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Reaching Urban and Semi-Urban Markets Using Superior Products: Dilemma of Small Firms from Rural Markets

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Problem definition: Small firms from rural markets are increasingly competing with larger firms to capture a share in India's rapidly growing urban and semi-urban markets using various strategies. The critical dimensions along which small (rural) firms in the food and agriculture industry differ are the markets they choose to serve, whether they supply their products to larger firms or offer own product brands, and the pack sizes they offer.

Methodology/results: We use theories from the supply chain literature to provide guidelines for small rural firms to enter urban markets. We explain such firms' rapid growth and anticipate that this phenomenon will spillover to the development of rural markets, a bane of economic development thus far. Our (non-cooperative) game-theoretic model explains small firms' product, market, and distribution channel choices using five competitive levers: (i) consumer heterogeneity, (ii) product wastage, (iii) product pack-size, (iv) consumer responsiveness to product pack-size, and (v) pack-size-driven product wastage reduction. We show that directly selling its *superior* product under own brand is viable even for a small firm from rural markets. When consumer heterogeneity is low and product wastage during consumption is high, the firm directly supplies its superior product in urban and semi-urban markets in a smaller pack-size. Otherwise, it supplies the product to large firms from urban markets that also offer *ordinary* products in standardized packs.

Managerial implications: We discover that rural firms' choices are not just in contrast to those of larger firms from urban markets who want to enter rural markets, but they are also in consonance with their choices to serve local markets. This reinforces the firms' growth strategies and connections between the two markets.

Key words: firm-size, pack-size, wastage, prejudice, rural, access, distribution

1. Introduction

1.1. Innovative Competitive Strategies of Small Firms from Rural Markets

For decades rural markets in developing countries such as India have been underserved. No amount of intervention to meet the requirements of rural consumers and producers has yielded significant returns. Rural markets have not only been geographically segregated from urban and semi-urban markets (hereafter simply referred to as urban), but they are also perceived to be different in

consumption patterns, consumer budgets, and supply capabilities of producers. Unlike urban consumers, rural consumers lack access to the *best* product brands. The strategy of serving the bottom of the pyramid, as conceptualized by Prahalad (2005), has been a call-to-action for urban firms that can partially meet the demands of rural consumers. The existing literature focusing on the bottom of the pyramid strategies of urban firms is quite vast in proposing a multitude of approaches, such as the choice of distribution channels, target markets, supply chain partners, product portfolios, product packaging, etc. Accordingly, firms in urban areas were expected to reach rural markets and increase their profitability. Nevertheless, not many firms that serve urban markets have entered rural markets. Plausible reasons for this include the dissimilarity in products demanded and supply chain characteristics necessary to serve rural versus urban markets effectively. On the other hand, in the past, firms from rural areas would not serve urban markets. There are many reasons for this, including the inability to design products for urban customers and limitations imposed by supply chains. Thus, the two markets have remained disconnected.

This article explores a novel phenomenon that has begun to connect rural markets with urban markets rapidly. The growth of consumption in urban markets, endowed with affluent consumers that desire variety and exclusivity in their consumption of food and agriculture products, has spurred the development of a new type of entrepreneur – a *small* rural firm that serves urban markets using *superior* products for high-valuation consumers. These firms from rural India are overcoming their handicaps in novel ways. As discussed by Narasimhan et al. (2015), "... studying the combination of consumer and firm choices in response to a more heterogeneous and dynamic set of environmental contexts across emerging [and developed] markets can serve to expand the scope of [both] theoretical [and empirical] enquiry, and thereby, enriching and deepening our understanding of markets and marketing."

Small firms from rural markets, particularly in the food and agriculture industry, face a dilemma of whether to enter urban markets and, if they do, whether to introduce own product brands or to supply the products to large urban firms under their brands. The former, which is an evolving phenomenon, suggests that small and large firms engage in horizontal competition by offering own product brands, and the latter setting that has been widely observed traditionally, captures vertical competition between the firms where only large firms' product brands are available in the market. For food and agriculture products, small rural firms accrue location advantage to produce high-quality *local* products. On the other hand, large urban firms procure food and agriculture products from rural markets and serve urban consumers by typically offering *ordinary* products to enhance market penetration. Additionally, small rural firms lack the capacities and capabilities to efficiently

market and distribute their products in distantly-located urban markets that large firms dominate. Due to lower brand awareness of small firms' products among urban consumers, prejudice against the products is higher when they are supplied by small firms directly versus through large firms. In this environment, small firms are required to manage consumer incentives based on critical factors for food and agricultural products, namely, product valuation, wastage, pack-size, and accessibility (see Hussain and Goyal (2021)).

This paper examines what aspects of products, markets, and supply chains facilitate rural firms' entry into urban markets. Based on our field study and theories from the existing supply chain literature, we identify five variables that drive the rural firms' decision-making. We establish what type of rural firms based on a product category in the food and agricultural sector will choose to enter urban markets and under which brands and packaging. We draw upon interviews with the management of the firms in our field study (see Table 2) to identify the variables – (i) consumer heterogeneity, (ii) product wastage, (iii) product pack-size, (iv) consumer responsiveness to product pack-size, and (v) pack-size-driven product wastage reduction – that are necessary to capture the observed decision-making by firms. Our results provide enough evidence for the increasing number of firms from rural markets serving urban markets and explain the nuances observed in their choices. For instance, we demonstrate Mielo honey is available in large pack-sizes due to superior competitiveness compared to Beelove and Phalam Sampada. Similarly, due to lower wastage of honey than milk, the former is available in relatively larger packs than the latter. (A detailed discussion follows in Section 5.1.)

1.2. Research Questions

We address the following questions in this paper to characterize the supply chain factors that enable firms from rural areas to compete in urban markets for food and agricultural products.

1. What is the impact of consumer heterogeneity and product wastage during consumption for a small rural firm's superior product pack-size compared to a large firm's ordinary product pack-size?

2. What are the conditions under which a small firm offers its superior product to urban consumers under own brand by adopting a *direct-sale* channel? On the contrary, when does it adopt a *sale-through-intermediary* channel in which the small firm's superior product is supplied in the market by a large firm under own brand?

3. What is the impact of consumers' responsiveness to product pack-size and pack-size-driven product wastage on a small firm's market entry strategy that specifies the superior product pack-size and direct-sale versus sale-through-intermediary channel?

1.3. Main Findings

Our field study, carried out to understand rural entrepreneurs' decision-making approach, highlights heterogeneity in the firms' choices. Qualitative analysis indicated that five factors explain the urban and semi-urban market entry choices made by small rural firms: (i) consumer heterogeneity, (ii) product wastage, (iii) product pack-size, (iv) consumer responsiveness to product pack-size, and (v) pack-size-driven product wastage reduction. We develop an analytical model to show that the expected returns of entering the urban markets can be significant for rural firms. However, for rural firms to enter new markets, they need to upend conventional thinking regarding markets to serve, products to offer, partnerships, prices, pack-sizes, etc. Contrary to a widely observed phenomenon in developing economies where small rural firms prefer supplying their products to large firms' in urban markets, we demonstrate that the former can manage their private product brands of superior quality products and cater to consumers at the higher end of the valuation continuum. Our findings augur well for increasing the connectedness of rural, semi-urban, and urban markets.

We provide guidelines for small rural firms to enter urban markets. We show that a small firm should enter urban markets by offering a superior product *only* when consumers are significantly heterogeneous in product valuation. Furthermore, it should adopt a direct-sales (sale-through-intermediary) channel when the consumer homogeneity (heterogeneity) is relatively high (low). A small firm should supply its superior product in urban markets in the direct-sale channel using own brand when the product wastage during consumption is relatively high. On the contrary, it should supply its superior product to the large firm when the product wastage is lower.

