Business Model Evaluation: Quantifying Walmart's Sources of Advantage

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A B S T R A C T

We develop an analytical framework on the basis of the economics of business performance to provide quantitative insight into the link between a firm's business model choices and their profit consequences. The method is applied to Walmart by building a qualitative representation of its business model and mapping that representation on an analytical model that quantifies the company's sources of advantage over time. The analysis suggests that the effectiveness of a particular business model depends not only on its design (its levers and how they relate to one another) but, most importantly, on its implementation (how the levers are pulled).

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1. Introduction

In recent years the strategy field has become increasingly interested in the study of business models.[2] Although the expression was introduced long ago by Peter Drucker (1954), academic work on business models began just a decade ago in the context of the Internet boom, where entrepreneurs were asked to explain how their ventures would create value (the wedge between customers' willingness to pay and suppliers' willingness to sell— Brandenburger and Stuart, 1996) and how value would be captured as profit. Indeed, the most common definition of business model is "the logic of the firm, the way it operates, and how it creates and captures value for its stakeholders." [3]

Casadesus-Masanell and Ricart (2008, 2010, 2011) and Casadesus-Masanell and Zhu (2010) operationalize this notion by decomposing business models into two fundamental elements: *choices*—such as policies, assets, and governance of policies and assets—and the *consequences* of these choices. The causal links between choices and consequences help explain the logic of the firm, how it creates and captures value for its stakeholders. These authors also propose a methodology to represent business models qualitatively.

In this paper we propose a novel approach to quantify the link between a firm's choices and their consequences and, ultimately, to gain a better understanding of the virtues and weaknesses of a firm's business model. The method builds on recent advances in the economics of business performance by Grifell-Tatjé and Lovell (1999, 2013, 2014a,b) and relates business model choices to profit variations over time. Its starting point is the observation that profits rise and fall for two reasons: changes in prices or in quantities. Specifically, a firm's profits could increase for any of the following reasons: (a) selling goods at higher prices; (b) paying less for inputs, such as labor or capital; (c) selling more

[2] The recent special issue of *Long Range Planning* on business models (April 2010) received more than 80 submissions and attracted contributions from scholars such as David Teece and Nobel Prize winning practitioner Muhammad Yunus. Zott, Amit and Massa (2011) review the growing literature in management on business models. A Google search for "Business Model" in October 2012 yielded 31.1 million hits.

[3] *Long Range Planning* (2008) call for papers for the Special Issue on "Business Models" by Charles Baden-Fuller, Ian MacMillan, Benoît Demil, and Xavier Lecocq.

goods while holding constant a positive cost markup; or (d) using fewer inputs per unit of good produced/sold. Note that (a) and (b) are related to prices whereas (c) and (d) are related to quantities.

The proposed analytical framework combines the theory of index numbers and production theory. Index numbers produce estimates of the impact of price and quantity changes on profit change. The price effect provides insight on the impact of business model choices that affect profits through input and output prices (e.g., product range changes and/or new supply sources). The quantity effect captures the impact of choices that affect profits through input and output quantities (e.g., hiring more staff or investing in larger stores). Having obtained an aggregated estimate of the impact of price and quantity changes on profits, we explore the quantity effect in more detail. In particular, we use production theory to gain additional insight on the drivers of quantity changes and to measure the contribution of these drivers to profit change. This additional level of detail is helpful to better understand how business model choices leading to growth contribute to higher profits.

To demonstrate how the method can be applied to produce insights on how a firm's business model operates, we apply the method to study the evolution of Walmart after its IPO in 1970, from 1971 to 2008. Walmart constitutes an ideal setting to apply our approach and demonstrate its value because: (i) there is a wealth of qualitative information about the company, which allows us to build a detailed business model representation, and (ii) being a public company, the accounting data needed for the analysis are readily available. The study has two parts. First, we use information from annual reports, analyst reports, academic papers, case studies, and books about Walmart to describe the company's business model choices over time. Second, we implement the quantitative model in order to determine the effect of Walmart's choices on its performance.

The results reveal that while Walmart's business model did not change during the 36-year period of study, by emphasizing different elements, each CEO implemented the business model differently. Specifically, input and output prices, technological progress, sales volume, and volume of inputs employed played different roles under Walton, Glass,

and Scott. Thus, the results suggest that the effectiveness of a particular business model depends not only on its design but also on its implementation.

Under Sam Walton (1972-1988), Walmart deepened its policy of everyday low prices (EDLP), which led to negative *output* price variation. These were somewhat offset by favorable *input* price concessions obtained from vendors. While price reductions to customers hurt profits, more favorable purchase prices from vendors had a substantial positive effect. The analysis also reveals that under Sam Walton, Walmart increased profits substantially through the adoption of new technology (e.g., investment on a satellite system, uniform product codes, or automated distribution centers) that corrected the inefficient expansion of its first decade. Thus, embracing new technology was a key determinant in Walmart's future success.

Walmart's success during David Glass's (1988-2000) period was due to business model choices aimed at increasing volume such as building new stores, increasing product variety, setting low prices, and implementing high-powered incentives for store managers. Technological improvements explain only a small fraction of the company's profit variation over this period.

The third and last period of the study corresponds to Lee Scott's tenure (2000-2008). Our results show weaker EDLP and cost controls. Indeed, value added per dollar sold and input prices—labor costs, mainly—were on the rise under Scott's tenure. Finally, our study indicates that by the early 1980s Walmart had become the most efficient discount retailer in the United States, a position it held through the end of our sample.

The paper is organized as follows. Section 2 briefly discusses the concept of business model, introduces the terminology of business lever and describes Walmart's most important business model choices. Section 3 presents the methodology. Section 4 is a description of the dataset. Section 5 presents the results. Section 6 concludes with a discussion of the advantages and drawbacks of the method.

2. Walmart's Business Model

The notion of the business model is recent topic in the scholarly literature. In the 1990s, as new ways of doing business that subverted the established logics of value creation and value capture emerged, practitioners used the expression to describe how untried e-business ventures were to operate (Chesbrough and Rosenbloom, 2002; Magretta, 2002). The term was thus used to describe a wide diversity of novel, heterodox e-commerce firms.

There is a myriad of definitions of the business model. This has led several authors to summarize and classify these definitions (e.g. Hedman and Kalling, 2003; Baden-Fuller and Morgan, 2010; Zott, *et al.,* 2011) and to provide theoretical foundations (Lecocq et al, 2010). Doz and Kosonen (2010) state that business models can be defined both objectively and subjectively. The objective definition corresponds to the structure of the firm's relationships and procedures (e.g. Teece, 2010) and the subjective definition relates to the cognitive structures that shape the managerial choices concerning a company (e.g. Tikkannen *et al.,* 2005). The present approach is "objective" since its goal is to examine the structural features of Walmart's business model and their profit implications.

In this study, we use the conceptual framework developed by Casadesus-Masanell and Ricart (2010). According to them, a business model is composed of two types of element: *choices* made by the management and the *consequences* of these choices. There are three types of choices: policies, assets, and governance of assets and policies. Policy choices refer to courses of action that the firm adopts for all aspects of its operation. Examples include opposing the emergence of unions; locating plants in rural areas; or providing high-powered monetary incentives. Asset choices refer to decisions regarding tangible resources, such as manufacturing facilities, a satellite system for communicating between offices, or the use by an airline of a particular aircraft. Governance choices refer to the structure of contractual arrangements that confer decision rights over policies or assets. For example, a given business model may contain (as a choice) the use of certain assets such as a fleet of trucks, which leads on to a governance choice for the firm as to whether it should own the fleet or lease it from a third party. Consequences can be flexible or rigid.

The flexibility of a consequence is determined by how fast it changes, as the choices that produce it vary.

Casadesus-Masanell and Ricart's framework is simple, flexible, and bridges industrial organization and the resource-based view, two alternative perspectives for the study of competitive advantage. According to the resource-based view, what determines a firm's success is control over valuable, rare, and imperfectly imitable resources (Barney, 1991). The industrial organization perspective, developed by Porter (1980, 1985), portrays the firm as a collection of activities on which competitive advantage resides. Casadesus-Masanell and Ricart (2010) and Zott and Amit (2010) recognize the importance of activities (policies) and assets as descriptors of a firm's business model. And, by incorporating the governance of assets and policies, Casadesus-Masanell and Ricart (2010) also consider insights from transaction cost economics.

The framework has two important additional elements. First, there is the idea that consequences are sometimes rigid, meaning that some choices made by the firm have a cumulative effect. This provides the "longitudinal dimension" explicitly sought by Hedman and Kalling (2003). The second element is the inclusion of causal relationships between choices and consequences. Choices produce consequences. Furthermore, consequences may generate other consequences, or enable choices. This feature can also be found in the dynamic framework developed by Lecocq *et al.* (2006).

The level of detail in a business model representation depends on the objectives of the practitioner or researcher. It is important to bear in mind the tradeoff between tractability and realism, as mentioned by Casadesus-Masanell and Larson (2009) when choosing the degree of precision in the representation. Casadesus-Masanell and Ricart (2008, 2010) describe two methods of simplifying a business model depiction. One is *aggregation*, which consists of grouping choices and consequences into larger constructs. The other is *decomposability*, which refers to the study of parts of a business model that can be analyzed in isolation. What follows makes use of aggregation and decomposability.

2.1 Performance and discount retail business model *Levers*

Walmart's performance has been impressive. Figure 1 presents the evolution of its real profits. In 2008, profits were nearly $1.8 billion 1970 dollars, 436 times greater than what the company earned in 1972. The compound annual growth rate was 17.82% for a 38-year period and the value added increased from $29.52 million constant dollars in 1971 to $17.14 billion in 2008.

