(0.019)	(0.013)	(0.013)
Early post-acquisition dummy	0.045*	0.060***	0.036
	(0.026)	(0.022)	(0.027)
Late post-acquisition dummy	0.126***	0.089***	0.044
	(0.033)	(0.025)	(0.034)
Constant	0.603***	0.102***	0.029***
	(0.032)	(0.013)	(0.010)
Acquisition fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	1,078	891	1,118
Adjusted R-squared	0.734	0.639	0.097

Figure A15. Within-acquisition TFPQ of acquired and incumbent plants



Do M&As Reallocate Resources to Better Producers?

- Main findings (2): Profitability gap from lower unit capital costs among acquirers
  - Higher capacity utilization
  - Lower average inventory levels and accrued revenues (i.e., payments in arrears)
  - These gaps arise in part from acquired firms' deficits in demand management (new mechanism in the literature)
  - Gaps closed after acquisition

Unrealized Output—Stuff That Isn't Sold

Means	Acquired plants (A)	Incumbent plants (B)	Difference (B-A)	Percentage difference
Inventory/produced output (C)	0.046	0.018	-0.028	-61.0***
Accrued revenues/produced output (D)	0.031	0.015	-0.016	-50.6***
Unrealized/produced output (C)+(D)	0.078	0.033	-0.045	-57.4***
# of observations	113	195		

Measuring Producers' Connections to Trading Houses

- Use 1898 nationwide registry to identify those most likely connected to cotton spinners' output markets
- Yielded list of 154 individuals
  - 98 cotton yarn traders across Japan who paid more than 50,000 yen worth of operation tax that year
  - 25 individuals listed as board members of the 4 largest incorporated cotton yarn-related trade companies
  - 31 board members and traders registered at Osaka cotton and cotton yarn exchange
- "Trader network" dummy = 1 if firm had at least 1 trader among board members and top shareholders (33 of 67 firms)
- Similar results using shares of stock owned by connected traders

Performance Metrics for In-Network and Out-of-Network Producers, 1898-1902

Outcome	Out-of-network (A)	In-network (B)	Difference (B-A)
TFPQ	0.433	0.488	0.055***
TFPQU	0.117	0.241	0.123***
ROCE	0.023	0.059	0.037***
Unrealized output ratios	0.127	0.084	-0.043***
Spindle utilization rates	0.739	0.781	0.043**
Logged price residuals	-0.025	0.018	0.044***
# of observations	127	170	

Do M&As Reallocate Resources to Better Producers?

- Main findings (3): Acquisitions did reallocate assets based on capability (profitability), but empirics more nuanced than single-dimensional productivity theory
  - Acquired plants weren't less productive (when operating) because they had newer, better capital
  - However, they used the capital suboptimally
  - New management had better connections in downstream market
  - These abilities let them raise productivity *and* profitability
  - We show similar results for acquirers with university-trained engineers (production expertise)

Do M&As Reallocate Resources to Better Producers?

- Bottom line: Acquisitions drove substantial industry productivity growth
  - Plants accounting for 70% of industry capacity in 1898 (year of first acquisition) had changed hands by 1918
  - Average industry TFP growth was 2.5% per year

Testing the Framework (2): Are More Patients Allocated to Better Hospitals?

- At least since Arrow (1963), many economists have believed that mechanisms that are standard in other markets don't operate in healthcare
- Among these differences are a lack of mechanisms to allocate more output to better providers
  - Consumers are uninformed about quality or unable to act on that information
- Combined with health insurance and poorly designed public sector reimbursement structures, this can create resource over-allocation and misallocation

Testing the Framework (2): Are More Patients Allocated to Better Hospitals?

- "Healthcare exceptionalism" w.r.t. consumers' choices is a prominent policy and research issue
  - Cutler (2010): "Difficulty measuring quality *makes expansion of high-quality firms more difficult*."
  - Skinner (2011): "[low-performing producers are] *unlikely to be shaken out by normal competitive forces*, given the patchwork of providers…each of which faces inadequate incentives to improve quality or lower costs…"
  - [Emphasis added in both quotations]

Are More Patients Allocated to Better Hospitals?

