



# E-commerce as a stockpiling technology: Implications for consumer savings<sup>☆</sup>



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## ABSTRACT

Shopping on the Internet spares customers the discomfort of carrying around heavy and bulky baskets of goods, since the service usually includes home delivery. This makes e-commerce a technology well suited to helping consumers to buy in bulk or to stockpile items on discount. I use grocery scanner data provided by a supermarket chain selling both online and through traditional stores to show that the introduction of e-commerce leads to an increase in bulk purchase and stockpiling behavior by customers. Since bulk and discounted items are sold at a lower price per unit, my findings highlight a new dimension in which online shopping can be beneficial to consumers. According to my calculations, the reduction in the cost of stockpiling triggered by the introduction of electronic commerce generates significant savings.

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## 1. Introduction

The introduction and spread of e-commerce have transformed retail markets, changing the way consumers shop for goods and services. For instance, the Internet facilitates price comparison between sellers (Brown and Goolsbee, 2002; Brynjolfsson and Smith, 2000) and offers a larger variety of products than traditional businesses (Brynjolfsson et al., 2003). Another fundamental difference between online and regular shopping is that Internet customers shop without traveling to a store and receive their purchases delivered at home, instead of picking and carrying them themselves. Delivery to door is not a new service, nor is it exclusively associated with electronic commerce. Items ordered through catalogues are typically delivered at home and some brick-and-mortar stores offer delivery services. Nonetheless, Internet shopping has greatly increased the number of people who have access to this service and the range of goods for which it is supplied.

Home delivery is of particular significance for regularly purchased goods. In this context, customers have the incentive to stockpile for future consumption to take advantage of nonlinear prices in quantity or of temporary price discounts. They face a trade-off between the benefit of stockpiling and the cost of doing so. Though such cost is typically represented as a storage cost, it includes other dimensions that Chintagunta et al. (2012) label as *physical costs*. These refer to the discomfort associated with carrying the grocery basket around the store and transporting it home. Consumers sustain physical costs every time they shop but we may think they are higher the larger the number of items bought in the trip or the bigger their size and weight. Providing mass access to home delivery, electronic commerce eliminates the physical costs of shopping and removes a substantial hurdle to households' stockpiling decisions.

This paper documents the effect of the introduction of e-commerce on households' propensity to buy in bulk and to stockpile on promotional items. Consistent with what a simple theory model would predict, the elimination of physical costs makes stockpiling and buying in bulk more popular. If the sign of the effect was anticipated, its magnitude is surprisingly large. A back-of-the-envelope calculation of the savings consumers can achieve once these hurdles to stockpiling are removed suggests that the savings represented by the increase in bulk purchases for soda and laundry detergent are worth around one percent of the total expenditure in those product categories. The increased efficiency in stockpiling on discounted items allows for even more significant expenditure reductions, close to 4% of the yearly household groceries budget. Though home delivery has received far less attention than other much heralded advantages offered by shopping online, it

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plays an important role in making e-commerce a superior stockpiling technology that delivers non-negligible benefits to users.

The setting for this study is the grocery industry. I use two years of scanner data on grocery purchases made by a large panel of households at a major US supermarket chain that sells groceries in brick-and-mortar stores and online. Although e-commerce in grocery items is still a niche market in the US, it is steadily growing and has already achieved a wide reach in other countries.<sup>1</sup> Grocery is a classic environment in which to study stockpiling behavior<sup>2</sup>: many grocery goods are storable for periods ranging from a few weeks (e.g. yogurt) to several months (e.g. soda) or even years (e.g. canned food and detergents). In addition, supermarkets often price packaged goods nonlinearly and subject them to frequent temporary price reductions. Finally, quantifying the savings that consumers can achieve through stockpiling in grocery it is important because they account for a sizeable share of consumption for American households. According to the 2010 Consumer Expenditure Survey, food at home, housekeeping and personal care items account for over 10% of consumers' total expenditure.

The estimation strategy used in this paper exploits the panel structure of the data. I observe the same household shopping on some occasions in supermarket stores, on others ordering online. Within-household variation on the shopping channel provides a source of identification cleaner than the cross-sectional variation used in most studies investigating the effects of e-commerce. In fact, it reduces the concerns about self-selection into online shopping, which may be driving the results if we were to compare the behavior of a sample of online shoppers to that of another sample of traditional customers. Other features of the setting lend strength to the empirical strategy. First, the retailer is committed to offering the same prices and promotions online and in brick-and-mortar stores. Heterogeneous pricing policies across channels would have been a confounding factor for the analysis, as expectations over prices are a major driver of the decision to stockpile. Second, the information comes from a single supermarket chain, ensuring that the seller reputation, the brand name and the assortment are the same across environments.