[INSERT FIGURE 1 ABOUT HERE]

Several papers and books claim to have established *the key* to Walmart's success as if it was due to a single silver bullet. Consistent with Porter (1996), this study's view is that what explains the firm's superb performance is an integrated set of choices. After reviewing publicly available information on the company—facts disclosed in its annual reports (years 1971-2008), analyst reports, academic papers, case studies, and books[4]— we have identified eight distinctive categories of *levers* (the categories of choices as defined in Porter's value chain; Porter, 1985) that define the generic discount retail business model:

1. Pricing. Discount retailers determine the prices of their merchandise and whether or not to price discriminate.

2. Pressure on vendors. Discount retailers choose how much pressure to exert on vendors to obtain favorable terms and conditions. They also look to build mutually beneficial partnerships with suppliers in order to create more value.

3. Investment in technology. At one extreme, discount retailers may incorporate the latest technologies in their daily processes (e.g. investments in satellite systems,

[4] The list of discount retailing levers is the result of the analysis of several sources of documentation: annual reports from Walmart (1971-2008) and Kmart (1971-2001); analyst reports (Bear Stearns, Citigroup, Global Insight Inc., Investext Group, and Thomson Financial, among others); case studies (Ghemawat, 1989; Bradley and Ghemawat, 2002; Ghemawat et al., 2004; Oberholzer-Gee, 2006); books (Walton, 2002; Fishman, 2006; Brunn 2006); and research articles (Graff and Ashton, 1994; Basker, 2005a,b; Hausman and Leibtag, 2007; Jia, 2008; Holmes, 2011; Basker et al., 2012). For Walmart's business model description we also consulted Graff (1998), Drogin (2003), Dube and Jacobs (2004), Dube and Wertheim (2005), Dunnett and Arnold (2006), Bonacich and Wilson (2006), Burt and Sparks (2006), Basker and Noel (2007) and Basker and Pham Hoang (2008). The report *The Economic Impact of Wal-Mart* from Global Insight (2005) was particularly helpful.

uniform product codes, Radio Frequency Identification RFID) and, at the other, may follow "artisanal" procedures (e.g. manual inventory systems).

4. Human resource practices. Discount retailers establish different policies that characterize their relationships with employees: compensation policies, power of incentives, screening of new employees, and so on.

5. Expansion policies. Discount retailers choose whether to locate their stores in rural, suburban, or urban areas and the rate at which new stores are added to the company.

6. Product selection. Discount retailers must choose the mix of goods they sell: private labels vs. national brands, selection of product categories, and selection within categories.

7. Cost consciousness. Discount retailers seek to minimize overhead to boost profits. However not all retailers do so the same way or with the same intensity. For example, some have lavish headquarters while others choose austere offices.

8. Customer service. Discount retailers choose how to treat their customers. Some retailers create a family atmosphere where customers are welcomed to the premises and persuaded to buy certain articles or are actively handheld. Others offer more leeway and only interact directly with customers if they request information. The customer service lever also includes store appearance, customer support, return policy, and complaint management. Figure 2 shows how each of these levers is linked with each of the elements that explain the change in profits. These elements are described in detail in the methodology section.

[INSERT FIGURE 2 ABOUT HERE]

Baden-Fuller and Morgan (2010) indicate the dual nature of the notion of business model. On the one hand, it represents a scale model, which corresponds to a description of an organization and its interactions. On the other hand, it is an example, a role model. The *lever* concept is useful for understanding this dual nature. *Levers* capture the "scale features" of business models.

Firms make particular choices to *configure* each of these levers (Porter and Siggelkow, 2008). These choices correspond to the role model nature of business models. Different choices generate different consequences. Therefore, a particular set of choices affects the success or failure of a business model. The following is a description of how the different Walmart CEOs pulled these levers (i.e., *configured* their activities) during their respective tenures. While none of these eight levers changed over the course of the company's history (as Walmart remained a traditional discount retailer), different leaders made dissimilar choices for some of them.

2.2 Business model choices under Sam Walton

Sam Walton and his brother Bud franchised several Ben Franklin variety stores in the early forties (Walmart Annual Report, 1974, p.4).[5] Walton wanted more freedom in the administration of these stores and when Ben Franklin rejected his idea of big stores in small towns, Walton decided to create his own chain (Graff and Ashton, 1994). The first Walmart store opened in 1962 in Rogers, Arkansas (AR, 1974, p. 4). Walton was CEO and Chairman almost uninterruptedly from 1962 to his retirement in 1988, Walton ceded his position as CEO to Ronald Mayer, a former Executive Vice President of Administration and Finance, in 1974. Walton resumed control in 1976, and tailored Walmart in accordance with his beliefs about how a discount retailing business should be run. Walton also travelled across the U.S. and abroad searching for innovative practices to copy; he found many, but usually implemented them differently. Walton's original vision is reflected in the choices he made for the levers described above.

1. Pricing. Early in his career, Walton realized that by setting low prices, he could boost sales growth by much more than the percentage reduction in mark-up (Walton, 1992, p. 119). When he entered the discount retailing business, he applied this principle obsessively, always trying to beat the competition in this dimension. He dubbed this choice: "Everyday low prices (EDLP)" (Originally it was dubbed "everyday discount prices" AR, 1977, p.5). The main difference from other retailers was that Walmart always

[5] In what follows, Walmart Annual Report will be abbreviated as AR.

offered its merchandise at the lowest price possible instead of offering promotional discounts. This choice created a low-price reputation for Walmart which increased sales volume as well as reducing the need for frequent advertising.

2. Pressure on vendors. While Walmart developed a reputation for hard bargaining with its vendors, the concept of "vendor partnership" was developed under Walton (AR, 1988, p. 10). The idea was to strengthen the business relationship between Walmart and its vendors by exchanging information about sales and inventory levels thus creating more value by cutting transaction costs and increasing efficiency. Walmart strategically located its distribution centers to solve the replenishment problem that the company faced in its early days (Walton, 1992, p.52). This enables the firm to save money by obtaining discounts from vendors for bulk purchasing. In addition, EDLP resulted in huge sales volume and Walmart quickly became a major distribution channel for many of its vendors. No vendor accounted for more than 2.8% of the company's total purchases in 1985 (Ghemawat, 1989).

3. Investment in technology. Ronald Mayer, Walmart's CEO from 1974 to 1976, was a major advocate of the use of technology to reduce costs (Walton, 1992, p.90). On returning to the helm of the company, Walton adopted Mayer's ideas (Walton, 1992, p.91). Walmart was an early adopter of uniform product codes (UPC) at the point of sale which reported the location of any item at any time (AR, 1985, p 8). The roll out of UPCs began in 1983 and ended in 1988, two years ahead of Kmart (at the time, a larger company than Walmart) (Bradley and Ghemawat, 2002). Walmart's satellite system was set up in 1983 at a cost of $20 million (Ghemawat, 1989) and it was completed in 1987 (AR, 1988, p.2). Walmart's investments in technology helped enhance communication between headquarters, stores, and vendors.

4. Human resource practices. Walton's view of human resource practices at Walmart is manifest in the following quote: "If you want the people in the stores to take care of the customers, you have to make sure you're taking care of the people in the stores" (Walton, 1992, p.80). The company implemented a varied array of high-powered incentives to attract talent, especially store managers. Initially, Walton lured talent from other companies by

offering them a percentage of the profits made by the store. (Walton, 1992, p.132) Later, when Walmart went public, a stock ownership plan was set up.

5. Expansion policies. According to Walton, an important determinant of Walmart's success was its choice of location: "Our key strategy was to put good-sized stores into little one-horse towns which everybody else was ignoring" (Walton, 1992, p.109). At least as important was Walmart's method of geographic expansion. Walmart started in rural areas in the southern region of the country, grew by building stores close to existing distribution centers, and then expanded to other regions (Graff and Ashton, 1994). Walmart would always push from the inside out rather than making long jumps and later backfilling (Ghemawat, 1989). The main advantage of this policy was the development of a dense distribution network that allowed the firm to spread costs and exploit economies of density (Graff and Ashton, 1994).

6. Product selection. Walmart sought to project an image "as the competitive, one-stop shopping center for the entire family where customer satisfaction is always guaranteed." (AR, 1975, p.2) Consequently, the company extended the product categories offered in its stores by including jewelry, shoes, photo labs, and pharmacies, as well as automotive centers. Early forays into groceries were undertaken under Walton (AR, 1988, p.3). The company offered national brands and for some products (such as apparel, health and beauty care, and dog food) also had private brand offerings (AR, 1984, p.4). Various retail formats were tested to attract customers with specific needs. These alternative retail formats had more limited product selections across categories. The most successful of these ventures was Sam's Club, a warehouse club that targeted customers who purchased wholesale amounts. Another significant aspect of Walmart's product selection was the "Buy American" program, set up in 1985, to sell American products and reduce the U.S. trade deficit (AR, 1989, p.9).

7. Cost consciousness. Walton emphasized cost cutting as one of the pillars of Walmart's culture. This was accomplished through the systematic elimination of superfluous expenses. There are many accounts of how tightly Walmart controlled costs. For example, whenever possible, managers (including Sam Walton) shared hotel rooms and

walked instead of taking taxis. Likewise, Walmart made a practice of calling its vendors collect (Bradley and Ghemawat, 2002).

8. Customer service. Walmart implemented policies that were aimed at creating a friendly shopping environment where customers felt they were part of a family. Walton reminded all employees in 1989 that customers should be treated as guests (AR, 1989, p.2). Walmart began formally implementing the "Aggressive Hospitality" program in 1984 (AR, 1985, p.4): customers were welcomed by "people greeters" and enjoyed such benefits as extended opening hours, free parking, no-hassle refund and exchange policies, speedy checkout lanes, wider aisles, and clean stores (AR, 1984, p.4; AR, 1988, p.4).[6] The company sponsored social programs in the communities where it was present (AR, 1988, p.4).

2.3 Walmart under Glass and Scott

David Glass (1988-2000)

Walton stepped down as CEO in 1988. His successor, David Glass, had joined Walmart in 1976 where he served as Chief Financial Officer (CFO), Chief Operative Officer (COO), and President prior to his appointment as CEO.[7] If Walton was the visionary leader, David Glass was the operational wizard who expanded his vision to transform the company into the world's largest discount retailer. Glass continued to use the business model inherited from Walton, but pulled some levers differently.