- Amitabh Chandra, Amy Finkelstein, Adam Sacarny, and I are in an ongoing project testing for healthcare exceptionalism in patient allocation
- Data on all U.S. Medicare patients treated for one of five conditions: heart attacks (AMIs), congestive heart failure, pneumonia, hip fractures, and hip and knee replacements
- Four hospital performance measures: 30-day survival rate, 30-day readmission rate, “process of care” grade, and a patient customer-service survey score (first three are condition-specific)

Are More Patients Allocated to Better Hospitals?

- We use this data to conduct two basic tests of patient allocation

1. Do higher-quality hospitals treat a greater share of patients? [Static allocation]
2. Do higher-quality hospitals see faster future growth in the number of patients? [Dynamic allocation]

- We quantify the strength of allocation and how it varies with patients' ability to make choices

Are More Patients Allocated to Better Hospitals?

- Main findings (1): Demand is allocated to better hospitals, even for emergency conditions like heart attacks and hip fractures
  - Static allocation holds for all conditions and all quality measures except patient satisfaction survey scores (!)
  - Dynamic allocation not as strong but holds more often than not
  - Strength of allocation quantitatively important
  - Strong form of “healthcare exceptionalism” is rejected

Static Allocation

Measure \ Condition	AMI	CHF	Pneu	Hip Fr	Hip/Knee
Risk-Adjusted Survival	**17.496**	**15.360**	**5.140**	**16.870**	
	(0.995)	**(1.320)**	**(0.777)**	**(2.194)**	
Risk-Adjusted Readmission	**-9.162**	**-10.346**	0.499	**-2.860**	**-21.037**
	(1.621)	**(1.782)**	(1.575)	**(1.313)**	**(2.027)**
Process of Care Z-Score	**0.319**	**0.332**	**0.211**		
	(0.026)	**(0.016)**	**(0.015)**		
Patient Survey Z-Score	**-0.321**	**-0.252**	**-0.210**	**-0.307**	0.057
	(0.052)	**(0.038)**	**(0.030)**	**(0.053)**	(0.051)

Dynamic Allocation

Measure \ Condition	AMI	CHF	Pneu	Hip Fr	Hip/Knee
Risk-Adjusted Survival	**1.533**	0.774	**1.220**	0.558	
	(0.379)	(0.501)	**(0.354)**	(0.967)	
Risk-Adjusted Readmission	**-1.428**	**-2.300**	-1.138	-0.020	-1.112
	(0.611)	**(0.651)**	(0.679)	(0.537)	(0.836)
Process of Care Z-Score	**0.048**	**0.043**	**0.026**		
	(0.010)	**(0.009)**	**(0.009)**		
Patient Survey Z-Score	**-0.065**	-0.003	0.007	**-0.062**	0.037
	(0.015)	(0.011)	(0.011)	**(0.019)**	(0.022)

Are More Patients Allocated to Better Hospitals?

- Static allocation tests indicate better hospitals treat a significantly larger share of patients than other hospitals in their market. For AMIs, e.g.:
  - 1-pp increase in 30-day survival (sample mean = 82%, SD = 3%) tied to a 17% higher market share
  - 1-pp reduction in 30-day readmission rate (sample mean = 21%, SD = 3%) tied to a 9% higher share
  - 1-SD increase in the use of consensus AMI treatments (processes of care) tied to 32% higher share
  - Exception is in patient satisfaction survey (negative correlation); not condition-specific metric, however

Are More Patients Allocated to Better Hospitals?

- Dynamic allocation tests are not as strong but also generally indicate shift of patients to higher-performing hospitals. Again for AMIs:
  - 1-pp increase in 30-day survival tied to a 1.5 pp higher growth in the number of AMI patients over next two years
  - 1-pp reduction in 30-day readmission rate tied to a 1.5 pp higher growth in patients
  - 1-SD increase in processes of care score tied to 4.8 pp higher growth in patients
  - Again patient satisfaction survey is the exception

Are More Patients Allocated to Better Hospitals?