We demonstrate that a small rural firm can enhance its superior product's competitiveness in urban markets by offering it in a smaller pack-size when the product wastage is high. The rural firm's strategy to enter urban markets by competing based on smaller product-packs is the reverse of an urban firm's strategy to enter a rural market – the strategy conceptualized by CK Prahalad in the theory of serving the bottom-of-the-pyramid. When consumer responsiveness to product pack-size (due to capacity constraints) and pack-size-driven product wastage reduction are lower, a rural firm should enter urban markets by supplying its product to the large firm. Otherwise, the rural firm should enter urban markets using its own product brand and a smaller pack-size.

1.4. Managerial Insights

The rural firms' rapid entry into urban markets is due to innovative supply chain strategies that parallel urban firms' entry strategies in rural markets. The contrasting strategies of urban firms entering rural markets and rural firms serving urban consumers are summarized in Table 1.

	Rural Firms		Urban Firms	
Market	Rural and Semi-urban	Urban	Rural and Semi-urban	Urban
Price	Medium	High	Low	Medium
Pack-size	Medium or customized	Small or customized	Small	Large
Product brand	Own brand or unbranded	Own brand or national brands	Own national brands	Own national brands
Sales channel	Direct sales	Piggy-back or direct sale	Traditional retailers	Traditional and e-retailers
Distribution	Piggy-back or direct supply	Piggy-back or direct supply	Through small vendors	Through large distributors
Marketing	Direct marketing	Direct marketing	Modern marketing	Modern marketing

Table 1 Comparison of Distribution Strategies of Rural and Urban Firms in India

In our field study, we observed that it is not that great a stretch on operations, and it is relatively more profitable for rural firms to enter urban markets. Table 1, conceptualized based on our model and field study, explains why small firms benefit from offering superior products to urban consumers. Accordingly, if we review small firms' positioning in various markets, we see a distinction in the conditions and manner in which the two types of firms choose to serve the markets. The difference based on products, product packaging, distribution channels, supply chain partners suggests different supply chain structures that partially explain why urban and rural markets are not well-connected by large firm operations even in developing economies. These distinctions are less so for small firms that are trying to serve the urban areas. We postulate that rural markets will also benefit as more and more firms start serving urban markets because the supply chains are similar for the two markets and can profitably serve both types of customers. We caution that this is a speculative claim but can be used to test the predictions from our model empirically. In demonstrating that the strategy of serving urban markets can enhance the competitiveness of small firms from rural markets and by examining the setting that could potentially yield spillover effects to rural market development as an added benefit, we enrich the evolving literature on empowering micro-entrepreneurs in developing countries (see Sodhi and Tang (2014), An et al. (2015)).

1.5. Motivation, Focus, and Approach

The gap between the sales growth rates realized by rural firms and urban firms has been widening recently. The combined sales growth rate of rural firms in the September 2018 quarter was 38 percent versus 15 percent for urban firms offering national brands. The corresponding rates in the December 2017 quarter were 19 and 11, respectively (see Ananthanarayanan (2018)). In this evolving environment, it is critical to obtain insights into growth avenues for small rural firms compared to large urban firms and growth trajectories followed by small firms from rural areas regarding distribution channel design and channel management.

We collaborated with a set of small firm managers from rural India to understand the phenomenon described above. All firms that we collaborated with face problems of choosing appropriate products to offer in different markets and choosing the suitable supply chain structures to serve urban markets. Our field study involved 33 small firms originating from rural India that supply 21 products classified into three categories – commodity (e.g., honey, groundnut, red-gram, rice, soybean), agricultural (e.g., milk, tomato, beetroot, potato), and fruits (e.g., custard apple, watermelon, pomegranate) – in packaged forms. We observe varying degrees of profitability of the firms based on diverse decision variables and the associated cost structures.

Small firms' growth trajectories typically begin with catering to rural markets due to their low-cost base, superior consumer proximity, and low real-estate challenges (see KPMG (2014)). With technological advances such as e-retailing platforms, different specialized farm-to-table settings for various products, and market liberalization such as the growth of intermediary service providers, and thus, access to niche markets, multiple avenues arise for small firms to reach urban markets. Many firms wanting to enter the urban market are drawn by the phenomenon of rapid growth, new channels, acceptance for new products, new packaging technology that is accessible to even to smallest firms, and they exhibit variety-seeking behavior. The dilemmas faced by the firms are whether to go it alone or to sell their products to national brands, which markets to target, what supply channels to adopt, what pack sizes to offer, and what price to charge. This paper aims to provide answers to these questions. We show that different decision regimes exist based on product characteristics and customer perception.

We develop an analytical model to explain the firms' choices concerning their supply chain structures, including which products, what pack-sizes, which markets, and what channels to adopt in devising their competitive strategies. The critical model parameters that we consider are (i) consumer heterogeneity, (ii) product wastage, (iii) product pack-size, (iv) consumer responsiveness to product pack-size, and (v) pack-size-driven product wastage reduction. We selected these five factors for inclusion in the model based on discussions with the firms in our field study (see Section 2). Additionally, small firms seek to identify and reach out to suitable consumers in cost-efficient ways and enhance the target consumers' product utility. We characterize the trade-offs between the variables, obtain economic insights into the interplay between these variables, propose a decision-making framework for similar firms that are high on their entrepreneurial spirits, and explore avenues to improve their profitability. We primarily focus on critically examining small firms' scope to offer superior product brands and target markets in urban areas. We also provide insights into the firms' choices for supply channels and product pack-sizes to improve their competitiveness.

1.6. Structure of the Paper

The remainder of the paper is organized as follows. In the following Section, we describe the problem context based on our examples. We also relate and position our work in the existing literature. In Section 3, we present a game-theoretic model. Section 4 presents the solution to the model and critically examines the solution to obtain managerial insights. Section 5 describes the relevance of our results to practice as demonstrated by the firms that participated in our field study. Section 6 summarizes our findings and concludes the paper. The proofs of the technical results with additional details are relegated to an online supplement.

2. Field Study and Related Literature

2.1. Observations from Field Study

The motivation for the work presented in this paper, as mentioned earlier, comes from questions raised by the managers of small firms from rural India who participated in our field study. The firms face challenges concerning channel design and channel management to supply their value-added products under three product categories – commodity, agriculture, and fruits.[1] These firms exhibit unequal profitability based on variables such as types of product, unit selling price, distribution cost, consumer access cost, consumer perception, product wastage, product pack-size, etc. While each of the variables exhibits significant variability across product categories, the relatively high (in magnitude) correlations between the firms' profits and the variables of interest highlight the importance of obtaining critical insights into trade-offs involved between these variables as they directly influence the firms' choices for channel design and channel management. Our model incorporates the variables identified in the field study. In Section 5.1, we demonstrate that these variables can capture the market entry decisions made by rural firms in our field study.

In our study, we observe diverse competitive strategies adopted by rural firms to supply products in Indian markets. These firms are regarded as (relatively) successful by the field experts that participated in our study. A firm's profitability from the superior product significantly differs depending on its target market, the sales channel adopted to reach out to consumers in the market, and the pack-size. We observe many situations that challenge popular beliefs. For instance, we note that a firm's profitability in the e-retailer channel is not necessarily more than that in the traditional retail channel. Similarly, its profitability from the product in a larger pack can be less than that in a smaller pack. A brand's profitability depends on the firm's distribution cost that involves handling, warehousing, transportation, and marketing. Clearly, there is no "one shoe" fits

[1] Table 4 in the online supplement presents an overview of diversity among the firms that participated in our field study. We also describe our approach for obtaining model parameters using real-world data from the field study.

all supply chain strategy, even though the products seem to be superficially similar! (In this regard, we describe one of the firms' profitability in Table 5 in the online supplement.)

