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**Article**

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<sup>13</sup> M. A. Rees, J. E. Kopke, R. P. Pelletier, D. L. Segev, M. E. Rutter, A. J. Fabrega, J. Rogers, O. G. Pankewycz, J. Hiller, A. E. Roth, T. Sandholm, M.U. Ünver, and R. A. Montgomery, "A Non-Simultaneous Extended Altruistic Donor Chain," *New England Journal of Medicine*, 360(11) (March 12, 2009) pp. 1096–1101.

<sup>14</sup> I. Ashlagi and A.E. Roth, "Individual Rationality and Participation in Large Scale, Multi-Hospital Kidney

Exchange," NBER Working Paper No. 16720, January 2011.

<sup>15</sup> I. Ashlagi, D. Gamarnik, M. A. Rees, and A. E. Roth, "The Need for (long) Chains in Kidney Exchange," NBER Working Paper No. 18202, July 2012.

<sup>16</sup> J. B. Kessler and A. E. Roth, "Organ Allocation Policy and the Decision to Donate," NBER Working Paper No. 17324, August 2011, and *American Economic Review*, 102 (August 2012), pp. 2018–47.

<sup>17</sup> A.E. Roth, "What Have We Learned from Market Design?" NBER Working Paper No. 13530, October 2007, and *Economic Journal*, 118 (March 2008) pp. 285–310.

<sup>18</sup> A.E. Roth, "The Economist as Engineer: Game Theory, Experimentation, and Computation as Tools for Design Economics," *Econometrica*, 70 (4) (July 2002) pp. 1341–78.

## The Sources and Consequences of Productivity Differences

Chad Syverson\*

Economists have consistently found both large and persistent differences in measured productivity across producers, even within narrowly defined industries. The size of these differences is striking: for instance, within U.S. 4-digit SIC manufacturing industries (such as saw blade manufacturing), the plant at the 90<sup>th</sup> percentile of the industry's productivity distribution typically obtains almost *twice* as much output with the *same measured inputs* as the plant at the 10<sup>th</sup> percentile of productivity. (These figures, and all those described below, use total factor productivity measures. They reflect the amount of output that a producer obtains from a given combination of labor, capital, and intermediate inputs.) And U.S. manufacturing is not exceptional in this regard; in fact, researchers have documented even larger dispersion in other sectors and countries.

The observed persistence of producers' productivity levels indicates that industries typically contain both firms that appear to have figured out their

business and those that are woefully lacking in such knowledge. Far more than bragging rights are at stake, because higher productivity producers are more likely to survive than their less efficient industry competitors.

The discovery of these ubiquitous, large, and persistent productivity differences has shaped research agendas in a number of fields, including (but not limited to) macroeconomics, corporate finance, industrial organization, labor, and trade. I have studied various aspects of the sources and consequences of productivity dispersion as a part of my research agenda; this essay summarizes that work.

### Two Sources of Productivity Differences

In a recent survey article, I review the research over the past decade that has sought to explain the sources of observed productivity differences.<sup>1</sup> I split the explanations into two categories. One includes factors that operate within the plant or firm and which directly affect productivity at the producer level. These are the "levers" that management or others potentially can use to influence productivity. The second category includes forces

that are external to the firm: elements of the industry or market environment that can induce productivity changes or support productivity dispersion. I have researched factors in both categories.

### Levers that Influence Productivity

On the "lever" side of the ledger, Steven Levitt, John List, and I look at the mechanisms that underlie learning by doing—productivity gains achieved through the very act of producing.<sup>2</sup> Using extremely detailed data from an assembly plant of a major auto producer, we find that productivity gains from learning arrive quickly and in force. Defects per vehicle fall by more than 80 percent in the first eight weeks of production. Interestingly, when the plant's second shift comes on line at this point, the learning process does not begin again. Instead, the second shift actually comes on line at defect rates lower than the first shift's contemporaneous rates, despite the first shift's two month head start in production. And, while worker absenteeism statistically affects defect rates, its impact is economically small. Furthermore, the hundreds of assembly processes on the line have

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highly correlated defect rates across shifts, even though the workers completing these tasks are different. Taken together, these patterns illustrate one of our main findings about the learning mechanisms at the plant: rather than remaining with workers, much of what is learned very quickly becomes embodied in the plant's physical or organizational capital. This finding is consistent with the institutional processes that plant management puts in place to encourage knowledge dissemination.

