Pick-up, Delivery, or Both? An Online Grocer’s Optimal Fulfillment Models

The grocery retail industry is quickly evolving as retailers become omni-channel. Because grocery retailers sell perishable products, their transition to an omni-channel business model has been particularly challenging on the fulfillment side. AmazonFresh’s business evolution illustrates how an online grocer learns and gradually fine-tune its fulfillment operations (Anderson, 2017). Founded in 2007, AmazonFresh rolled out its grocery delivery service gradually to several metropolitan areas, after an initial pilot period in Seattle, WA. In 2017, AmazonFresh opened two pick-up locations in Seattle, WA to allow its customers to choose between delivery or pick-up of their online orders. In the same year, it discontinued the delivery service in several zip codes. AmazonFresh’s experience demonstrates that even a business with limited capital constraints faces considerable challenges in identifying the right level of delivery zones and right mix of fulfillment models depending on regional characteristics.

In this paper, we partner with an online grocery retailer to answer the practice-based question of the optimal mix of delivery zones and fulfillment models using data-driven analytics. Our partner retailer is founded on the Buy-Online-Pick-Up-In-Store (BOPS) fulfillment strategy: instead of offering pick-up service at brick-and-mortar stores, the retailer uses delivery trucks parked at various convenient pick-up locations to deliver orders to customers. As the retailer expanded, it began offering home delivery service at select markets for a specified delivery fee. Although a team of managers determined where to add the delivery option, the retailer believes that analytics could be used to improve their fulfillment offering decisions.

Using the retailer’s proprietary data, we investigate (A) how consumers respond to the locally tailored fulfillment options made available to them by the online grocer, and (B) how to leverage data to customize locally available fulfillment options while scaling the retailer’s operations, especially into new regions with new customers and preferences. Our study and methodology address questions – data-driven
omni-channel retailing, scaling of operations, and preference-based targeting – of prominent interest for today’s retail businesses.

Our work relates to the empirical estimation of omni-channel demand in retailing. Bell et al. (2014) find that the introduction of offline showrooms by a previously online-only retailer increased sales. Wang and Goldfarb (2016) present evidence for the coexistence of substitution across channels and complementarity in demand. Shriver and Bollinger (2017) employ a structural analysis in a fashion retail setting and find that a 10% reduction in distance to the nearest retail stores increases total expenditures among existing customers by 2%. In their counter-factual analysis, they explore channel-based pricing policies and identify desirable locations for retail entry.

In contrast, we use a data-driven approach to determine the optimal fulfillment option offerings and the scale of each fulfillment option offering in each market in which the retailer operates. In addition, customers in our setting have the same set of information when purchasing regardless of their choice of fulfillment, whereas prior literature examines settings where the online and offline channels offer different information for customers. Consequently, we study the sole effect of fulfillment offerings on consumer choice and not the joint effect of differing fulfillment offerings and information.

To do so, we first establish that the firm’s choice of fulfillment offerings is economically important, both for attracting new customers and in realizing value for – and revenues from – existing customers. This analysis requires combining data analytics and mining for large-scale, geospatial data with rigorous causal inference and structural modeling. Using fixed effects regressions, we find that when customers switch their fulfillment mode from pick-up to delivery, their weekly spending increases by $8 on average and they purchase more non-perishable items. This spending increase suggests that the firm could offer delivery not only to attract new customers, but also to increase sales from its current customer base.
However, we note that this spending increase may not reflect the causal effect of offering delivery because the retailer strategically offered delivery availability. To estimate a causal effect, we exploit the fact that the retailer introduced delivery by zip code, so that zip code borders create a discontinuity in delivery offerings. We compare the change in sales for customers just inside of a zip code border to the change in sales for their neighbors just outside the border in a differences-in-differences analysis. To the extent that customers just inside the border are otherwise similar to their neighbors just outside the border, this analysis estimates a causal effect. We find that the increase in revenue from offering delivery varies from no additional weekly sales to an increase of $300, depending on the zip code.

In the next step, based on this empirical evidence, we build and estimate a structural model and perform a counter-factual analysis to estimate the revenue increase from additionally offering delivery. We build the model on a customer utility maximization framework, where each customer faces a stochastic need for groceries. We model the consumer’s decision to purchase from our retailer and the related decision of which fulfillment offering to use based on latent consumer preferences, fulfillment option availability, the availability of nearby grocers, and the consumer’s product mix preference (i.e., non-perishable goods vs. perishable goods). Based on the estimation results, we recommend whether the retailer should offer pick-up, delivery, or both services in each geographic market.

References