2.2. Relevant Literature

We contribute to various streams of literature from operations and supply chain management, marketing, and economics. The supply chain literature that focuses on competing firms' profitability based on product characteristics and their distribution strategies is relevant for our work presented in this paper. The existing studies, e.g., Jingxian et al. (2017), Chung and Lee (2017), demonstrate how a firm's profitability is governed by demand-side characteristics such as product substitutability, brand awareness, product quality, consumer prejudice, etc. Other studies, e.g., Bell et al. (2014), Chopra (2016), examine the implications of firms' supply-side characteristics such as unequal cost efficiency, traditional versus online retail channels, urban versus rural markets, heterogeneous infrastructure, marketing efforts, etc. The existing studies highlight the importance of appropriately choosing supply channels and channel management to enhance a firm's competitiveness. Our paper enriches this stream of literature by combining supply- and demand-side characteristics in a game-theoretic setting to explain firms' optimal choices.

The existing literature offers multiple studies that focus on firms' single and multi-channel decisions involving traditional and online retail partners. Contrary to the expectation of reducing distribution costs and consumers' product access costs, an online retail channel alone need not reduce consumers' product access costs in developing countries on account of a variety of reasons, such as poor infrastructure, lower penetration of the Internet, lower adoption rates of technology and digital transactions, urban-rural divide, etc. (see e.g., Brynjolfsson et al. (2009), Gao and Su (2016)). Similarly, consumers' product access costs in the traditional retail channel alone need not be small as they are governed by a variety of factors such as retailer density in the consumers' neighborhood, product availability at stores, availability of information on product functioning, purchase and delivery options offered by the retailers, etc. (see, e.g., Iyer and Palsule-Desai (2019)). We examine a firm's market entry strategy based on a supply channel and the associated supply-demand characteristics. Specifically, we consider rural firms' channel design and channel management decisions considering product distribution costs and consumers' product access costs.

A stream of literature offers many studies that examine the competitiveness of small firms and their market participation strategies using *local* product labels and partnership models. For instance, store brands and consumer store loyalty (Seenivasan et al. (2016)), store versus national brands (Ru et al. (2015)), a manufacturer's channel strategy and retailers' local brand decisions (Jin et al. (2017)), distribution of sales in the Internet channel versus a traditional channel (Brynjolfsson

et al. (2011)), a low-end market and a firm's quality choice (Amaldoss and Shin (2011)), partnership models (Hu et al. (2019)), etc. These studies examine firms' problems from the perspectives of consumer choice, market structure, supply channel, product profile, competitive strategy, etc., separately. They also provide insights into alternatives for firms from urban markets exploring avenues to reach rural markets (see e.g., Prahalad (2005), Karnani (2007), Simanis (2012)). Our paper is distinct from the existing studies in multiple ways. We examine a small rural firm's strategy to enter urban markets based on its choice of the supply channel that determines the product brand and the product pack-size that impacts own profitability and the consumers' cost and utility functions. Additionally, the small firm in our model serves urban consumers at the higher-end of the valuation continuum, contrary to urban firms that tap consumers at the low-end by entering rural markets. To the best of our knowledge, the existing literature does not provide any studies that comprehensively operationalize supply- and demand-side characteristics – product wastage, pack-size, and supply channel – in a firm's market entry strategy.

Many studies, e.g., Koenigsberg et al. (2010), Jain (2012), Yonezawa and Richards (2016), Yao et al. (2020), demonstrate that product pack-size not only impacts a firm's profitability, but the firm can also adopt pack-size as a competitive tool based on the nature of the product, availability of packaging technology, consumers' product consumption practices, product handling and availability of storage facilities, shipping modes, etc. These studies mainly focus on examining the implications of a firm's pack-size decisions for consumers. In this paper, drawing upon the strategy of small rural firms in our field study, we examine the significance of a firm's pack-size choice to improve its profitability by capturing its supply- and demand-side implications; specifically, the firm's distribution cost, consumers' product access cost, and product wastage.

Our work also enriches the existing literature on market segmentation using a product line of vertically quality-differentiated products. This stream of literature addresses issues such as product (performance) quality design (e.g, Moorthy (1984)), new versus remanufactured products (e.g., Atasu et al. (2008)), national versus store brands (e.g., Alan et al. (2019)), production yield loss (Li et al. (2019)), etc. Our modeling approach is adopted from these studies to obtain insights into market entry strategies for small rural firms characterizing interrelationships between the firm's brand choice captured in the supply channel, product wastage, pack-size, firms' distribution costs, and consumers' product access costs. Interestingly, the small firm in our model participates in the market by offering a product that is superior to a competing large firm's ordinary product.

Another stream of literature relevant for our work focuses on competing firms' market entry strategies involving either a centralized or a decentralized supply channel. In their seminal work in

this area, McGuire and Staelin (1983) provide insights into firms' channel structure decisions from product substitutability. In recent years, many authors have extended this stream of literature by examining competing firms' channel design problems in a variety of settings such as closed-loop supply chains with remanufacturing (Savaskan et al. (2004)), platform versus traditional retailers (Shen et al. (2019)), divisional conflicts (Shi et al. (2020)), cause marketing (Gao (2020)), etc. We enrich the stream of literature by focusing on consumer heterogeneity, product wastage, pack-size, and market segmentation.

Our paper borrows ideas from many strands of literature from operations, marketing, and economics. It offers a relatively comprehensive model to show how supply chain factors from the supply and demand sides influence the market entry strategies of small firms.

3. Model Building

This Section develops our model by capturing the dynamics between small (or rural) and large (or urban) firms that compete on various product and supply chain dimensions discussed above.

3.1. Competing Firms and Product Characteristics

Consider a competitive market setting in which a *small* rural firm (producer, denoted by subscript p) and a *large* urban firm (buyer, denoted by subscript b) participate in the market by supplying value-added products that are imperfect substitutes in the consumers' product consideration sets. The large firm supplies in the market an *ordinary* product (denoted by subscript o) that is *standardized* in nature with *ordinary* quality characteristics. On the other hand, the small firm offers a *superior* product that is *unique* in nature with distinguishing quality characteristics, and it is targeted at consumers at the higher end of a valuation continuum. As discussed in the previous sections, the small firm faces a dilemma of entering the market by selecting one of the two alternate product sale strategies that identify the supply chain structure: (i) *Sale-Through-Intermediary (STI) Channel*: The small firm supplies its superior product to the large firm that offers the product further to consumers in the market under own brand along with its ordinary product, and thereby, expanding own product line in the existing supply chain structure. (ii) *Direct-Sale (DS) Channel*: The small firm supplies its superior product directly in the market under own brand by establishing own supply chain structures.

The competing firms distinguish their products based on various product *quality* parameters, and they are not perfect substitutes in the minds of the consumers. One of the firms in our field study, for example, that originates from a rural region supplies multiple variants of *natural* honey – e.g., flavors of guava, ginger, jujube, black plum, litchi, etc. – that are produced under

specialized agro-climatic conditions. The small firm distinctly identifies and categorizes honey based on diverse product quality defining characteristics such as production and processing techniques adopted, tastes, flavor, product perishability, medicinal utility, product viscosity, ease of handling the product, etc. Hence, we refer to the small firm's product as the *superior* product. The rural firm is referred to as a *small* firm due to its limited supply capacity on account of the firm's focus on retaining diverse product quality characteristics to maintain the uniqueness in the product offering. On the other hand, a large firm that mainly originates from urban regions typically procures the honey of either multi-flora or mustard type from *any* source and supplies it in the market. The large firm procures and supplies honey in bulk that is *ordinary* in nature, yielding a *standard* quality performance for the consumers based on any product quality parameter, and hence, the terminology *ordinary* product. The large firm attains its product sales targets by adopting various artificial production and processing techniques, such as mixing multiple types of honey, adding flavoring agents and preservatives, that essentially makes the firm's product offering *ordinary* in the minds of the consumers.