Walmart invested in information technologies to link stores with vendors (AR, 1997, p.12). Glass also strengthened pressure on vendors. As the company grew, vendors became increasingly dependent on Walmart. For example, in 1993, 10% of Procter & Gamble's (P&G) sales went through Walmart. However, that year, P&G represented less than 2.4% of Walmart's purchases (Bradley and Ghemawat, 2002). This pressure was so intense that

[6] Elements of "Aggressive Hospitality" had been applied earlier on a non-formal basis.

[7] Walmart.com. 2009. *David Glass to Retire From Wal-Mart Board of Directors*. http://news.walmart.com/news-archive/investors/david-glass-to-retire-from-wal-mart-board-of-directors-1278353, Accessed October 16th, 2013.

many vendors chose to outsource production to low-wage countries (Bonacich and Wilson, 2006). Relatedly, Glass deemphasized the "Buy American Program."

There were also changes in product selection. During the Glass years, Walmart expanded the use of private brands. Walmart developed these brands to offer customers opening price points (AR, 2003, p.6), i.e. the lowest price available in the store for an item.[8] The use of private brands was well aligned with Walmart's pricing lever (EDLP, as under Walton). Walmart also moved decisively to include groceries in its products offered at Supercenters (AR, 1999, p.6). A supercenter was a discount store combined with a grocery store and other small departments. When Walton left the company there were three supercenters; after Glass left the company, the number had risen to 721. In fact, Glass started replacing discount stores with supercenters.

Under Glass, Walmart continued Walton's growth strategy in the U.S. and opened stores in all fifty states. The number of stores increased from 1,364 in 1988 to 3,989 in 2000. However, there were also changes in the geographic expansion policies he had inherited from Walton. Specifically, Glass built more of its stores in suburban locations and also invested heavily abroad. In 2000, a quarter of all Walmart stores were located outside the U.S. (AR, 2001, p.6).

While human resource practices did not change much, the company became the largest private employer in the U.S. (AR, 1997, p.11) and the largest retailer in Mexico and Canada (AR, 2000 p.11). As a consequence, Walmart's human resource practices were under increased public scrutiny.

Lee Scott (2000-2008)

Lee Scott became Walmart's CEO in January 2000. With the exception of human resource practices, Scott did not significantly alter the configuration of Walmart's business model levers. However, he had to wrestle with important changes in the external environment. At the same time, Walmart's size made it particularly vulnerable to criticism.

[8] Walmart also offered premium brands such as "Sam's American Choice," which were manufactured in the U.S.

Moreover, Kmart's 2002 bankruptcy had profound effects on the public perception of the company.

During Scott's early tenure as CEO, Walmart faced a number of criticisms regarding its human resource practices. Claims were made that it mistreated non-managerial workers by paying them low wages and providing poor benefits (Dube and Jacobs, 2004; Dube and Wertheim, 2005). The company was also accused of favoring men over women in a lawsuit filed in 2001.[9] Furthermore, Walmart opposed two attempts at unionization: meat cutters in Jacksonville, Texas in 2000 and workers from a Quebec Walmart store in 2005 (Bair and Bernstein, 2006).[10] As a consequence of these challenges, the company offered improved health benefits to employees (AR, 2006, p.13) and implemented new job and salary structures for non-managerial workers (AR, 2005, p. 26).

Walmart continued to build new stores in the U.S., but the main source of growth came from the international stores.[11] Likewise, Scott transformed many existing discount stores into supercenters, which altered the merchandise mix by further expanding into groceries. At the same time, Sam's Club faced increased competition from Costco, which surpassed Sam's in sales volume (Ghemawat *et al,* 2004). Sam's Club tested several defensive strategies such as focusing on business customers (AR, 2004, p.21) and offering luxury items (AR, 2006, p.15).

To increase margins, Scott expanded Walmart's global sourcing activities. Specifically, the company began to manage its global procurement directly rather than relying on third parties (AR, 2003, p.3).[12] This measure sought to further reduce vendors' prices. Relatedly, Walmart's investment in technology increased the company's leadership in managing vendor inventories.

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[9] The U.S. Supreme Court rejected the class-action lawsuit in June 20, 2011. The Court denied that the lawsuit fulfilled the requirements of a "class-action rules" (Liptak, A. 2011. "Justices rules for Wal-Mart in class-action bias case". *New York Times*. June 20th).

[10] Zimmerman, A. 2000. "Pro-union butchers at Wal-Mart win a battle, but lose the war." *Wall Street Journal Online Edition*, April, http://online.wsj.com/article/SB955407680495911513.html, Accessed December 10th, 2011.

[11] Some of these business ventures failed (e.g. Germany and Korea) which might have encouraged Walmart to change course towards a more painstaking international expansion as related by Burt and Spark (2006).

[12] Saporito, B. 2003. "Can Wal-Mart get any bigger?" *Time Magazine*. January 13.

Finally, during this period Walmart intensified its philanthropic activities and its efforts to improve its public image. The company assisted New Orleans following Hurricane Katrina, became largest contributor to charity in the U.S. (AR, 2005, p.10), invested heavily in advertising, and created a webpage to fend off criticism (AR, 2005, p.14).[13]

3. Quantifying the Effect of Business Model Choices

The proposed method relies on index numbers and production theories to assess the impact of Walmart's choices on the evolution of profits over time. The roots of the index numbers theory can be traced back to the 18th century. It has been subject of continuous and uninterrupted research because it is the theory used by the national departments of statistics to produce quantitative economic information.[14] This information influences the behavior of economic agents.

The complexity of a modern economy is no different from an organization such as Walmart. Hence, this research extends the index numbers methodology to the study of business models. This approach is complemented with production theory, which provides the fundamentals required to define concepts such as productivity, technical change, and operating efficiency in the context of assessing economic performance. Once they are defined, these concepts can be incorporated naturally as explanatory variables of profit change, our measure of financial performance.

The framework by Casadesus-Masanell and Ricart (2008, 2010, 2011) facilitates mapping choices with theoretical constructs of the production theory and these constructs with performance. The combination of index numbers and production theory is used in this application as a tool to quantify these theoretical constructs. Figure 2 shows the implementation of the method for the case of Walmart. This approach has the advantages of

[13] Barbaro, M., Gills, J. 2005. "Wal-Mart at the forefront of the hurricane relieve." *Washington Post*, September 6.

[14] Balk (2008) provides an updated revision of the theory of index numbers and an interesting historical introduction

using commonly accessible data and not requiring the assumption of profit-maximizing behavior, which is controversial in the field of management.

The method is related to work by Siggelkow (2001) and Porter (1996) to study the impact of business choices on performance based on production frontiers or on fitness landscapes (Levinthal and Warglien, 1999; Rivkin, 2000). In the case of Siggelkow (2001) and Porter (1996) the frontier is built as a map directly connecting business choices and performance measures. In the present case, the frontier is a production possibility frontier, a well-known concept in the economic literature.

Our method offers an alternative to the traditional econometric approach[15] based on regression where the dependent variable is a performance measure (e.g., return on assets, profits) and the independent variables are those of interest to the researcher. The methodology implemented in this study is based on mathematical programming (Data Envelopment Analysis, DEA), and does not require large samples as is the case with regression methods. This approach does not impose functional forms and uses the best performers in the industry as a benchmark rather than average performance, as is common in regression analysis. However, it does not offer the flexibility that a regression model could provide (e.g., testing whether a particular exogenous variable is related with profit change). The method dissects profits within the tradition of production theory rather than making assumptions about possible explanatory variables of profit change.

The method has two levels of analysis (Grifell-Tatjé and Lovell, 1999). The first uses publicly available information on Walmart's prices and quantities to explain variation in profits through index numbers. The price effect measures the impact of Walmart's policies affecting input and output prices on profits. The quantity effect measures the impact of decisions on output or input quantities on profits. Recently, Boussemart *et al.* (2012) present a method that uses index number theory and profit frontiers to compare profits between different firms. Hence, index numbers are useful not only to evaluate the effectiveness of a particular business model and its implementation, but also to understand interactions between competitors.

[15] Zott and Amit (2007, 2008) are an example of the econometrics approach applied in the business model context.

The second level of analysis decomposes the quantity effect. To do this, such concepts as the production possibilities set and the production possibility frontier must be introduced. Production theory offers additional insight into the quantity effect using well-known economic performance measurement concepts. This level of detail is useful to understand how Walmart's growth policies contributed to higher profits. In addition, it is possible to explore the effects on profits of technological progress and efforts to achieve higher efficiency levels. The empirical application of this second layer of analysis requires the construction of a dataset with information about other firms in the industry.

Figure 3 is a visual representation of the method. It describes the change in profit as the result of the price and quantity effects (first level). The quantity effect is decomposed using production theory (second level). The remainder of this section provides technical details on both levels of analysis.

