ELSEVIER

KELLEY SCHOOL OF BUSINESS
INDIANA UNIVERSITY

How data analytics is transforming agriculture

CrossMark

Xuan Pham*, Martin Stack

Helzberg School of Management, Rockhurst University, 1100 Rockhurst Road, Kansas City, MO 64110, U.S.A.

Abstract   Two discussions about the interaction between data analytics and competitive analysis have been taking place in the past decade: one focusing on micro-level firm capabilities and the other on macro-level industry competitiveness. We seek to integrate the micro- and macro-level analyses via the lenses of firms in agricultural input markets. Agriculture is undergoing a tremendous transformation in the collection and use of data to inform smarter farming decisions. Precision agriculture has brought a heightened degree of competition for input supply firms, forcing greater interactions among friends and foes.

"We are on the cusp of a third revolution in agriculture—the digitization of the farm."
— Mike Stern, President and COO, The Climate Corporation (Bell, Reinhardt, & Shelman, 2016, p. 1)

"Farmers and entrepreneurs are starting to compete with agribusiness giants over the newest commodity being harvested on U.S. farms—one measured in bytes, not bushels."
(Bunge, 2015)

* Corresponding author
  E-mail addresses: xuan.pham@rockhurst.edu (X. Pham),
martin.stack@rockhurst.edu (M. Stack)

1. The rise of precision agriculture

In 2015, investors poured $661 million into 84 agricultural startups designed to help farmers transform agriculture into the next big data industry (Burwood-Taylor, Leclerc, & Tilney, 2016). Farm machines equipped with sensors and cameras are capturing minute field-level data like soil moisture, leaf greenness, temperature, seeding, fertilizer and pesticide spraying rate, yield, fuel usage, and machine performance. Agriculture, the oldest sector of the U.S. economy, is quickly becoming a data savvy domain. The rise of data analytics in farming is commonly referred to as precision agriculture (PA). While the data analytics trend is occurring at all stages of the agricultural vertical chain, the most noticeable changes are happening in the upstream input markets. Our focus for this article is the suppliers of machinery, seeds, fertilizers, and

chemicals. We begin by synthesizing two recent discussions of data analytics in the competitive analysis literature: the first emphasizing micro-level firm capabilities and the second focusing on macro-level industry competition. We then provide capsule summaries of the agriculture value chain and conventional agriculture—the period that came before PA. We next describe how PA is reshaping competitive dynamics in the agricultural input markets. We conclude with implications of the data analytics trend for agricultural input markets and beyond.

2. How big data is impacting competition

In 2014, *Business Horizons* published a special issue highlighting the significance of data analytics in today's business environment. The guest editors, Frank Acito and Vijay Khatri, chose three case studies—healthcare, supply chain management, and financial accounting—to illustrate how organizations in a growing array of fields are adroitly employing analytics in their operational and strategic decision making (Crawley & Wahlen, 2014; Souza, 2014; Ward, Marsolo, & Froehle, 2014). The discussion was limited to micro-level firm capabilities, however, because the authors focused on innovative ways firms in these sectors are reducing costs, increasing revenues, and managing risks.

In their seminal work, Mayer-Schonberger and Cukier (2014) introduced the big data value chain and discussed its three sets of players: data holders, data specialists, and data strategists (i.e., those with the big data mindset). Data holders are firms that have the capabilities to generate and/or collect data. Data specialists mine the troves of data for informational gold nuggets that can strengthen firms' competitive positions in markets; however, the most important (and the rarest) players in the value chain are those manifesting a big data mindset: firms that take advantage of what Mayer-Schonberger and Cukier called the 'option value' of data. Data has three value options: (1) reuse for different purposes, (2) recombine with other data to create new insights, and (3) extend to new applications that are not yet defined. The big data

mindset firms are flexible creatures. These firms are fully informed regarding data analytics in their markets today, but they are also actively keeping their options open in case innovations require organizational and strategic changes down the road. Mayer-Schonberger and Cukier were open to the possibility of big data creating new competition within and across industry boundaries, but they did not entertain the idea in depth.

At roughly the same time, Michael Porter and James Heppelmann (2014, 2015) published two related essays in the *Harvard Business Review*: "How smart connected products are transforming competition" and "How smart connected products are transforming companies." The 2014 article focused on how internet connected products were redefining and rewriting traditional industry boundaries, while the 2015 essay discussed how firms could utilize these new developments to improve their operational arsenals. Porter and Heppelmann encouraged firms to step back and broadly assess how their competitive environments were changing: former foes could become allies (and vice versa) and what was irrelevant may become immediately important. Macro-level implications for competition are just as important, if not more, in industries affected by big data technologies.
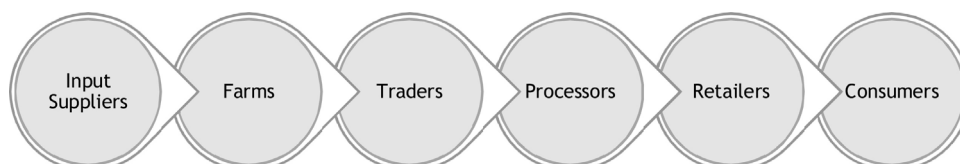
Our intent is to integrate both discussions of micro-level firm capabilities and macro-level industry competitiveness. We frame our discussion in the context of the agricultural input markets, which are experiencing significant transformations thanks to the rise of big data, Internet of Things (IoT), and data analytics.

3. The agriculture value chain

Agriculture, like healthcare, is a very broad term that encompasses a series of connected but discrete markets. Figure 1 illustrates the string of markets that form the agriculture value chain (AVC).

Big data and intensive use of analytics have begun to impact every node in this chain and, in the process, are redefining competition, operations, and strategy within and between these various circles. In the same way that hospitals and healthcare providers have downstream and

Figure 1.   The agriculture value chain (AVC)