3.2. Consumer Characteristics

The consumers in the market are heterogeneous in the utility derived by purchasing[2] one pack of a product (e.g., one box) with a generic quality level $x \geq 0$ and the pack-size[3] of one unit (e.g., one cubic meter). Let $u \sim U[0, \alpha]$, $\alpha > 0$, be the *base* consumer utility parameter. Given the number of consumers in the market, the parameter α captures the degree of heterogeneity among the consumers. The higher (lower) the value of α, the higher (lower) is the consumer heterogeneity. Accordingly, let the gross (base) utility a u-type consumer derives by purchasing a pack of the product of unit pack-size and the quality level x be ux. Without loss of generality, we normalize the product quality level x to one and consider that the market size is one.

A u-type consumer's utility from each pack of the ordinary product offered by the large firm is amplified by the parameter $\theta_o > 0$, and it is equal to $\theta_o u$. Similarly, the gross utility derived from each pack of the superior product offered by the small (large) firm in the DS (STI) channel is amplified by the parameter $\theta_p\,(\theta_b) > 0$, and it is equal to $\theta_p u\,(\theta_b u)$. The consumers' utility amplification parameters θ_o, θ_p, and θ_b are governed by factors such as the firms' marketing and product branding capabilities, product packaging, etc. One may interpret that the parameters

[2] To obtain insights into product wastage and pack-size and their implications for consumer utility, we particularly distinguish the consumer activities regarding product purchase and product consumption in this paper. More specifically, consumers' product consumption quantity could be less than the quantity of the product purchased due to product wastage during consumption.

[3] More on consumer utility and the product pack-size to follow in the next Section.

are adjusted for generic quality dimensions used to vertically differentiate the firms' value-added products.

We assume that $\theta_o < \theta_b$ and $\theta_o < \theta_p$. These two assumptions reflect the fact that the small firm's product offering inherently exhibits unique quality characteristics that are *vertically* superior to the large firm's ordinary product, even though the large firm supplies the small firm's superior product in the market under its own brand in the STI channel. It may be noted that we do not make any assumptions regarding $\theta_b \lessgtr \theta_p$. In our field study, we observe that some of the small firms' products are valued more by the consumers in the DS channel than those in the STI channel, i.e., $\theta_p > \theta_b$. It captures the small firm's strategy, contrary to that of the large firm, to identify niche consumer segments to target its superior product using approaches such as door-to-door marketing, prioritized delivery of the product, customized payment terms, assured product delivery during an emergency with no additional delivery charges, etc. On the other hand, we also observe in our field study that some of the products benefit from the large firms' brand image in the STI channel, i.e., $\theta_p < \theta_b$. It would be interesting to identify situations wherein $\theta_p < \theta_b$, reflecting consumer prejudice against the small firm. Yet, the small firm prefers the DS channel to the STI channel.

3.3. Consumer Utility Amplification, and Product Pack-Size and Wastage

The gross utility a u-type consumer derives from each product pack purchased is impacted by (i) the fraction of the product pack *actually* consumed; the remainder gets wasted during consumption, and (ii) the product pack-size.

Let $\delta_t(z) = \delta[1 + k_d(1 - z)]$ be the fraction of a product pack that is *actually* consumed by a consumer when the size of each pack is $z \in [0, 1]$ unit. The remainder of the fraction, $[1 - \delta_t(z)]$, of the purchased pack is wasted (or not consumed). The consumer incurs product wastage in each pack of the product purchased due to a variety of reasons such as product perishability, viscosity, storage facilities available, ease of handling the product, packaging material used by the firm, pack-size, etc. We consider that the parameter $\delta \in [\underline{\delta}, 1]$, $\underline{\delta} > 0$, and it signifies *inherent product wastage reduction* in each product pack that depends on the product type. For instance, δ for honey is higher than milk. The higher the inherent product wastage reduction is, i.e., δ is higher, the higher the actual consumption is in each purchased pack. $\delta_t(z)$ can be interpreted likewise. To ensure the relevance of the model, i.e., $\delta_t(z) \leq 1$, we assume that $0 \leq k_d \leq \underline{k_d} = (1 - \delta)/\delta$. The parameter k_d is referred as the *pack-size-driven product wastage reduction*. The higher (lower) the level of k_d, the lower (higher) is the product wastage.

Our modeling approach to connect the product pack-size z with product wastage reduction δ_t that improves the consumption of each product pack purchased by the consumers is based on the

strategy of the (small) firms that participated in our field study. They are increasingly offering their products – such as honey, milk with high-fat content, A2 milk, specially produced fruits and vegetables (e.g., organic or processing-friendly products), pulses, spices, and agriculture crops produced with customer-specific customized farming – in relatively smaller packs. The aim is to improve material handling for the consumers, reduce product wastage, and enhance consumer valuation of products. Our approach of modeling the product wastage during consumption is similar to Koenigsberg et al. (2010).

The gross utility a u-type consumer derives by purchasing one pack of the superior product of pack-size $z \in (0, 1]$ offered by the small firm in the DS channel is amplified by $\delta_t(z)$, and it is equal to $\delta_t(z)\,\theta_p u$. The corresponding consumer utility function in the STI channel is $\delta_t(z)\,\theta_b u$. Similarly, the gross utility a u-type consumer derives by purchasing one pack of the ordinary product offered by the large firm is equal to $\delta_t(z)\,\theta_o u$.

To capture the implications of the pack-size of the superior product offered by the small firm for its competitiveness vis-à-vis the large firm's product offerings (either its own ordinary product or the superior product supplied by the small firm in the STI channel), we assume that the large firm's ordinary product is available for purchase in the market in unit pack-size, i.e., $z = 1$. Our approach of normalizing the large firm's product pack-size to one is based on the large firms' packaging decisions that are mainly governed by their *nation*-wide marketing strategies lacking localized customization in packaging, marketing, and consumer-oriented service delivery, etc. Thereby, the large firm offers the small firm's superior product in the STI channel by matching the ordinary product's unit pack-size.

When the small firm supplies its superior product under own brand in the DS channel, it chooses the product pack-size such that $z\,(0, 1]$ while responding to the customers' purchasing and consumption requirements. Due to the relatively restricted market presence on account of limited supply capacity and constrained marketing capability, the small firm adopts a more flexible product delivery approach. It offers the superior product in a relatively smaller pack-size and provides the consumers a *better* consumption experience. The small firm's smaller pack-size strategy is particularly critical when the consumers are concerned about product wastage during consumption.

It may be noted that the wastage reduction for either of the products in the STI channel, given the superior product pack-size, is never larger than that in the DS channel as $\delta \leq \delta_t(z)$. It may also be noted that the wastage reduction in the large firm's ordinary product is identical to that in the superior product of the small firm in the STI channel.[4]

[4] One may extend our model to a setting in which the wastage reduction parameters (δ) for the ordinary product and

3.4. Cost Functions

Let c_p^a be a consumer's product access cost when *she* purchases a pack of the superior product from the small firm in the DS channel. Similarly, let c_b^a be a consumer's product access cost when she purchases a pack of the product from the large firm – ordinary and/or superior product in the STI channel. The consumers' product access cost, as mentioned earlier, consists of direct and indirect costs of purchasing one pack of a product. For instance, product search cost, traveling cost, opportunity cost of payment terms offered by the firm, storage cost, material handling cost depending on the firm's product packaging choice, etc., constitute the consumers' product access cost. We assume that the consumers' product access costs are constant and firm-specific.