[INSERT FIGURE 3 ABOUT HERE]

First level

The first level of analysis decomposes change in profits into a quantity effect and a price effect. Profit (π) is defined as the difference between revenue and operating cost where revenue is given by $R = p^T y = \Sigma p_m y_m$ and operating cost by $C = w^T x = \Sigma w_n x_n$. Output vectors are represented by $y = (y_1,\ldots,y_M) \in R_+^M$ and input vectors by $x = (x_1,\ldots,x_N) \in R_+^N$. In addition, output price vectors are denoted $p = (p_1,\ldots,p_M) \in R_{++}^M$ and input price vectors $w = (w_1,\ldots,w_N) \in R_{++}^N$. Profit is expressed as $\pi = R - C = p^T y - w^T x$, and profit change, from period t to period t+1, is defined as

$$\pi^{t+1} - \pi^t = [\bar{p}^T(y^{t+1} - y^t) - \bar{w}^T(x^{t+1} - x^t)] + [\bar{y}^T(p^{t+1} - p^t) - \bar{x}^T(w^{t+1} - w^t)]. \qquad (1)$$

Vectors $\bar{p}$, $\bar{y}$, $\bar{w}$ and $\bar{x}$ are averages of current and next period vectors, where $\bar{p} = \frac{1}{2}(p^t + p^{t+1})$, $\bar{y} = \frac{1}{2}(y^t + y^{t+1})$ and so on. The first term on the right hand side of expression (1) is the *quantity effect*, showing the impact of quantity changes on profit change. The second term is the *price effect*, which shows the impact of price changes on profit change. Each

expression has two components. In the case of the price effect, the first component, $\bar{y}^T(p^{t+1} - p^t)$ quantifies the variations in the prices of outputs; as discussed below, in this application the change is measured in value added per unit of output. The second component, $\bar{x}^T(w^{t+1} - w^t)$, measures the impact on profit of variations in input prices. Equation (1) expresses changes in profit using Bennet quantity and price indicators ($\bar{p}$, $\bar{y}$, $\bar{w}$ and $\bar{x}$).[16]

Second level

Using production theory (Grifell-Tatjé and Lovell, 1999, 2014a and De Witte and Saal, 2010), the second level of analysis further decomposes the quantity effect into an *activity effect*, an *operating efficiency effect*, and a *technical change effect*:

$$\begin{aligned} \bar{p}^T(y^{t+1} - y^t) - \bar{w}^T(x^{t+1} - x^t) = [\bar{p}^T(y^{t+1} - y^t) - \bar{w}^T(x^C - x^B)] & \quad \text{Activity Effect} \\ + \bar{w}^T(x^t - x^A) - \bar{w}^T(x^{t+1} - x^C) & \quad \text{Operating Efficiency Effect} \\ + \bar{w}^T(x^A - x^B). & \quad \text{Technical Change Effect} \end{aligned} \tag{2}$$

The technology available in one period corresponds to the period's production possibility frontier F and its convex hull h(F) = {(y,x): x can produce y} is the set of feasible input/output combinations given F. Figure 4 shows the production possibility frontiers and the convex hull of period t.

[INSERT FIGURE 4 ABOUT HERE]

Input vectors x^A, x^B, and x^C are theoretical constructs. Specifically, x^A is the efficient amount of input needed to produce realized output level y^t with technology F^t; x^B is the

[16] Bennet (1920) advocates using the *arithmetic mean* of price and quantities to evaluate change. We follow this approach because Diewert (2005) has shown that the Bennet indicators have a set of properties that make them superior to the traditional Laspeyres and Paasche indicators.

efficient amount of input needed to produce realized output level y^t with technology F^{t+1}; and x^C is the efficient amount of input needed to produce realized output level y^{t+1} with technology F^{t+1}.

Figure 4 (for the case M = N = 1) is useful for understanding the decomposition. The *activity effect* measures how much variation in profits is due to changes in sales volume and change in the volume of inputs employed (making efficient use of the latest available technology in the retailing industry). This corresponds to a movement along the production possibility frontier of period t+1 and is indicated by the arrow connecting operating-efficient vectors (x^B, y^t) and (x^C,y^{t+1}). The activity effect contributes to or detracts from profit depending on whether the change in outputs exceeds or falls short of the corresponding change in the efficient quantities of inputs, with the changes being evaluated at Bennet output and input prices, $\bar{p}$ and $\bar{w}$. Grifell-Tatjé and Lovell (1999) have shown that in a situation with multiple outputs and inputs, the activity effect also reflects changes in the mixes of outputs and inputs. However, in the case of Walmart, it should mainly reflect the impact of the company's efficient growth.

The *operating efficiency effect* measures the change in the difference between the chosen amount of inputs to produce the observed level of output and the efficient amount of inputs needed to produce that level of output. To produce a valuation of the operating efficiency of the firm, we multiply these differences in inputs by the Bennet input price index, $\bar{w}$.

The *technical change effect* is measured as the decrease in the efficient input quantity ($x^A - x^B$) needed to produce output y^t allowed by the improvement in technology, the shift in the production technology frontiers from F^t to F^{t+1} in Figure 4. To produce a monetary valuation that can be related to the evolution of profits, the change in efficient input quantities is multiplied by the Bennet input price index. Productivity is defined as the sum of operating efficiency and technical change effects (Grifell-Tatjé and Lovell, 1999, 2014a).

The calculation of the activity, operating efficiency, and technical change effects require estimation of the unobserved input vectors: x^A, x^B, and x^C. Figure 4 shows that these vectors lie on the frontiers F^t and F^{t+1}. These vectors can be expressed in terms of

observable inputs and easy-to-estimate distance function procedures that are developed in the appendix.

4. Data

Walmart went public in October, 1970. For the first level of analysis, this empirical investigation covers the period from 1971 to 2008. Because calculations of best-practice frontiers require substantial amounts of data, the second level of analysis covers the period from 1977 to 2008. The data from 1971 to 1977 is used to build the first best-practice frontier (see appendix). To estimate best-practice frontiers, we use data from Walmart and six additional discount retailers: Kmart, Target, Sears, May, Costco, and Bradlees (Table 1). The data comes from annual reports and publicly available financial statements. We also used the Osiris database and analysts reports (from Thompson-Financial) to build a time series of employee counts and to complete information about Sam's Club. In the 31-year period for which we construct best-practice frontiers, some discount retailers went bankrupt, some were taken over, and some merged with other firms. Firms after a merger or an acquisition are treated as new companies.[17]

[INSERT TABLE 1 ABOUT HERE]

The measure of performance is operating profits, or profits from revenues generated from the firm's retail operations. Thus the accounting record "other income" (which averages about 1% of total sales) is not included in these calculations. To obtain operating

[17] In the case of Costco, the company merged with Price in 1993. Costco is therefore treated as two separate firms, one prior to the merger and the other afterwards. Kmart filed for bankruptcy in 2002. The successor company survived for two years before merging with Sears. Each circumstance was treated as a separate case (three firms). May Department Stores was treated as two separate companies, one before the acquisition of Caldor and the other after the acquisition. We include information about May until 2003. Kmart, Target and May had multiple retail formats during the period of study. The financial information on these businesses is not separated from discount retailing activities. We do not consider this a problem, as all these activities are in the same line of business. The same is not true for Sears which had a very broad spectrum of businesses besides retailing (e.g. Dean Witter, Allstate Insurance Company, Coldwell Banker among others). For this reason, it was essential to analyze the merchandise part only. Fortunately, Sears discloses information on each division separately. We therefore include only the retail part of Sears.

profits, we subtract cost of sales, operating, general and administrative expenses, and capital cost from revenue. Using the consumer price index, all figures are deflated to 1970.

Consistent with their consideration within Walmart, we treat discount stores and Sam's Club as separate entities. Thus we define two outputs: y_1 = average of beginning-of-year and end-of-year real discount stores sales (deflated to 1970) and y_2 = average of beginning-of-year and end-of-year real Sam's Club sales (deflated to 1970). We use value added per dollar of sales by store format (discount stores and Sam's Club), defined as sales minus cost of intermediate goods, as the measure of price for each of the two outputs (p).[18] The use of real value added simplifies and homogenizes outputs in an industry characterized by major heterogeneity in disclosure policies among retailers.

We define two inputs: labor and capital. Labor quantity, x_1, is captured by the average beginning-of-year and end-of-year number of employees. Total labor cost would be the ideal price variable w_1 for x_1. Unfortunately, there is no publicly available data on labor cost for Walmart. Drogin (2003) has gathered sparse labor cost data and other researchers have used Drogin's data to project total labor costs at Walmart. It was not possible to apply the same approach here because this study begins in 1971. Therefore, we chose real operating, general and administrative expenses as a proxy for labor costs. Thus w_1 is the ratio of real operating, general and administrative expenses to the average number of employees each year.

The second input is capital. The standard approach is followed to quantify this: capital in period t equals capital in period t-1 minus amortization expenses plus investment in period t (all amounts expressed in 1970 dollars). Data on capital was obtained from annual reports where a measure of net property and equipment is provided. Amortization expense is calculated as the difference between the accumulated amortization and depreciation expenses from period t to period t-1. Quantity of capital, x_2, is then the average beginning-of-year and end-of-year capital (computed as described above). The price of

[18] No information is available on the value added amount for each type of retail format, discount and warehouse club at Walmart. However, we know the total sales and the operating profit obtained by each branch for every year in the sample. We assume that the value added is distributed in the same way as the income variable is distributed each year.

capital, w_2, is the ratio of the sum of current depreciation and amortization expenses plus the net interest paid to the quantity of input capital for the period.

[INSERT TABLE 2 ABOUT HERE]

Table 2 presents averages for each of the variables as well as their rates of growth. In general terms, we see a moderation in growth rates as the company increased in size. Summarized statistics are presented for each of the three CEOs. In February 2009, Mike Duke was appointed Walmart's fourth Chief Executive Officer. He is therefore not included in this study. Due to the lack of data before Walmart's IPO, we cover seventeen years (1971-1987) of Walton's tenure, a period in which Walmart grew rapidly. This is noticeable in the double-digit growth in output, capital and labor. Capital prices increased moderately, while output and labor prices fell. Glass's term is similar, though less aggressive: capital costs decreased and labor costs increased by less than 1%. Finally, under Scott, Walmart's discount store sales rose by an average of 8.6%, markedly less than under Walton and Glass. Output prices (value added) grew an insignificant 0.4%. Capital and labor prices showed similar behavior to that under earlier CEOs. The increase in Sam's Club sales was less than that experienced by Walmart's discount stores. Average capital input growth was higher than labor input growth for all three periods; thus, there has been a trend towards substituting capital with labor throughout Walmart's history.