In a series of papers, Enghin Atalay, Ali Hortaçsu, and I examine the connections between firms' vertical structures and their plants' productivity levels.<sup>3</sup> We find that vertically integrated plants have higher productivity levels than their non-integrated industry cohorts. However, the evidence suggests that little of this difference is related to the firms' vertical structures per se, but rather to other factors correlated with integration status. In fact these productivity differences—and the firm's decisions about whether to have a vertical structure in the first place—are not usually related to the movement of goods along the production chain. Using detailed shipment-level data on the flow of goods throughout the economy, we find that vertically integrated firms' upstream plants ship a surprisingly small amount to downstream plants in their firm (that is, small relative to both the firms' total upstream production and their downstream needs). Almost half of upstream plants report no shipments to downstream units inside their firm. About 90 percent of upstream plants ship less than a third of their output internally. These patterns suggest that vertical ownership is not usually about moderating goods transfers along production chains. We propose and find suggestive evidence that the primary purpose of integration instead is to facilitate within-firm transfers of intangible inputs (for example, managerial oversight or intellectual capital).

### External Factors that Influence Productivity

My research on the external factors shaping productivity has looked at the

roles of both competition and regulations in influencing producer productivity levels. Most models of competition among heterogeneous-productivity producers share a prediction that a greater ability or willingness of consumers to substitute across producers either will induce low productivity suppliers to improve their efficiency or will force them to exit. Either effect truncates the market's equilibrium productivity distribution from below, thereby raising average productivity and reducing productivity dispersion.

I test this prediction in studies looking both across industries and across markets within an industry. The across-industry analysis uses producer-level data from 443 U.S. manufacturing industries and finds that industries with more substitutable output—measured in several ways, including aspects of spatial, physical, and brand-driven differentiation—have less productivity dispersion and higher median productivity levels.<sup>4</sup> The within-industry investigation focuses on the ready-mixed concrete industry.<sup>5</sup> The industry's homogeneous product and very high transport costs make the density of concrete producers in a market a primary determinant of the intensity of competition (that is, substitutability). There too, the predicted truncation effect of substitutability is observed in the data. Markets with denser construction activity (an exogenous shifter of concrete producer density) have higher lower-bound productivity levels, higher average productivity, and less productivity dispersion. In follow-up work, I demonstrate that these patterns of competition-driven selection on costs also are reflected in ready-mixed prices.<sup>6</sup>

My recent work with Michael Greenstone and John List considers regulation's effect on plants' productivity levels.<sup>7</sup> We use detailed production data from nearly 1.2 million plant observations from the 1972–93 Annual Survey of Manufactures to measure the economic costs of the Clean Air Act Amendments. We track productivity growth at plants from heavily polluting industries that are located in counties declared by the EPA to

be in nonattainment with the Act's pollution limits, a determination that subjects those plants to command-and-control-style abatement mandates. We compare productivity growth at these plants to their industry cohorts located in counties that are in attainment with the Act's provisions, and to plants in non-polluting industries that are free from regulation in all counties. We find that for surviving plants in heavily polluting industries, a nonattainment designation and its associated abatement mandates result in an average 4.8 percent decline in the plants' total factor productivity. In plain language, this means the amount of output that the plants are able to produce from a given amount of inputs (that is, labor, capital, and materials) is 4.8 percent lower than before the abatement mandates. This output loss corresponds to an annual economic cost from the regulation of manufacturing plants of roughly \$21 billion in 2010 dollars, about 8.8 percent of average annual manufacturing sector profits over the sample period.

### Productivity vs. Demand

While productivity is typically thought of as a feature of the production technology, as actually measured in producer micro-data it generally reflects more than just supply-side forces. Much of the work I've just described, and most of the broader literature investigating productivity differences among businesses, uses revenue to measure output because business-level price indexes are rarely available. This means that within-industry price differences are embodied in output and productivity measures. If prices reflect in part idiosyncratic demand shifts or market power variation across producers—a distinct likelihood in many industries—then high “productivity” businesses may not be especially technologically efficient.