- Main findings (2): We estimate patients' MRS of quality for distance
  - E.g, AMIs (median travel to hospital = 7.0 miles):
    - Will travel an additional 1.8 miles for a 1-pp increase in 30-day survival
    - Will travel an additional 1.1 miles for a 1-pp increase in 30-day readmission rate
    - Will travel an additional 4.4 miles for a 1-SD increase in processes of care score

Are More Patients Allocated to Better Hospitals?

- Main findings (3): Allocation is stronger for patients with greater scope for choice—those not admitted through a hospital's emergency department

Allocation for ED and non-ED Transfer Patients (Risk-Adjusted Survival)

Condition:	AMI		Heart Failure		Pneumonia	
Source of admission:	ED	Transfer	ED	Transfer	ED	Transfer
Share of patients in 2008	0.76	0.16	0.75	0.03	0.77	0.01
Static Allocation	14.49	42.53	15.73	50.67	7.17	14.05
	(1.022)	(2.609)	(1.586)	(4.664)	(0.983)	(2.941)
P-value of equality	0.000		0.000		0.009	
Dynamic Allocation	0.572	7.258	2.300	13.94	3.423	4.454
	(0.496)	(1.260)	(0.799)	(2.635)	(1.006)	(1.793)
P-value of equality	0.000		0.000		0.562	

Are More Patients Allocated to Better Hospitals?

- Main findings (4):
  - Allocation results also hold with respect to hospital productivity (quality per unit input), though this comes through allocation on quality rather than inputs conditional on quality
  - Up to 20% of aggregate gains in survival rates have come through reallocation of patients to better hospitals rather than through within-hospital improvements in survival

- Bottom line: Healthcare isn't so exceptional after all

Zooming Out: Firm Heterogeneity, Allocation, and Misallocation, and the Big Picture

- As mentioned, the allocation-across-heterogeneous-producer framework plays a big role in several fields
  - Dominant in trade
  - Expanding quickly in macro
  - Expanding quickly in development

- These are great entry points for IO methods and ideas

Zooming Out: Firm Heterogeneity, Allocation, and Misallocation, and the Big Picture

- Examples of IO-type questions in trade
  - How do market shares / costs /demand elasticities change with trade openness?
  - How do exporters choose markets to enter?
  - How do exporters build distribution networks in new markets?
  - What factors affect the scope of products firms choose to make?
  - How to vertical production structures extend across countries?
- IO has something to say!

Zooming Out: Firm Heterogeneity, Allocation, and Misallocation, and the Big Picture

- Examples of IO-type questions in macro
  - What explains the firm size distribution?
  - How much of aggregate productivity growth comes from reallocation?
  - Do buyer-supplier networks amplify and transmit shocks, and if so, how?
  - Are resources misallocated? What are the sources? How much output is lost because of this?
- IO has something to say!

Zooming Out: Firm Heterogeneity, Allocation, and Misallocation, and the Big Picture

- Examples of IO-type questions in development
  - Is the firm size distribution different in developing countries? Why if so?
  - What affects startup rates in developing countries?
  - Why don't small businesses grow faster?
  - Is there more vertical integration?
  - Is it harder for firms in developing countries to adopt new technologies or better practices? Why?
- IO has something to say!

Beyond the Framework

- What else does IO have to say?
- IO is good at:
  - Breaking a market down into demand and supply components
  - Modeling interactions of multiple agents
  - Estimating demand and costs
  - Institutional detail
- These are all massively useful tools for many fields
- Already mentioned trade, macro, and development
- But there's more: education, healthcare, finance,…

Beyond the Framework

- Let's keep the big questions, broader themes, and more general implications in mind: What can we say to our colleagues?
- Don't give up case studies!
  - But do keep in mind how to extend what the case shows to other settings
  - And don't be afraid to pool across markets (especially if identification is within-market)
- Other fields are doing IO anyway; let's help them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