5. Results

Table 3 presents our decomposition of profit variation.[19] Columns 3 and 4 show the results of the first level of analysis (equation 1), the decomposition of change in real profit into price and quantity effects. Of course, the sum of these two columns equals column 2. The results from the second level of analysis are shown in columns 5, 6, 7, and 8. There, we decompose the quantity effect into the activity and productivity effects and the productivity

[19] These computations were programmed in the statistical package R. To calculate the input distance functions, we used the FEAR (Frontier Efficiency Analysis for R) package by Paul Wilson.

effect into operating efficiency, and technical change. Columns 5 and 6 are added to produce column 4, the quantity effect, and columns 7 and 8 are added to produce column 6, the productivity effect. Columns 5, 7 and 8 correspond to equation (2). Table 4 provides further details of the price effect by breaking it down by outputs and inputs.

[INSERT TABLE 3 ABOUT HERE]

In general terms we observe an increase in the values of the components of profit change. Table 3 shows that prices had a negative impact and quantities a positive impact on profits. The quantity effect more than compensated for the price effect, so the resulting change in profit was positive. Table 4 shows that the output price effect was generally negative during Walton's and Glass's tenure, but positive under Scott. Capital input prices decreased, while labor prices increased (with the exception of Walton's years). The analysis shows that Walmart generated profit through continuous aggressive expansion (activity effect) without compromising operating efficiency. Walmart's growth was based on low prices and was possible because the company shared productivity gains with customers. Thus, increases in input prices did not result in increases in output prices. Walmart's investment in technology paid off, and was critical in overcoming the company's early inefficient growth. A detailed analysis of each CEO's tenure is now presented.

[INSERT TABLE 4 ABOUT HERE]

Sam Walton 1972-1988:

Real profits rose during Sam Walton's tenure.[20] The price effect was slightly negative, while the quantity effect was notably positive. Table 4 reveals that the output price effect was generally negative, which implies a reduction in real value added per item

[20] The only exception was the 1973-1974 period (Table 3). The explanation for this fall in profits was the adoption of the LIFO method of costing inventories. The change in accounting practice resulted in a reduction in earnings of 1.8 million 1970 dollars in real terms, although the company profits rose if measured in current dollars (AR, 1975, p.1).

sold. The input price effect was also negative, which is consistent with the cost consciousness and human resource practices applied by Walton. Since the price effect is defined as the difference between output price effect and input price effect, for some years the firm enjoyed positive price effects because it did not pass on all the savings obtained by controlling costs to customers. Negative output price effects are associated with EDLP and pressure on vendors.

In aggregate terms, the productivity effect was more important than the activity effect during Walton's tenure (Table 3). The results of this study show that technology was the most important lever during Walton's years, accounting for more than 65% of the change in profits. Walmart's early success mainly came from levers linked to operational efficiency and technological change, which are reflected in improvements in productivity.

Taking a closer look, there are evidently two different periods during Walton's tenure. Before 1983, the company was reporting a mostly positive price effect. The input price was generally negative (the firm was paying less for capital and labor) while the output price effect fluctuated. The operative inefficiency of the company nullified a large percentage of the total value created by the business model (60%), the main contributors to which were the activity effect and input prices. It can be deduced that the inefficiencies hindered the full application of EDLP. This would be captured by a significantly negative output price effect. After 1983, when the discount retail chain invested heavily in technology, there was a significant shift in the behavior of the profit change components. Output prices became much more negative, the contribution of technological change became positive and Walmart recovered from its operational inefficiency. We believe that this is one of the turning points of Walmart's history. Without the decision to invest heavily in technology, its future would have been completely different.

1981 was special, as reflected in Tables 3 and 4 (for the 1980-1981 period). This was the year that Walmart made its first major acquisition: Kuhn's Big K stores. Sam Walton made the following statement about the event: "But we'd never bitten off anything close to this size before, and we didn't know what it would be like trying to digest it" (Walton, 1992, p. 197). This acquisition could explain the singular values for the output prices and the price of capital. This year was also exceptional due to a 41% increase in sales (in

nominal terms), the second largest in the complete series (the largest increase in sales occurred in the 1972-1973 period).

David Glass 1988-2000:

As opposed to Walton's era, change in profit during Glass's period was mainly due to the activity effect. The company experienced few technological improvements and no changes in efficiency levels (observe David Glass's subtotal row in Table 3). When Glass left, Walmart's sales were 12 times greater than when Walton stepped down. The analysis reveals that the secret to Glass's success was his emphasis on all levers related to the activity effect while keeping Walmart operationally efficient. Table 4 shows that the output price effect was mainly negative (as in Walton's case), while the input prices of capital and labor followed different trends. Specifically, the labor input price effect was positive (in aggregate terms), as opposed to what had happened in the previous period. Labor real prices therefore increased under Glass's administration. On the other hand, the capital input price effect was negative for the whole period.

As described in Section 2, David Glass pulled some business model levers differently to Sam Walton. These differences mainly affected the quantity effect. Walton's years were characterized by the importance of investing in technology and improving efficiency, while in Glass's years, Walmart focused more on business choices that expanded the business, such as building new stores, increasing product variety and improving customer service which are mainly reflected in the activity effect.

Three years (1991, 1995, and 1997) warrant separate discussion. In 1991, the price effect decreased substantially (although the activity effect more than compensated for it). In December 1990, Walmart completed the acquisition of McLane (a company that provided and distributed goods to different retail stores, including Walmart). At the same time, Walmart was fully deploying Sam's Club nationwide.[21] Both Sam's Club and McLane had lower mark-ups than Walmart. This could explain why the company's output prices

[21] When Walton left the CEO position in 1988, there were 105 Sam's Club stores; by 1991 that number was 205.

decreased substantially in 1991. The strong positive activity effect in 1991 could reflect the higher output and input quantities associated with the acquisition of McLane and the expansion of Sam's Club.

Walmart had a difficult year in 1995. In previous years, sales were growing at rates greater than 20% but in 1995 the growth rate was only 13%. The company was investing heavily outside the U.S. with mixed results. Sam's Club was not performing as expected; its sales growth rate was below inflation in 1995. Although this information is not reported in the tables, the output quantity effect for Sam's Club never recovered the growth levels of prior to 1995.

The price effect became positive after 1997. Table 4 reveals that the output price effect (which used to be negative) was positive at that time. A possible explanation could be the outward spread of the supercenter format. In 1997, the number of discount stores declined while the number of supercenters increased significantly. Thus, the expansion of the supercenter format appears to have occurred together with a weakening of EDLP. Additionally, several systems that improved inventory management and a change in the merchandise mix were implemented during those years which reduced the cost of sales (AR, 1998, p.5). This could be the cause behind the significant technical change between 1997 and 1998, as well as contributing indirectly to the moderation of EDLP. Despite Walmart obtaining higher value added per dollar sold, the activity effect remained strong, though smaller, than in previous years.

Lee Scott 2000-2008:

Scott's tenure was characterized by a moderation in growth rates. Walmart's profit increased not only because of changes in activity levels, but also because of improvements in productivity due to technical change (see subtotal in Table 3). The company enjoyed substantial technical progress and the price effect had a similar negative impact to that of the previous period. Nevertheless, the output price effect (Table 4) changed sign, becoming positive in aggregate terms. This result suggests a laxer implementation of EDLP. However, the labor input price effect was the component that showed the most striking shift. Labor prices increased significantly during this period. Company records show

increases in insurance and payroll-related costs.[22] The present analysis indicates that of all the levers that were pulled differently by Lee Scott as described in Section 2, it was human resource practices that had the largest effect on Walmart's performance during this period.

Walmart's biggest rival, Kmart, declared bankruptcy in 2002. Two years before, both companies had been engaged in a price war.[23] The effects of this price war can be seen in David Glass's last year, and the first years under Lee Scott, when output prices were negative (Table 4) and there was a boom in productivity (Table 3). After Kmart's bankruptcy, there was a change in trend for the output price effect.

2003 warrants separate analysis. McLane was sold that year for $1.5 billion and the company recorded extraordinary income of $151 million after taxes. Walmart sold McLane because it did not fit with its core business. McLane's sales in 2002 were $14.9 billion, so its influence on the company's finances was substantial. The component of profit change most affected by this sale was the activity effect.

The final year in the series shows a negative change in real profits. In current dollars, Walmart registered an increase in profits. However, profits grew less than inflation. The main reasons for the poor performance were a disappointing year for Sam's Club, almost zero contribution of productivity and a very modest activity effect.

6. Conclusions

The aim of this paper has been to contribute to the extant literature on business models. Building on Casadesus-Masanell and Ricart's (2010) framework, we have introduced the notion of business model lever, which helps to disentangle two perspectives on business models: they can be conceived as scale models or as role models (Baden-Fuller and Morgan, 2010). Levers correspond to the scale model viewpoint, which defines the set of categories of choices available for a particular business type. In our case, we define the typical elements found in discount retail chains. Business model choices are the actual

[22] Walmart applied a new pay structure for U.S. workers in 2004.

[23] The Economist. 2002. *The blue light blues, the perils of trying out-Wal-mart Wal-mart*. June 17th, http://www.economist.com/node/941028/print, Accessed August 12th, 2013.

realizations of these levers; they determine whether a specific, realized business model should be considered a role model. At the scale level, two business models might be considered identical but the actual implementations would be the critical determinants of their success. We found that although the core of Walmart's business models did not change in the period of analysis, the emphasis on certain business choices (how the levers were "pulled") made a significant difference.

Although the literature on business models is rich in theoretical frameworks that help analysts describe business models qualitatively, little progress has been made in developing micro-founded methods to quantify business model performance. Ours is a first step in this direction. Specifically, relying on the economics of business performance, our analysis has shown three distinct stages in the evolution of Walmart. In the first one, Walmart was under the management of a visionary leader (Sam Walton) who implemented several choices that sought to achieve cost leadership. The second stage was characterized by a large-scale deployment of the original business concept. The final stage corresponds to the downside of success. Walmart's human resource practices were criticized, which prompted higher salaries and benefits to employees.