A new strand of research has begun to extend the productivity literature to also explicitly account for such idiosyncratic demand effects. Lucia Foster, John Haltiwanger, and I have been active in this area. We take advantage of the avail-

ability of physical output data for a select set of “commodity-like” product industries (for example, cardboard boxes, white pan bread, and sugar). This lets us measure not just the standard revenue-based productivity metric, but also its two components: physical-quantity-based productivity (number of units of output per unit input, reflecting more closely the pure supply-side concept of productivity) and average unit price. We show that there are important differences between revenue and physical productivity.

In one paper, we consider the separate roles that supply- and demand-side fundamentals play in driving selection and survival in heterogeneous-producer industries.<sup>8</sup> We show that physical productivity is inversely correlated with price while revenue productivity is positively correlated with price. This means that previous work linking (revenue-based) productivity to survival has confounded the separate and opposing effects of technical efficiency and demand on survival, understating the true impacts of both. Perhaps most strikingly, we find that even in these near-commodity industries, a producer’s demand is particularly important for its survival prospects. A given-sized shift in a producer’s demand level has four times the effect on its likelihood of surviving as does the same-sized shift in its physical productivity.

A second paper looks at the role of demand in explaining the well documented fact that new businesses on average are much smaller than their estab-

lished industry competitors, and that this size gap closes slowly.<sup>9</sup> We show that these patterns are not a result of physical productivity gaps, but instead reflect differences in demand. Even though new producers are technically more efficient, they sell only a fraction of the output of their more established competitors. Estimating a dynamic model of plant expansion in the presence of a demand accumulation process (for example, building a customer base), we find that this accumulation results mostly through businesses’ active investments in building demand, rather than through passive processes tied simply to the passage of time. We also show that within-firm demand spillovers, like those conferred by established firms on their new plants, affect plants’ initial demand levels but not their growth.

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<sup>1</sup> C. Syverson, “What Determines Productivity?,” NBER Working Paper No. 15712, January 2010, and *Journal of Economic Literature*, 49(2) (2011), pp. 326–65.

<sup>2</sup> S. D. Levitt, J. A. List, and C. Syverson, “Toward an Understanding of Learning by Doing: Evidence from an Automobile Assembly Plant,” NBER Working Paper No. 18017, April 2012.

<sup>3</sup> A. Hortaçsu and C. Syverson, “Cementing Relationships: Vertical Integration, Foreclosure, Productivity, and Prices,” NBER Working Paper No. 12894, February 2007, and *Journal of Political Economy*, 115(2) (2007), pp.

250–301, and E. Atalay A. Hortaçsu, and C. Syverson, “Why Do Firms Own Production Chains?” NBER Working Paper No. 18020, April 2012.

<sup>4</sup> C. Syverson, “Product Substitutability and Productivity Dispersion,” NBER Working Paper No. 10049, October 2003, and *Review of Economics and Statistics*, 86(2), May 2004, pp. 534–50.

<sup>5</sup> C. Syverson, “Market Structure and Productivity: A Concrete Example,” NBER Working Paper No. 10501, May 2004, and *Journal of Political Economy*, 112(6) (2004), pp. 1181–1222.

<sup>6</sup> C. Syverson, “Prices, Spatial Competition, and Heterogeneous Producers: An Empirical Test,” NBER Working Paper No. 12231, May 2006, and *Journal of Industrial Economics*, 55(2) (2007), pp. 197–222.

<sup>7</sup> M. Greenstone, J. A. List, and C. Syverson, “The Effects of Environmental Regulation on the Competitiveness of U.S. Manufacturing,” NBER Working Paper No. 18392, September 2012.

<sup>8</sup> L. Foster, J. C. Haltiwanger, and C. Syverson, “Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?” NBER Working Paper No. 11555, August 2005, and *American Economic Review*, 98(1) (2008), pp. 394–425.

<sup>9</sup> L. Foster, J. C. Haltiwanger, and C. Syverson, “The Slow Growth of New Plants: Learning about Demand?” NBER Working Paper No. 17853, February 2012.