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DATA-DRIVEN DECISION MAKING IN ACTION

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Dramatic improvements in data storage and processing technologies in recent years have fundamentally reshaped entire sectors of the economy. In U.S. manufacturing, new opportunities to collect and leverage data have led many managers to change how they make decisions, encouraging a greater reliance on digital information rather than intuition.

Anecdotes abound suggesting that a shift to more data-driven decision making (DDD) can improve performance in individual cases. But how widespread are these improvements? What kind of firms adopt data-driven practices, and what conditions make adoption more likely?

In two recent research projects, we explored these and other questions, providing the first large-scale empirical study of the diffusion of DDD and the factors influencing its adoption, as well as the performance effects and organizational complementaries of DDD in U.S. manufacturing firms.

We worked with the U.S. Census Bureau and academics at other top institutions to design and field the first-ever Management and Organizational Practices Survey (MOPS), which provided the preponderance of data on which our two studies are based. In 2010, this survey was included as a supplement to the Annual Survey of Manufacturers (ASM), which targets a representative sample of roughly 50,000 of the over 300,000 establishments in the U.S. manufacturing sector.

MOPS asked respondents about their use of key performance indicators (KPI) such as production targets, waste, and on-time deliveries. The bulk of the survey focused on management practices related to monitoring of these KPIs, communicating within the firm, promotion and bonuses for managers and non-managers, and how authority is allocated within the firm.

*Note on Survey Design: Management and Organizational Practices Survey (MOPS) took place once only in 2010, but the questions required responders to report on their 2005 state of practices. The ASM provided data on both 2005 and 2010. For our modeling and analysis, we used the differences between what was reported for 2005 and 2010, and employed a fixed-effects research design to control for time-invariant unobserved heterogeneity at the plant. Linking the 2010 MOPS sample to the 2005 ASM reduced the size of the analysis sample from roughly 34,000 observations in 2010 to 18,000 observations.

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PERFORMANCE AND BEHAVIORAL ACTIVITIES OF ORGANIZATIONS

We included in the survey a set of questions about data-driven decision making, asking respondents to choose a value on a five-point scale according to "what best describes the availability of data to support decision making at this establishment," and "what best describes the use of data to support decision-making at this establishment."

The survey went to a large and representative sample of firms, with an ultimate response rate of 78%, which is extremely high for surveys of this nature.*

Along with the survey, we conducted qualitative interviews with plant managers to determine whether firms reporting intensive collection and use of data to track KPIs actually engaged in these practices.

We zeroed in on how intensively firms use objective KPIs, and interpreted the number of KPIs tracked by a plant as an indicator of the breadth and/or intensity of data gathering throughout the operation.

THE SURVEY FOCUSED ON MANAGEMENT PRACTICES RELATED TO MONITORING OF THESE KPIS, COMMUNICATING WITHIN THE FIRM, PROMOTION AND BONUSES FOR MANAGERS AND NON-MANAGERS, AND HOW AUTHORITY IS ALLOCATED WITHIN THE FIRM.

IN THIS RESEARCH BRIEF

- We find that greater use of data-driven decision making is associated with a statistically significant increase of 3% or more in productivity, on average.
- Consistent with a causal relationship running from DDD to performance, the improvements appear only after plants report adopting DDD."
- Performance differentials associated with data-driven decision making decrease over time for early and late adopters, consistent with firm learning and development of organizational complementarities.

On the basis of these interviews, we also identified the use of both long-and short-term performance targets as an indicator of more sophisticated use of data for management purposes.

We were interested in understanding the behavior of organizations at the frontier of practice. Therefore, to meet our definition of data-driven decision-making, our studies required that plants report being in the top two categories for both availability and use of data; tracking 10 or more KPIs; and using both long- and short-term targets.

The aggregate results of the survey and interviews provided a highly detailed view of a spectrum of organizational and managerial activities inside manufacturing plants from 2005 to 2010, as well as specific insights into how firms take advantage of data. But isolating the specific effects of data-driven decision-making in this pool of results posed a non-trivial challenge.

For instance, in seeking a relationship between DDD and higher productivity, we had to determine whether DDD merely served as a proxy for other "structured" management practices at the firm. We also had to take into account investments and changes in information technology that might affect what kind of data was available, and how a firm collected and used it.

In addition, our analysis took stock of the organizational structure in which the plant was embedded (single-unit firms versus multi-unit firms, for example); the investments made in capital stock and hiring educated workers; whether it followed lean manufacturing practices; and whether workers and managers at the plant engaged in delegated or joint decision making.

After designing econometric models to account for these and many other variables, our research provided a host of insights on the critical role of data-driven decision making in U.S. manufacturing.

DDD PRACTICE AND PRODUCTIVITY

Our analysis reveals the first evidence that management practices focused on collecting and using data are correlated with better performance in a wide range of operational settings. We find that substantially more data-intensive decision making is associated with a statistically significant increase of 3% in productivity, on average.