As a discount retailer, Walmart's business model is oriented at selling more goods by reducing prices. What makes the company remarkable is its ability to grow while staying highly efficient. Walmart highlights the importance of business model choices that generate growth in the discount retail industry, such as the creation of a network of distribution centers and increased product variety. Our analysis suggests that these choices—captured by the activity effect—explain a large share of profit change for Walmart. Interestingly, other retailers such as Kmart attempted to emulate Walmart (especially by setting low prices) and failed. This suggests that while Walmart increased its business by selling more goods at low prices (as any discount retailer would), its success was ultimately due to the overall implementation of its business model, with its many complementary choices.[24]

The method employed has some limitations. As noted above, our approach cannot identify whether business model choices are reactions to changes in the institutional context

[24] Despite having an apparently insurmountable advantage in the mid-1980s, Kmart declared bankruptcy in 2002.

within which they were made (e.g. a store manager raising wages in response to a new government policy) or they are proactive decisions made by managers to influence outcomes (the store manager choosing to rise wages to attract qualified employees). In order to address this issue one must complement our quantitative method with a detailed analysis of case facts. Still, the quantitative analysis may be used as a problem-identification device and thus can be applied independently of the qualitative business model examination. For example, by applying the method, a manager may become aware that the operating efficiency effect is detrimental to profits. In that case, the manager could analyse the firm's business model and focus on reconfiguring the levers that affect operating efficiency.

The method proposed is an application of nonparametric empirical techniques, which have the advantage of not imposing particular functional forms governing relationships between variables. Moreover, we do not need to assume that managers optimize. On the other hand, nonparametric techniques have a deterministic approach; they do not consider statistical noise, a drawback that hinders the application of statistical inference and neglects measurement errors. These issues remain open and are subjects of current research. Another option is to use stochastic methods but this would require a much larger dataset and distributional and functional assumptions.[25]

In addition to the results on Walmart discussed in Section 5, our proposed method delivers comparable insights on the set of competitors considered to build the common benchmark frontier. We did not make use of this information because we focused on Walmart. A future line of research could exploit these data to produce detailed assessments of how industries evolve. In addition, the method is flexible in that it allows the possibility of evaluating business models in relation to specific competitors instead of in relation to a common frontier. We are currently pursuing this line of research by studying the interactions between Walmart and Kmart's models to understand the influence of business model innovation on the performance of conventional models. Finally, when fine-grained proprietary data are available, the method delivers more nuanced, less aggregated

[25] Coelli, *et al.* (2003) explain in more detail the advantages and disadvantages of the index numbers, stochastic frontier analysis and data envelopment analysis.

quantifications. For example, it is possible to use this study's approach for internal assessment, especially when business levers are adjusted and the implementation of these adjustments is done gradually. Specifically, the method is useful to contrast the performance of different units within a company.

The results revealed that while the first three CEOs pulled Walmart's business model levers differently, the business model did not change. Perhaps the most important challenge currently faced by Michael Duke (CEO since 2009) is deciding whether to continue Walmart's traditional business model (and consider pulling levers differently) or to come up with a different, original set of levers that fundamentally redefines what it means to compete in discount retail. For example, how important should the online channel be to Walmart and what should the company do to build a competitive advantage in that area? Or should Walmart adopt elements of multi-sided platforms in addition to those of a merchant? Hopefully, the proposed method can guide companies that wish to transform their business models by quantifying the effects of such transformations.

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Figure 1. Walmart's real profits from 1972 to 2008.

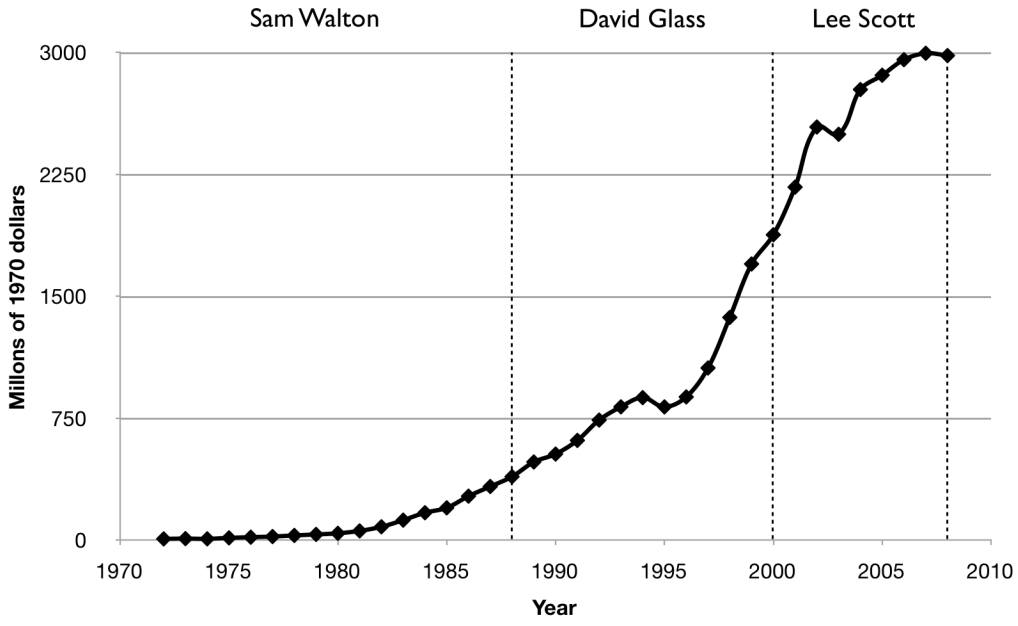


Figure 2. Walmart's discount retailer business model.

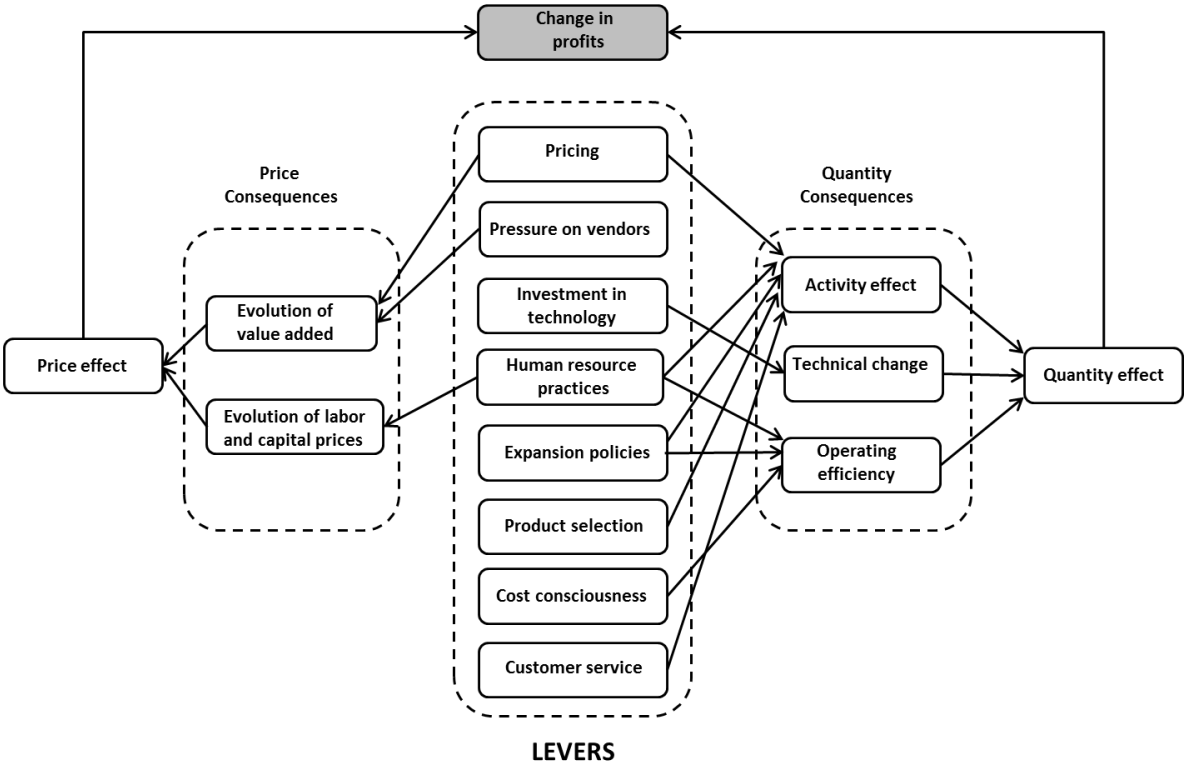
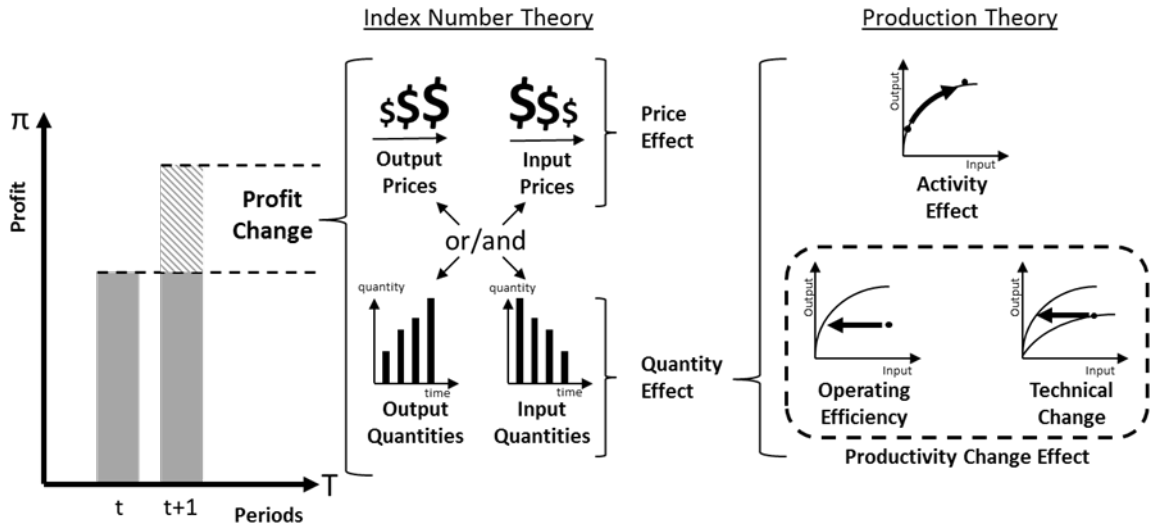
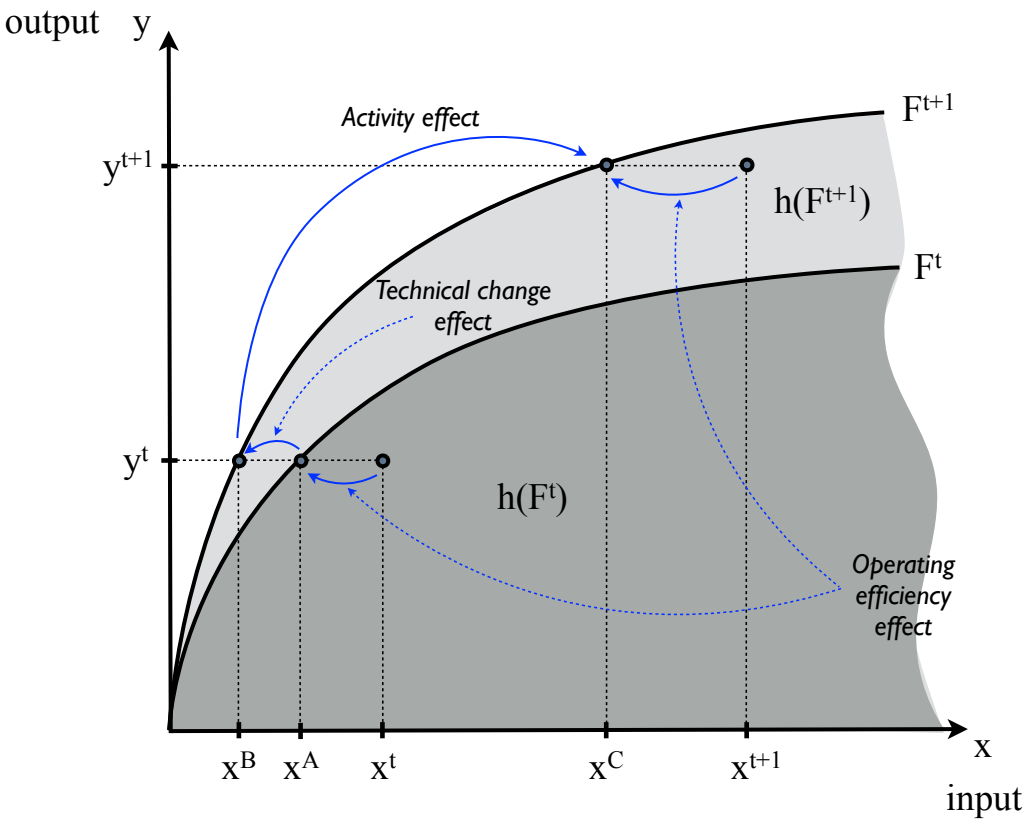