Let c_p^d and c_b^d be the small and large firms' constant marginal costs, respectively, to distribute each product pack in the market. Since the large firm adopts identical approaches for marketing, branding, and distribution of the ordinary product and the superior product of the small firm in the STI channel, the consumers' product access cost at the large firm and the firm's product distribution costs do not depend on the type of the product.[5]

Let c_q be the constant marginal cost the small firm incurs in producing the superior product in the DS channel. The small firm's (constant) marginal cost of producing and supplying the superior product to the large firm in the STI channel is $k_q c_q$. Here, $k_q > 0$ is the scale parameter that reflects the small firm's production and supply costs in the STI channel being distinct from those in the DS channel due to various production and logistical specifications enforced by the large firm in the former setting. Likewise, $k_q < (>) 1$ implies that the large firm's production and logistical requirements are less (more) stringent than the small firm's own requirements. For instance, in our motivating example, when the large firms procure honey from small firms, they ensure that the small firms adopt mechanized systems for honey extraction, collection, processing, and preservation to align with its existing process-quality certification norms. It may be noted that our terminology for the small firm's production and supply costs do not correspond to the packaging cost that we model separately. To keep our focus on examining the small firm's decisions regarding packaging and supply chain design for its superior product, we normalize the large firm's production (or procurement) costs for the ordinary product to zero. Similarly, we ignore the fixed costs of production for the competing firms.

the superior product in the STI channel are unequal. In our separate analysis (not presented here for brevity), we consider distinct product wastage reduction parameters for the two products and observe that the qualitative results discussed in this paper remain valid.

[5] In the online supplement, motivated by the firms in our field study, we extend our model and present the results by considering the small firm's superior product distribution cost c_p^d is a function of the product pack-size.

Let $c_z z^2$, $c_z > 0$, be a firm's marginal cost of creating product packs of size $z \in (0, 1]$. The convex increasing marginal cost function with respect to pack-size signifies diminishing marginal returns in the pack-size. The small firm's aggregate packaging cost for the superior product in the DS channel is $c_z z^2 q_p$, where q_p is the firm's supply quantity in the market. Similarly, $c_z q_b$ is the large firm's aggregate packaging cost for the superior product in the STI channel. Here, q_b is the quantity of the superior product the small firm supplies to the large firm. The large firm's aggregate packaging cost for the ordinary product is $c_z q_o$, where q_o is the quantity of the ordinary product supplied in the market. We explicitly associate the product packaging cost to a firm that supplies the product to the consumers in the market.[6]

We consider that w is the wholesale price per pack of the superior product the small firm charges to the large firm in the STI channel.

3.5. Demand Functions, Firms' Profits, and Product Wastage

Without loss of generality, we assume that a u-type consumer's consumption requirement of a product in each period is one unit. Given the product wastage during consumption, the consumer purchases $1/[z\delta_t(z)]$ packs of the superior product of the small firm in each period when the firm adopts the DS channel. Otherwise, the consumer purchases $1/\delta$ packs of either the ordinary product of the large firm or the superior product of the small firm when the latter adopts the STI channel.

To respond to the access costs, the consumers purchase multiple packs of a product at each purchasing instance in a period. Without loss of generality, we consider that the storage space available with a consumer is one unit corresponding to her consumption requirement in each period. Let $n_t(z) = 1 + k_n(1 - z)$ be the number of packs of a product a consumer purchases at any purchasing instance. The parameter $k_n \geq 0$, referred to as *consumer responsiveness to pack-size*, captures the consumers' sensitivity to logistical constraints such as storage and material handling of small v/s large packs, availability of storage space, etc. Since the large firm's ordinary product and the superior product in the STI channel are unit pack-size, a customer purchases one pack of a product at each purchasing instance during the period.

To meet her product consumption requirement in each period, a consumer's product purchasing frequency, that has immediate implications for the product access cost, for the superior product in the small firm's DS channel is $1/[z\delta_t(z)\, n_t(z)]$. The frequency for the large firm's ordinary product and that for the superior product in the small firm's STI channel is $1/\delta$.

[6] Our qualitative results presented in this paper would not change if one were to associate packaging costs to the firms that produce the product.

Let p_p be the retail price the small firm announces for each pack of the superior product in the DS channel. Let p_b be the large firm's retail price for each pack of the superior product when the small firm adopts the STI channel. Similarly, let p_o be the price the large firm announces for each pack of the ordinary product.

In what follows, we describe the firms' problems in the STI and DS channels of the small firm by appropriately deriving product demand functions separately. (For the ease of exposition, we use superscripts I and D to describe variables in the STI channel and the DS channel, respectively, wherever it is necessary. Also, for notational simplicity, we drop the reference to (z) from variables, e.g., $\delta_t(z)$, $n_t(z)$, wherever it is evident from the context.)

3.5.1. Sale-Through-Intermediary (STI) Channel

The sequence of events in the STI channel adopted by the small firm is as follows: (i) the small firm announces the unit wholesale price for the superior product to be supplied to the large firm, (ii) the large firm responds by announcing the retail prices for the superior and ordinary products, (iii) the consumers observe the retail product prices and adopt at most one of the products during a consumption period, and (iv) production and demand are realized.

A u-type consumer derives the net utility from the superior product, denoted by N_p^I, equal to the difference between the gross utility derived from the product and the aggregate product purchase cost consisting of the product retail price and the product access cost, i.e., $(p_b + c_b^a/n_t)/(z\delta_t)$. Recall that $n_t(z=1)=1$ and $\delta_t(z=1)=\delta$. Thereby, $N_p^I = \delta\theta_b u - (p_b + c_b^a)/\delta$. Similarly, a u-type consumer derives the net utility from the ordinary product, denoted by N_o^I, that is described as $N_o^I = \delta\theta_o u - (p_o + c_b^a)/\delta$.

A u-type consumer meets her consumption requirements from the superior product *iff* $N_p^I > N_o^I$ and $N_p^I > 0$, i.e., when $u > \underline{u_p^I} = (p_b - p_o)/[\delta^2(\theta_b - \theta_o)]$. On the contrary, a u-type consumer meets her consumption requirements from the ordinary product *iff* $N_o^I > N_p^I$ and $N_o^I > 0$, i.e., when $u > \underline{u_o^I} = (p_o + c_b^a)/(\delta^2\theta_o)$ and $u < \underline{u_p^I}$. A consumer with $u = \underline{u_p^I}$ is indifferent between the two products as long as $\underline{u_o^I} \leq \underline{u_p^I}$. Similarly, the consumer with $u = \underline{u_o^I}$ is indifferent between adopting the ordinary product and not opting for the product.

Demand rates: The fraction of the consumers in the market that adopt the superior product in each period is described as $q_p^I = \left(\alpha - \underline{u_p^I}\right)/\alpha = [p_o - p_b + \alpha\delta^2(\theta_b - \theta_o)]/[\alpha\delta^2(\theta_b - \theta_o)]$. Similarly, the fraction of the consumers in the market that adopt the ordinary product in each period is described as $q_o^I = \left(\underline{u_p^I} - \underline{u_o^I}\right)/\alpha = [\theta_o p_b - \theta_b p_o - (\theta_b - \theta_o)c_b^a]/[\alpha\delta^2\theta_o(\theta_b - \theta_o)]$.

Product wastage: Considering the demand for the superior product and the product wastage rate, the quantity of the superior product wasted in each period is given by $g_p^I = (1-\delta)q_p^I/\delta$.

Similarly, the quantity of the ordinary product wasted in each period is given by $g_o^I = (1-\delta)\, q_o^I/\delta$. Here, q_p^I and q_o^I are the supply quantities described above.