For the typical plant in our sample, the output increase is comparable to investing an additional $5 million in IT capital, or $60,000 per employee over the five-year period – without actually spending any more on technology.

What's more, we observed that performance increases appear only after plants adopt DDD, and not before. This is consistent with a causal relationship. In our sample of firms and at this point in time, more DDD was always better.

But what types of firms adopt DDD practices, and under what conditions are these practices likely to improve productivity?

When we looked at the diffusion of DDD from 2005 to 2010, we found that adoption of DDD varies considerably, and that firms reporting earlier adoption of DDD are different from later adopters.

The top industries for DDD adoption by 2010 were Transportation, Beverage and Tobacco, Food,Paper Chemicals, and Electrical and Appliance, manufacturing. DDD prevalence by 2010 in our sample ranges from 34-41% for these industries.

In contrast, laggard industries include Apparel and Leather, Furniture, and Printing; the average DDD prevalence in these industries by 2010 ranges from 13%-19%. The most significant change in the prevalence of DDD practices is in the Beverage and Tobacco manufacturing industries, which vary widely from wineries to cigarette manufacturers, and Transportation, which includes aerospace and automobile manufacturing.

We grouped together Wood, Paper, Petroleum, Chemicals, Non-Metallic Minerals, and Primary Metal industries into a "continuous flow" category. The average adoption in these industries is also relatively high (34%).

MANAGEMENT PRACTICES FOCUSED ON COLLECTING AND USING DATA ARE CORRELATED WITH BETTER PERFORMANCE IN A WIDE RANGE OF OPERATIONAL SETTINGS. WE FIND THAT SUBSTANTIALLY MORE DATA-INTENSIVE DECISION MAKING IS ASSOCIATED WITH A STATISTICALLY SIGNIFICANT INCREASE OF 3% IN PRODUCTIVITY, ON AVERAGE.

Our studies revealed a number of correlations or likely drivers for DDD adoption:

- Greater investment in IT at the establishment is correlated with the presence of DDD. More specifically, the firms that have more IT appear to reap a greater reward from DDD and vice versa. This effect is largest for a subsample of single-unit firms.

- Plants with more educated workers, more managers, and more layers of management are more likely to report DDD adoption, and the percentage of workers at the plant with bachelor's degrees is consistent with complementarities between DDD and skilled labor.

- Multi-unit establishments are disproportionately more likely to have cleared the threshold for intensive DDD by 2010. By 2010 multi-unit plants reported a mean adoption of DDD of roughly 34%, while single-unit plants reported an estimated mean adoption of 15%. This pattern is seen in 2005, as well: 13% of multi-unit plants used data intensively, while only 5% of single-unit firms did.

- Older plants report a lower likelihood of DDD, which might signal either a common resistance among older organizations to new technology, or suggest the substitution of experience and tacit knowledge for objective data.

- Firms with broad access to information about new managerial and operational practices are more likely to adopt DDD.

ADVANTAGES AND FUTURE INVESTMENTS

In summary, we found that the use of DDD is strongly concentrated in plants with three key advantages: high levels of such potential complements as IT and educated workers; size (both numbers of employees in a plant, and its multi-unit status); and diverse ways of learning about new management practices.

More specifically, our study provides statistical evidence that higher productivity is associated with leveraging IT investments to collect and bring data to bear in managerial decision making, tracking performance within the firm, and communicating about the state of the production process. Putting data "into action" this way provides a mechanism by which early adopters of technologies can get and stay ahead of competitors who cannot realize performance benefits in time, although competition

HIGHER PRODUCTIVITY IS ASSOCIATED WITH LEVERAGING IT INVESTMENTS TO COLLECT AND BRING DATA TO BEAR IN MANAGERIAL DECISION MAKING, TRACKING PERFORMANCE WITHIN THE FIRM, AND COMMUNICATING ABOUT THE STATE OF THE PRODUCTION PROCESS.

While the share of plants that have adopted data-driven decision-making between 2005 and 2010 has nearly tripled to 30%, our studies show that this rapid diffusion is uneven—consistent with our understanding of differences among firms in their ability to invest in complementary assets, leverage their size, and engage with innovations such as new management practices.

While the effects of DDD are already economically important, there appears to be room for further diffusion. About 70% of the plants in our sample had not yet adopted DDD by 2010 and even after controlling for many observable characteristics, there remains significant heterogeneity in the use of DDD. In short, even our very rich window on the phenomenon is still incomplete. A number of potentially salient factors, such as firm culture are beyond easy reach of our data.

Our ongoing work aims to uncover other mechanisms that may further explain the adoption and productivity effects of this rapidly diffusing approach to managerial decision making. We also hope to spur further research into the relationship between data-driven decision making and firm performance in manufacturing and other sectors of the economy – particularly retail and services.

Given the large increases we are certain to see in both IT capabilities and the availability of digital data for use in decision making, the effects we identify, and the role of complementary changes in organizations, may grow even more economically important in the coming years.

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The full article can be found here.