Figure 3. Visual representation of the methodology.



This figure should be read from left to right. In the first part, there is a change in profit from period t to t+1, under the assumption of positive profit change. This change in profit can be explained as a result of changes in prices (price effect) and/or changes in quantities (quantity effect). This level of analysis uses Index Number Theory. The quantity effect can be further decomposed into three different components. The first two elements are operating efficiency and technical change, which together define productivity change. The third component is the activity effect.

Figure 4. Decomposition of quantity effect for the case M = N = 1.



The *activity effect* is captured by the arrow connecting (x^B,y^t) and (x^C,y^{t+1}).

The *operating efficiency effect* is proportional to the difference between the distance from (x^t,y^t) to (x^A,y^t) and the distance from (x^{t+1},y^{t+1}) to (x^C,y^{t+1}).

The *technical change effect* is represented by the arrow connecting (x^A,y^t) and (x^B,y^t).

Table 1. List of companies in the dataset.

Company	Period	Description
Walmart	1971-2008	Discount stores (domestic and international)
Sam's Club	1983-2008	Warehouse club
Target	1971-2008	
Kmart	1971-2002	Filed for bankruptcy in 2002
Kmart post-bankruptcy	2003-2004	Merged with Sears in 2005
Sears	1994-2004	Merged with Kmart in 2005
Sears / Kmart	2005-2008	
Costco	1984-1992	Ancestor company
Costco	1993-2008	Successor company
Bradlees	1971-1986	Went bankrupt in 1995 and again in 2000
May	1971-1985	Acquired Caldor in 1985
May post-Caldor acquisition	1986-2003	Only until 2003

Table 2. Average and average growth rate of variables of interest under each CEO.

	Sam Walton (1971-1988)		David Glass (1988-2000)		Lee Scott (2000-2008)		Total	
	Average	Avg. Growth	Average	Avg. Growth	Average	Avg. Growth	Average	Avg. Growth
y_1	1,164.54	28.5%	15,145.10	18.2%	49,226.15	8.6%	17,389.44	20.09%
y_2	356.75	162.8%	3,608.18	18.9%	7,282.48	4.6%	4,410.70	31.51%
p_1	0.29	-0.9%	0.24	-0.8%	0.24	0.4%	0.26	-0.52%
p_2	0.27	-14.7%	0.17	-2.2%	0.16	-0.3%	0.18	-3.03%
x capital	201.47	34.9%	3,943.43	22.4%	15,636.50	11.4%	5,169.54	24.87%
w capital	0.16	2.1%	0.11	-2.2%	0.08	-3.0%	0.12	-0.61%
x labor	42.34	32.2%	548.04	16.7%	1,616.33	8.1%	589.22	21.01%
w labor	6.45	-3.3%	5.26	0.8%	5.83	1.1%	5.91	-0.83%

Variable	Measurement
y_1	Discount store sales expressed in millions of 1970 dollars
y_2	Warehouse club sales expressed in millions of 1970 dollars
p_1	Discount store, value added per dollar sold in 1970 dollars
p_2	Warehouse, value added per dollar sold in 1970 dollars
x capital	Capital valued at prices of 1970 (in millions)
w capital	Cost of capital per dollar invested in capital in 1970 dollars
x labor	Number of workers (thousands)
w labor	Operating, General & Administrative expenses per 1,000 employees in millions of 1970 dollars

Table 3. Decomposition of change in profits (millions of 1970 dollars).

	Period	Change in Profits [2]	Change in Profits		Quantity Effect		Productivity Effect	
			Price Effect [3]	Quantity Effect [4]	Activity Effect [5]	Productivity Effect[6]	Technical Change [7]	Operational Efficiency [8]
Sam Walton	1972 – 1973	1.63	-0.41	2.05	N/A	N/A	N/A	N/A
	1973 – 1974	-1.34	0.30	-1.64	N/A	N/A	N/A	N/A
	1974 – 1975	6.04	6.26	-0.23	N/A	N/A	N/A	N/A
	1975 – 1976	4.21	-2.04	6.25	N/A	N/A	N/A	N/A
	1976 – 1977	3.81	1.53	2.28	N/A	N/A	N/A	N/A
	1977 – 1978	6.88	4.49	2.39	15.96	-13.56	-	-13.56
	1978 – 1979	6.22	-1.04	7.26	14.62	-7.36	-	-7.36
	1979 – 1980	6.80	8.29	-1.49	13.44	-14.93	-	-14.93
	1980 – 1981	14.92	23.47	-8.55	16.22	-24.77	-	-24.77
	1981 – 1982	25.22	-2.22	27.44	37.47	-10.04	-	-10.04
	1982 – 1983	40.83	-4.75	45.58	40.11	5.47	-	5.47
	1983 – 1984	45.78	1.63	44.15	-26.82	70.97	-	70.97
	1984 – 1985	30.13	-17.20	47.33	-12.47	59.80	59.80	-
	1985 – 1986	71.83	-0.66	72.49	5.75	66.74	66.74	-
	1986 – 1987	59.36	-30.20	89.56	25.76	63.80	63.80	-
	1987 – 1988	60.59	-29.09	89.67	37.99	51.68	51.68	-
Total 1977-1988		368.56	-47.28	415.84	168.03	247.81	242.03	5.78
Total 1972-1988		382.91	-41.65	424.55	N.A.	N.A.	N.A.	N.A.
David Glass	1988 – 1989	90.15	12.13	78.02	43.11	34.90	34.90	-
	1989 – 1990	48.80	-8.94	57.74	48.27	9.47	9.47	-
	1990 - 1991	83.97	-134.72	218.68	159.06	59.62	59.62	-
	1991 - 1992	125.05	-164.76	289.81	289.81	-	-	-
	1992 - 1993	81.36	-30.86	112.21	112.21	-	-	-
	1993 - 1994	56.76	-48.17	104.94	104.94	-	-	-
	1994 - 1995	-57.01	-224.17	167.16	135.74	31.42	31.42	-
	1995 - 1996	61.33	-92.07	153.41	153.41	-	-	-
	1996 - 1997	178.05	114.28	63.78	63.78	-	-	-
	1997 - 1998	310.81	99.11	211.70	132.10	79.60	79.60	-
	1998 - 1999	328.85	183.66	145.19	145.19	-	-	-
	1999 - 2000	179.69	36.04	143.65	143.65	-	-	-
Total 1988-2000		1,487.82	-258.47	1,746.29	1,531.27	215.02	215.02	-
Lee Scott	2000 – 2001	293.09	-27.79	320.88	203.12	117.76	117.76	-
	2001 – 2002	369.71	-210.09	579.80	444.73	135.07	135.07	-
	2002 – 2003	-44.74	-317.76	273.01	273.01	-	-	-
	2003 – 2004	275.44	703.23	-427.78	-427.78	-	-	-
	2004 – 2005	87.89	209.36	-121.47	-187.66	66.19	66.19	-
	2005 – 2006	95.85	-233.39	329.24	272.79	56.45	56.45	-
	2006 – 2007	39.26	-303.61	342.88	192.78	150.10	150.10	-
	2007 – 2008	-14.23	-83.59	69.36	66.66	2.70	2.70	-
Total 2000-2008		1,102.27	-263.64	1,365.91	837.65	528.27	528.27	-
Total 1977-2008		2,958.64	-569.39	3,528.04	2,536.95	991.09	985.31	5.78
Total 1972-2008		2,972.99	-563.76	3,536.75	N.A.	N.A.	N.A.	N.A.