Firms' problems: The competing firms in our motivating example are profit-maximizing players. The small firm's expected profit, π_p^I, and that for the large firm, π_b^I, are described as follows:

$$\pi_p^I(w; p_o, p_b) = (w - c_q)\left[\frac{p_o - p_b + \alpha\delta^2(\theta_b - \theta_o)}{\alpha\delta^2(\theta_b - \theta_o)}\right] \tag{1}$$

$$\pi_b^I(p_o, p_b; w) = \left(p_o - c_b^d - c_z\right)\left[\frac{\theta_o p_b - \theta_b p_o - (\theta_b - \theta_o)\, c_b^a}{\alpha\delta^2\theta_o(\theta_b - \theta_o)}\right] + \left(p_b - c_b^d - c_z - w\right)\left[\frac{p_o - p_b + \alpha\delta^2(\theta_b - \theta_o)}{\alpha\delta^2(\theta_b - \theta_o)}\right] \tag{2}$$

Accordingly, the large firm's problem is described as follows: $P_b^I : \pi_b^{I*}(w) = \max_{p_o, p_b \geq 0} \pi_b^I(p_o, p_b; w)$ s.t. $0 \leq \underline{u_o^I} \leq \underline{u_p^I} \leq \alpha$. Similarly, the small firm's problem is described as follows: $P_p^I : \pi_p^{I*} = \max_{w \geq 0} \pi_p^I(p_o^*(w), p_b^*(w), w)$ s.t. $\underline{u_p^I} \leq \alpha$. Here, $p_o^*(w)$ and $p_b^*(w)$ is the optimal solution to the large firm's problem P_b^I.

3.5.2. Direct-Sale (DS) Channel

The modeling approach in this Section parallels that in the previous section. The sequence of events in the DS channel adopted by the small firm is as follows: (i) the small firm announces the pack-size for the superior product to be supplied in the market, (ii) the small and large firms simultaneously announce the retail prices for the superior and ordinary products, respectively, (iii) the consumers observe the retail product prices and adopt at most one of the products in a consumption period, and (iv) production and demand are realized.

A u-type consumer derives the net utility by consuming the superior product of the pack-size z in each period is given by $N_p^D = \delta_t\theta_p u - \left(p_p + c_p^a/n_t\right)/(z\delta_t)$. Similarly, a u-type consumer derives the net utility by consuming the large firm's ordinary product in each period is given by $N_o^D = \delta\theta_o u - (p_o + c_b^a)/\delta$.

A u-type consumer meets her consumption requirements from the superior product *iff* $N_p^D > N_o^D$ and $N_p^D > 0$, i.e., when $u > \underline{u_p^D} = \left[\delta\left(n_t p_p + c_p^a\right) - z n_t \delta_t (p_o + c_b^a)\right] / \left[z n_t \delta_t \delta (\delta_t\theta_p - \delta\theta_o)\right]$. On the contrary, a u-type consumer meets her consumption requirements from the ordinary product *iff* $N_o^D > N_p^D$ and $N_o^D > 0$, i.e., when $u > \underline{u_o^D} = (p_o + c_b^a)/(\delta^2\theta_o)$ and $u < \underline{u_p^D}$. A consumer with $u = \underline{u_p^D}$ is indifferent between the two products as long as $\underline{u_o^D} \leq \underline{u_p^D}$. Similarly, the consumer with $u = \underline{u_o^D}$ is indifferent between adopting the ordinary product and not opting the product.

Demand rates: The fraction of the consumers in the market that adopt the superior product in each period is described as $q_p^D = \left(\alpha - \underline{u_p^D}\right)/\alpha = \left[-\delta\left(n_t p_p + c_p^a\right) + z n_t \delta_t (p_o + c_b^a) + \alpha z n_t \delta_t \delta (\delta_t\theta_p - \delta\theta_o)\right] / \left[\alpha z n_t \delta_t \delta (\delta_t\theta_p - \delta\theta_o)\right]$. Similarly, the fraction of the consumers in the market that

adopt the ordinary products in each period is described as $q_o^D = \left(\underline{u_p^D} - \underline{u_o^D}\right)/\alpha = \left[\delta^2\theta_o\left(n_t p_p + c_p^a\right) - z n_t \delta_t^2 \theta_p \left(p_o + c_b^a\right)\right] / \left[\alpha z n_t \delta_t \delta^2 \theta_o \left(\delta_t \theta_p - \delta\theta_o\right)\right]$.

Product wastage: Considering the demand for the superior product and the product wastage rate, the quantity of the superior product wasted in each period is given by $g_p^D = (1-\delta_t)\, q_p^D / (z\delta_t)$. Similarly, the quantity of the ordinary product wasted in each period is given by $g_o^D = (1-\delta)\, q_o^D/\delta$. Here, q_p^D and q_o^D are the supply quantities described above.

Firms' problems: The small firm's expected profit, π_p^D, and that for the large firm, π_b^D, are described as follows:

$$\pi_p^D\left(p_p, z; p_o\right) = \left(p_p - c_p^d - c_q - c_z z^2\right)\left[\frac{-\delta\left(n_t p_p + c_p^a\right) + z n_t \delta_t \left(p_o + c_b^a\right) + \alpha z n_t \delta_t \delta \left(\delta_t \theta_p - \delta\theta_o\right)}{\alpha z n_t \delta_t \delta \left(\delta_t \theta_p - \delta\theta_o\right)}\right] \tag{3}$$

$$\pi_b^D\left(p_o; p_p, z\right) = \left(p_o - c_b^d - c_z\right)\left[\frac{\delta^2\theta_o\left(n_t p_p + c_p^a\right) - z n_t \delta_t^2 \theta_p \left(p_o + c_b^a\right)}{\alpha z n_t \delta_t \delta^2 \theta_o \left(\delta_t \theta_p - \delta\theta_o\right)}\right] \tag{4}$$

The small firm's problem is described as follows: $p_p^D : \pi_p^{D*}\left(p_o\right) = \max_{p_p \geq 0, z \in (0,1]} \pi_p^D\left(p_p, z; p_o\right)$ s.t. $\underline{u_o^D} \leq \underline{u_p^D} \leq \alpha$. Similarly, the large firm's problem is described as follows: $P_b^D : \pi_b^{D*}\left(p_p, z\right) = \max_{p_o \geq 0} \pi_b^D\left(p_o; p_p, z\right)$ s.t. $0 \leq \underline{u_o^D} \leq \underline{u_p^D}$.

We also evaluate consumer surplus and social welfare to analyze the implications of the firms' competitiveness in the STI and DS channels (see the online supplement for further details).

4. Model Analysis

4.1. Sale-Through-Intermediary (STI) Channel

We obtain the equilibrium solution to the competing firms' problems using a backward induction-based approach. In particular, we solve the large firm's problem P_b^I and obtain the equilibrium retail prices for the superior and ordinary products for a given wholesale price. We substitute the equilibrium solution in the small firm's problem, p_p^I, to determine its profit-maximizing wholesale price. Proposition 1 completely describes the (Nash) equilibrium solution for the game between the competing firms in the STI channel.

PROPOSITION 1. *Define bounds for the parameter α in the STI channel as follows:* $\check{\alpha}_b^I = \left(c_b^a + c_b^d + c_z + k_q c_q\right)/\left(\delta^2\theta_b\right)$, $\check{\alpha}_o^I = \left(c_b^a + c_b^d + c_z\right)/\left(\delta^2\theta_o\right)$, $\overline{\alpha_b^I} = k_q c_q / \left[\delta^2\left(\theta_b - \theta_o\right)\right]$, $\overline{\alpha_o^I} = \left[2\left(\theta_b - \theta_o\right)\left(c_b^a + c_b^d + c_z\right) - \theta_o k_q c_q\right] / \left[\delta^2\theta_o\left(\theta_b - \theta_o\right)\right]$, *and* $\underline{\alpha_b^I} = \left[\left(2\theta_b - \theta_o\right)\left(c_b^a + c_b^d + c_z\right) - \theta_o k_q c_q\right] / \left[\delta^2\theta_o\theta_b\right]$.