Even though I am able to compare one same household when shopping in different channels, the possibility that households sort their trips still provides an identification challenge. For instance, if customers systematically shop on the Internet when they have independently decided to build up stocks, a positive association between stockpiling and online shopping would not necessarily imply that e-commerce increases the propensity to stockpile or buy in bulk. I deal with this issue by exploiting the staggered rollout of the online delivery service by the supermarket chain. In fact, the option of shopping on the web became available at different times to households living in different zip codes. Internet shopping is eventually introduced in all the zip codes included in the data and the timing of the rollout of the web delivery service is mainly dictated by supply side considerations; therefore it is orthogonal to households' shopping decisions. This ensures that comparing customers' purchasing patterns before and after the introduction of the Internet channel delivers an estimate of the causal effect of e-commerce on the tendency to stockpile.

I find that when the chain introduces online grocery shopping in a market, the households living there increase their share of expenditure in shopping instances involving large bulks of goods. The share-of-wallet of purchases involving at least 300 oz of liquid laundry detergent goes up by 15% and that of trips including 24 or more cans of soda rises by 90%. The average quantity purchased of an item conditional on being on sale is also positively affected by the availability of e-commerce. The share of expenditure on discounted

items rises by a figure between 9% and 20%. This latter result can be linked to an effect on stockpiling behavior only if it is driven by an increase in the quantity bought conditional on buying on discount. To assess whether this is the case, I contrast the effect of e-commerce on the extensive margin of promotional purchases (i.e. the probability of buying a good when it is in promotion) and its intensive margin (i.e. the quantity purchased, conditional on buying on sale). Consistently with my claims, I find that online shopping does not increase the likelihood that customers buy items when they are on promotion but has a positive impact on the amount they buy when they do so.

That e-commerce can foster bulk purchases and stockpiling of items on sales has important implications for consumers, since Griffith et al. (2009) show that those two are major sources of savings for households purchasing groceries. My estimates provide a chance to quantify the dollar impact of lowering the cost of stockpiling for households. As mentioned, the extra savings account for a small but far from insignificant fraction of the overall grocery consumption of the average household.

This paper provides two novel insights. First, I extend the literature on inventory models delivering empirical evidence on the impact of the cost of stockpiling on shopping behavior. Past contributions examined the effect of price changes (Boizot et al., 2001; Hendel and Nevo, 2006b; Neslin et al., 1985) and inventory held (Hendel and Nevo, 2006b; Neslin and Schneider Stone, 1996) on the decision to stockpile. Efforts to quantitatively explore the impact of variation in the cost of stockpiling have been plagued by the lack of direct data. I expand the definition of stockpiling cost beyond the storage cost considered by traditional inventory models (Erdem et al., 2003; Hendel and Nevo, 2006a) to include the physical discomfort from carrying the goods purchased. In my application, the introduction of e-commerce provides exogenous variation in the physical cost of stockpiling that does not impact on storage cost, therefore allowing to shed light on the importance of this determinant.

Second, I further the understanding of the effect of information technology on consumers' behavior. Prior literature has studied the impact of online shopping on price sensitivity (Chu et al., 2008; Ellison and Ellison, 2009), brand loyalty (Danaher et al., 2003; Pozzi, 2012), and product choice (Brynjolfsson et al., 2011; Goldfarb et al., 2012; Zentner et al., forthcoming). I study how the availability of this technology affects inventory decisions. Characterizing the Internet as a superior technology for stockpiling and quantifying the monetary gains for shoppers, I highlight another benefit that online commerce can deliver to consumers in addition to the well known gains derived from lowered search costs and increased provision of variety. To the best of my knowledge, this is the first paper to focus on the home delivery aspect of Internet commerce and to study its implications for the incentive to stockpile.

The rest of the paper is structured as follows. Section 2 describes the data used in the analysis; Section 3 presents the identification strategy and empirical specification of the econometric model. Section 4 comments on the results of the empirical analysis and Section 5 computes the consumers' savings implied by the estimates. Section 6 concludes.

## 2. Data description

The analysis is based on scanner data on purchases at a large US supermarket chain that sells both online and in regular stores. The sample is a panel of 11,646 households who shopped for grocery both at stores of the chain and using its web delivery service between June 2004 and June 2006. Purchases by all members of a household are linked using an identification number that the retailer associates to all the loyalty cards belonging to members of the same family.<sup>3</sup> For each shopping trip, data record the household identification

<sup>1</sup> For instance, Tesco online delivery service covers the U.K. in almost its entirety.

<sup>2</sup> See Hendel and Nevo (2004) for a survey of studies providing evidence of stockpiling behavior using supermarket scanner data.

<sup>3</sup> Purchases made without using the loyalty card are not part of the data. However, the penetration rate of the card is high and customers use it regularly as it is the only way to take advantage of promotions.

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