Table 4. Decomposition of price effect (millions of 1970 dollars).

	Period	Output Price 1	Output Price 2	Output Price Effect	Input Price K	Input Price L	Input Price Effect	Price Effect
Sam Walton	1972 – 1973	-1.70	-	-1.70	1.10	-2.39	-1.28	-0.41
	1973 - 1974	-1.81	-	-1.81	0.72	-2.83	-2.11	0.30
	1974 - 1975	2.81	-	2.81	-0.62	-2.83	-3.46	6.26
	1975 - 1976	0.93	-	0.93	0.08	2.88	2.97	-2.04
	1976 - 1977	-2.30	-	-2.30	-3.10	-0.73	-3.83	1.53
	1977 - 1978	-0.17	-	-0.17	-0.86	-3.81	-4.66	4.49
	1978 - 1979	-0.71	-	-0.71	-0.88	1.22	0.34	-1.04
	1979 - 1980	-5.02	-	-5.02	-1.29	-12.03	-13.31	8.29
	1980 - 1981	19.79	-	19.79	4.10	-7.77	-3.67	23.47
	1981 – 1982	-1.58	-	-1.58	-0.62	1.25	0.63	-2.22
	1982 – 1983	-2.09	-	-2.09	-5.43	8.09	2.66	-4.75
	1983 – 1984	-14.74	-	-14.74	-0.14	-16.23	-16.37	1.63
	1984 – 1985	-47.54	-5.65	-53.19	-4.57	-31.42	-35.99	-17.20
	1985 – 1986	18.63	-14.04	4.59	4.76	0.49	5.25	-0.66
	1986 – 1987	-50.88	-20.95	-71.83	3.07	-44.70	-41.62	-30.20
	1987 – 1988	-48.20	-18.42	-66.62	-1.80	-35.73	-37.53	-29.09
Total 1972-1988		-134.58	-59.06	-193.64	-5.46	-146.53	-151.99	-41.65
David Glass	1988 – 1989	-10.51	-15.72	-26.23	-11.29	-27.07	-38.36	12.13
	1989 – 1990	-35.59	4.21	-31.38	-8.50	-13.94	-22.44	-8.94
	1990 – 1991	-20.69	-6.89	-27.58	10.56	96.57	107.14	-134.72
	1991 – 1992	-85.45	-20.13	-105.59	-19.86	79.04	59.17	-164.76
	1992 – 1993	2.39	-21.22	-18.83	1.65	10.38	12.03	-30.86
	1993 – 1994	-25.56	27.72	2.16	11.95	38.39	50.34	-48.17
	1994 – 1995	-101.19	-99.45	-200.63	12.65	10.89	23.54	-224.17
	1995 – 1996	-90.75	1.47	-89.28	-46.42	49.21	2.79	-92.07
	1996 – 1997	109.95	6.38	116.33	-42.21	44.27	2.05	114.28
	1997 – 1998	169.32	3.05	172.37	-12.80	86.06	73.26	99.11
	1998 – 1999	144.05	41.71	185.75	19.50	-17.41	2.09	183.66
	1999 – 2000	-188.06	-14.97	-203.03	-36.77	-202.30	-239.07	36.04
Total 1988-2000		-132.09	-93.85	-225.94	-121.55	154.08	32.54	-258.47
Lee Scott	2000 – 2001	-185.09	-10.93	-196.03	-45.71	-122.52	-168.23	-27.79
	2001 – 2002	140.70	-7.73	132.97	-132.89	475.94	343.05	-210.08
	2002 – 2003	17.98	40.41	58.40	-42.97	419.12	376.15	-317.76
	2003 – 2004	559.41	-6.53	552.88	-48.93	-101.41	-150.35	703.23
	2004 – 2005	-5.02	6.09	1.07	-34.25	-174.03	-208.28	209.36
	2005 – 2006	317.84	3.93	321.77	53.86	501.30	555.16	-233.39
	2006 – 2007	-162.34	-2.42	-164.76	45.57	93.29	138.86	-303.61
	2007 – 2008	-12.29	-44.61	-56.90	-8.91	35.60	26.69	-83.59
Total 2000 – 2008		671.20	-21.79	649.41	-214.24	1,127.29	913.05	-263.64
Total 1972 – 2008		404.54	-174.70	229.84	-341.24	1,134.84	793.60	-563.76

Appendix

The calculation of the activity, operating efficiency, and technical change effects require estimates of the unobserved input vectors: x^A, x^B, and x^C. Figure 4 shows that these vectors lie on the frontiers F^t and F^{t+1}. These vectors can be expressed in terms of observable inputs and easy-to-estimate distance functions.

We define the *same-period input distance function* as $D^t(y^t,x^t) = \max\{\theta: (y^t, x^t/\theta) \in F^t\}$. $D^t(y^t,x^t) \geq 1$ because when x^t is producing the maximum feasible output with period t's technology ($x^t \in F^t$), we have $D^t(y^t,x^t) = 1$. The *adjacent-period input distance* function $D^{t+1}(y^t,x^t)$ is obtained by replacing F^t with F^{t+1}. Because some input/output combinations in period t+1 may not be feasible under period t's technology, we have $D^{t+1}(y^t,x^t) \gtreqless 1$.

Input vectors x^A, x^B, and x^C are radial expansions of the observed quantity vectors (x^t,y^t) and (x^{t+1},y^{t+1}). It is easy to see that the technically efficient period t input vector x^A can be expressed as $x^t/D^t(y^t,x^t)$. Likewise, the technically efficient period t+1 input vector x^C is given by $x^{t+1}/D^{t+1}(y^{t+1},x^{t+1})$. Finally, x^B is a radial scaling of x^t to the boundary of F^{t+1}; therefore, $x^B = x^t/D^{t+1}(y^t,x^t)$. Thus, if we calculate the input distance function D(x, y), we will be able to produce estimates of x^A, x^B and x^C, which are all we need to compute the activity, operating efficiency, and technical change effects.

To estimate the function D(x,y) we use Data Envelopment Analysis (DEA), a technique introduced by Charnes *et al*. (1978) and extended to production theory by Färe *et al.* (1985). DEA constructs best-practice frontiers, which provide empirical approximations to the production possibility y frontiers F^t and F^{t+1}. These frontiers are used to measure the performance of a producer relative to the best practice observed in the sample.

We assume that the feasible set F^t includes all observations from period 1 to period t. Hence, the best-practice production possibility frontier in year t is constructed using data from all producers in all years prior to and including year t. In other words, best practices in previous years are remembered and remain available for use in the current year. Note that this approach does not allow for technical regression and implies that $x^A \geqq x^B$ always (as in the example shown in Figure 4).

The unobserved input distance function $D^t(y^t,x^t)$ of retailer '^{o}', is calculated by solving the following linear program:

$$[D^t(y^{ot},x^{ot})]^{-1} = \min_{\phi^A,\lambda^S} \phi^A$$

$$\text{s.t} \qquad X^s \lambda^s \le \phi^A x^{ot}, \qquad y^{ot} \le Y^s \lambda^s, \qquad \lambda^s \ge 0, \qquad \Sigma_i \lambda_i = 1. \tag{3}$$

Consider period t. At time $s \le t$ we have I_s retailers; $Y^s = [y^{1s},...,y^{os},...,y^{Is}]$ is an $M \times \Sigma_{s=1}^{t} I_s$ matrix of M outputs produced by all I_s retailers in each of periods s = 1,...,t, and $X^s = [x^{1s},...,x^{os},...,x^{Is}]$ is an $N \times \Sigma_{s=1}^{t} I_s$ matrix of N inputs used by I_s retailers in each of the periods s = 1,...,t. The data matrices Y^s and X^s are sequential, i.e., they include output and input quantity data for all producers from the beginning of the sample through period t; λ^s is a $\Sigma_{s=1}^{t} I_s \times 1$ activity vector and, finally, the convexity constraint $\Sigma_i \lambda_i = 1$ allows the approximating technology F^t to satisfy variable returns to scale, and to envelop the data tightly. This program is solved $\Sigma_{s=1}^{t} I_s$ times, once for each retailer in each year, although we report only Walmart's results.

The outcome of the linear program (3) is ϕ^A, which enables the calculation of the unobserved input quantity vector x^{oA} as $x^{oA} = \phi^{oA} x^{ot}$. The value of the input distance function $D^t(y^{ot},x^{ot}) = 1/\phi^{oA}$. The estimation of $D^{t+1}(y^{t+1},x^{t+1})$ is similar to $D^t(y^t,x^t)$. We need to replace (x^{ot},y^{ot}) with (x^{ot+1},y^{ot+1}) and s = 1,...,t with s = 1,...,t+1 in (3). Thus the solution of this new linear program is ϕ^{oC} which, as before, permits the valuation of x^{oC} as $x^{oC} = \phi^{oC} x^{t+1}$ and the value of the input distance function as $D^{t+1}(y^{ot+1},x^{ot+1}) = 1/\phi^{oC}$. In the case of $D^{t+1}(y^t,x^t)$ we replace s = 1,...,t with s = 1,...,t+1 in (3) and the outcome of this linear program is ϕ^{oB} and $x^{oB} = \phi^{oB} x^t$. As before, the value of the input distance function $D^{t+1}(y^{ot},x^{ot}) = 1/\phi^{oB}$. We calculate the activity, operating efficiency, and technical change effects by replacing x^A, x^B, and x^C in equation (2).