Also, let $\overline{c_q^I} = \left(\theta_b - \theta_o\right)\left(c_b^a + c_b^d + c_z\right)/\left(\theta_o k_q\right)$.

(i) If $\alpha > \max\left\{\overline{\alpha_b^I}, \overline{\alpha_o^I}\right\}$, *then the unique (Nash) equilibrium specifying the wholesale price for the superior product, and the retails prices and demands for the superior and ordinary products is described (using notation* $\hat{(\cdot)}$*) as follows:*

$$\hat{w}^I = \frac{\alpha\delta^2\left(\theta_b - \theta_o\right) + k_q c_q}{2} \tag{5}$$

$$\hat{p}_b^I = \frac{\alpha\delta^2\left(3\theta_b - \theta_o\right) - 2\left(c_b^a - c_b^d - c_z\right) + k_q c_q}{4}, \qquad \hat{p}_o^I = \frac{\alpha\delta^2\theta_o - c_b^a + c_b^d + c_z}{2} \tag{6}$$

$$\hat{q}_b^I = \frac{\alpha\delta^2\left(\theta_b - \theta_o\right) - k_q c_q}{4\alpha\delta^2\left(\theta_b - \theta_o\right)}, \qquad \hat{q}_o^I = \frac{\left[\alpha\delta^2\theta_o - 2\left(c_b^a + c_b^d + c_z\right)\right]\left(\theta_b - \theta_o\right) + \theta_o k_q c_q}{4\alpha\delta^2\theta_o\left(\theta_b - \theta_o\right)} \tag{7}$$

(ii) If $c_q < \overline{c_q^I}$ *and* $\alpha \leq \overline{\alpha_o^I}$*, then the unique (Nash) equilibrium solution (described using notation* $\check{(\cdot)}$*) is such that* $\check{q}_b^I = 0$ *and*

$$\check{w}^I = \begin{cases} \dfrac{\alpha\delta^2\theta_b - c_b^a - c_b^d - c_z + k_q c_q}{2} & \text{if} \quad \alpha \in \left[\check{\alpha}_b^I, \underline{\alpha_b^I}\right] \\ \dfrac{\left(\theta_b - \theta_o\right)\left(c_b^a + c_b^d + c_z\right)}{\theta_o} & \text{if} \quad \alpha \in \left(\underline{\alpha_b^I}, \overline{\alpha_o^I}\right] \end{cases} \tag{8}$$

$$\check{p}_b^I = \begin{cases} \dfrac{3\alpha\delta^2\theta_b - 3c_b^a + c_b^d + c_z + k_q c_q}{4} & \text{if} \quad \alpha \in \left[\check{\alpha}_b^I, \underline{\alpha_b^I}\right] \\ \dfrac{\alpha\delta^2\theta_o\theta_b + \left(\theta_b - 2\theta_o\right)c_b^a + \theta_b c_b^d + \theta_b c_z}{2\theta_o} & \text{if} \quad \alpha \in \left(\underline{\alpha_b^I}, \overline{\alpha_o^I}\right] \end{cases} \tag{9}$$

$$\check{q}_b^I = \begin{cases} \dfrac{\alpha\delta^2\theta_b - c_b^a - c_b^d - c_z - k_q c_q}{4\alpha\delta^2\theta_b} & \text{if} \quad \alpha \in \left[\check{\alpha}_b^I, \underline{\alpha_b^I}\right] \\ \dfrac{\alpha\delta^2\theta_o - c_b^a - c_b^d - c_z}{2\alpha\delta^2\theta_o} & \text{if} \quad \alpha \in \left(\underline{\alpha_b^I}, \overline{\alpha_o^I}\right] \end{cases} \tag{10}$$

(iii) If $c_q \geq \overline{c_q^I}$ *and* $\alpha \in \left[\check{\alpha}_o^I, \overline{\alpha_b^I}\right]$*, then the unique (Nash) equilibrium solution (described using notation* $\check{(\cdot)}$*) is such that* $\check{q}_b^I = 0$ *and*

$$\check{p}_o^I = \frac{\alpha\delta^2\theta_o - c_b^a + c_b^d + c_z}{2}, \qquad \check{q}_o^I = \frac{\alpha\delta^2\theta_o - c_b^a - c_b^d - c_z}{2\alpha\delta^2\theta_o} \tag{11}$$

Proposition 1 presents structural results describing the equilibrium solution to the competing firms' problems when the small firm adopts the STI strategy. It shows that the competing firms' equilibrium (retail and wholesale) prices and demands for the superior and ordinary products are governed by threshold levels of the consumer heterogeneity parameter α and the small firm's marginal cost for the superior product c_q. More specifically, the demand for the superior and ordinary products is positive *only* when the consumers in the market are significantly heterogeneous in their product valuation, i.e., $\alpha > \max\left\{\overline{\alpha_o^I}, \overline{\alpha_b^I}\right\}$. Otherwise, either the superior product dominates the ordinary product in the consumers' product preference set or vice versa. When the superior product's marginal cost c_q is relatively small, and below the threshold $\overline{c_q^I}$, the small firm can appropriately choose the wholesale price for the superior product to be supplied to the large firm so that the ordinary product can be driven out of the market. On the other hand, when the superior product's marginal cost c_q is beyond the threshold $\overline{c_q^I}$, the competitiveness of the superior product against the ordinary product is too low that drives the former out of the market, unless the consumers are sufficiently heterogeneous in the product valuation, i.e., $\alpha > \overline{\alpha_b^I}$.

4.2. Direct-Sale (DS) Channel: Exogenously Given Superior Product Pack-Size

The analysis approach in the DS channel parallels that in the STI channel. Using a backward induction-based solution approach, we solve the large firm's problem P_b^D and the small firm's problem p_p^D to obtain the superior and ordinary products' equilibrium retail prices for given pack-size z of the small firm's superior product. We substitute the equilibrium solution in the small firm's problem, p_p^D, to determine its profit-maximizing pack-size for the superior product.

For the ease of exposition, we present in Proposition 2 the (Nash) equilibrium solution to the pricing game between the firms by parameterizing the superior product pack-size.

PROPOSITION 2. *Consider the superior product pack-size $z \in (0,1]$. Define bounds for the parameter α in the DS channel as follows:* $\breve{\alpha}_p^D = \left(c_p^a + n_t c_p^d + n_t c_q + z^2 n_t c_z\right) / \left(z n_t \delta_t^2 \theta_p\right)$, $\breve{\alpha}_o^D = \left(c_b^a + c_b^d + c_z\right) / \left(\delta^2 \theta_o\right)$, $\overline{\alpha_p^D} = \{-z n_t \delta_t^2 \theta_p c_b^a - z n_t \delta_t^2 \theta_p c_b^d + \delta\left(2\delta_t\theta_p - \delta\theta_o\right) c_p^a + n_t \delta\left(2\delta_t\theta_p - \delta\theta_o\right) c_p^d + n_t \delta\left(2\delta_t\theta_p - \delta\theta_o\right) c_q - z n_t\left(z\delta^2\theta_o - 2z\delta_t\delta\theta_p + \delta_t^2\theta_p\right) c_z\} / \{2 z n_t \delta_t^2 \delta\theta_p\left(\delta_t\theta_p - \delta\theta_o\right)\}$,
$\overline{\alpha_o^D} = \{z n_t \delta_t\left(2\delta_t\theta_p - \delta\theta_o\right) c_b^a + z n_t \delta_t\left(2\delta_t\theta_p - \delta\theta_o\right) c_b^d - \delta^2\theta_o c_p^a - n_t\delta^2\theta_o c_p^d - n_t\delta^2\theta_o c_q - z n_t \delta\theta_o\left(\delta_t + z\delta\right) c_z\} / \{z n_t \delta_t \delta^2 \theta_o\left(\delta_t\theta_p - \delta\theta_o\right)\}$, *and* $\underline{\alpha_p^D} = \left(c_p^a + n_t c_p^d + n_t c_q + z^2 n_t c_z\right) / \left(z n_t \delta_t^2 \theta_p\right)$.

Also, let $\overline{c_q^D} = \left[z n_t \delta_t^2 \theta_p\left(c_b^a + c_b^d\right) - \delta^2\theta_o\left(c_p^a + n_t c_b^d\right) - z n_t\left(\delta_t^2\theta_p - z\delta^2\theta_o\right) c_z\right] / \left(n_t \delta^2 \theta_o\right)$.

(i) If $\alpha > \max\left\{\overline{\alpha_p^D}, \overline{\alpha_o^D}\right\}$, *then the unique (Nash) equilibrium specifying the retails prices and demands for the superior and ordinary products is described (using notation* $\hat{(\cdot)}$*) as follows:*

$$\hat{p}_p^D(z) = -\{-2\alpha z n_t \delta_t^2 \delta\theta_p\left(\delta_t\theta_p - \delta\theta_o\right) - z n_t \delta_t^2 \theta_p c_b^a - z n_t \delta_t^2 \theta_p c_b^d + \delta\left(2\delta_t\theta_p - \delta\theta_o\right) c_p^a - 2 n_t \delta_t \delta\theta_p c_p^d - 2 n_t \delta_t \delta\theta_p c_q - z n_t \delta_t \theta_p\left(2z\delta + \delta_t\right) c_z\} \times \{n_t \delta\left(4\delta_t\theta_p - \delta\theta_o\right)\}^{-1} \tag{12}$$

$$\hat{p}_o^D(z) = -\{-\alpha z n_t \delta_t \delta^2 \theta_o\left(\delta_t\theta_p - \delta\theta_o\right) + z n_t \delta_t\left(2\delta_t\theta_p - \delta\theta_o\right) c_b^a - 2 z n_t \delta_t^2 \theta_p c_b^d - \delta^2\theta_o\left(c_p^a + n_t c_p^d + n_t c_q\right) - \left(z^2 n_t \delta^2 \theta_o + 2 z n_t \delta_t^2 \theta_p\right) c_z\} \times \{z n_t \delta_t\left(4\delta_t\theta_p - \delta\theta_o\right)\}^{-1} \tag{13}$$

$$\hat{q}_p^D(z) = -\{-2\alpha z n_t \delta_t^2 \delta\theta_p\left(\delta_t\theta_p - \delta\theta_o\right) - z n_t \delta_t^2 \theta_p c_b^a - z n_t \delta_t^2 \theta_p c_b^d + \delta\left(2\delta_t\theta_p - \delta\theta_o\right)\left(c_p^a + n_t c_p^d + n_t c_q\right) - z n_t\left(z\delta^2\theta_o - 2z\delta_t\delta\theta_p + \delta_t^2\theta_p\right) c_z\} \{\alpha z n_t \delta_t \delta\left(4\delta_t\theta_p - \delta\theta_o\right)\left(\delta_t\theta_p - \delta\theta_o\right)\}^{-1} \tag{14}$$

$$\hat{q}_o^D(z) = -\theta_p\{-\alpha z n_t \delta_t \delta^2 \theta_o\left(\delta_t\theta_p - \delta\theta_o\right) + z n_t \delta_t\left(2\delta_t\theta_p - \delta\theta_o\right) c_b^a + z n_t \delta_t\left(2\delta_t\theta_p - \delta\theta_o\right) c_b^d - \delta^2\theta_o c_p^a - n_t\delta^2\theta_o c_p^d - n_t\delta^2\theta_o c_q - z n_t \delta\theta_o\left(\delta_t + z\delta\right) c_z\} \{\alpha z n_t \delta^2 \theta_o\left(4\delta_t\theta_p - \delta\theta_o\right)\left(\delta_t\theta_p - \delta\theta_o\right)\}^{-1} \tag{15}$$

(ii) If $c_q < \overline{c_q^D}$ *and* $\alpha \in \left[\breve{\alpha}_p^D, \overline{\alpha_o^D}\right]$, *then the unique (Nash) equilibrium solution (described using notation* $\breve{(\cdot)}$*) is such that* $\breve{q}_o^D = 0$ *and*

$$\breve{p}_p^D(z) = \frac{\alpha z n_t \delta_t^2 \theta_p - c_p^a + n_t\left(c_p^d + c_q + z^2 c_z\right)}{2 n_t}, \qquad \breve{q}_p^D(z) = \frac{\alpha z n_t \delta_t^2 \theta_p - c_p^a - n_t\left(c_p^d + c_q + z^2 c_z\right)}{2\alpha z n_t \delta_t^2 \theta_p} \tag{16}$$

(iii) If $c_q \geq \overline{c_q^D}$ *and* $\alpha \in \left[\breve{\alpha}_o^D, \overline{\alpha_p^D}\right]$, *then the unique (Nash) equilibrium solution (described using notation* $\breve{(\cdot)}$*) is such that* $\breve{q}_p^D = 0$ *and*

$$\breve{p}_o^I = \frac{\alpha\delta^2\theta_o - c_b^a + c_b^d + c_z}{2}, \qquad \breve{q}_o^I = \frac{\alpha\delta^2\theta_o - c_b^a - c_b^d - c_z}{2\alpha\delta^2\theta_o} \tag{17}$$

Proposition 2 presents structural results describing the equilibrium solution to the competing firms' problems for given pack-size z of the superior product when the small firm adopts the DS strategy. The structure of the equilibrium solution is similar to that in the STI channel. It suggests that thresholds for the consumer heterogeneity parameter α and the marginal cost of the superior product c_q determine whether the superior and/or ordinary products realize positive demands.

(See Lemmas 2 and 3 in the online supplement.) Further analysis of the equilibrium solutions in the STI and DS channel shows that the necessary consumer heterogeneity, as described in Propositions 1 and 2, to ensure that the supply of the ordinary product and/or the superior product in the STI channel is economical decreases in increasing inherent product wastage reduction during consumption. It implies that the competing firms' competitiveness is higher (lower) in a relatively homogeneous market, provided the product wastage is lower (higher).

4.3. Direct-Sale (DS) Channel: Endogenously Determined Superior Product Pack-Size

To relate with our motivating examples and without loss of generality, in the remainder of the paper we consider that $c_q < \overline{c_q^I}$ and $\alpha > \overline{\alpha_o^I}$. It implies that the large firm supplies its ordinary product in the market in addition to the small firm's superior product when the small firm adopts the STI channel to enter the market.

It will be evident later in the section that the small firm's choice of the pack-size of the superior product in the DS channel depends on whether the large firm's ordinary product co-exists in the market in equilibrium. The small firm's choice of the superior product pack-size is analogous to a competing firm's product quality choice in a (duopoly) competitive setting that suggests a firm should position its product *far away* from the competitor on a (vertical) quality differentiation scale (see Moorthy (1988) for the seminal work, and, e.g., Yayla-Kullu et al. (2020) for an application). In view of the results presented in Proposition 2, we obtain the equilibrium pack-size in the DS channel by considering two scenarios distinctly: (i) D_{so}: when the small firm's superior product and the large firm's ordinary product co-exist in the market, and (ii) D_s: when the small firm's superior product dominates the large firm's ordinary product in the consumers' product consideration set. (The small firm's market entry strategy in the STI channel is designated using the notation I_{so}.)

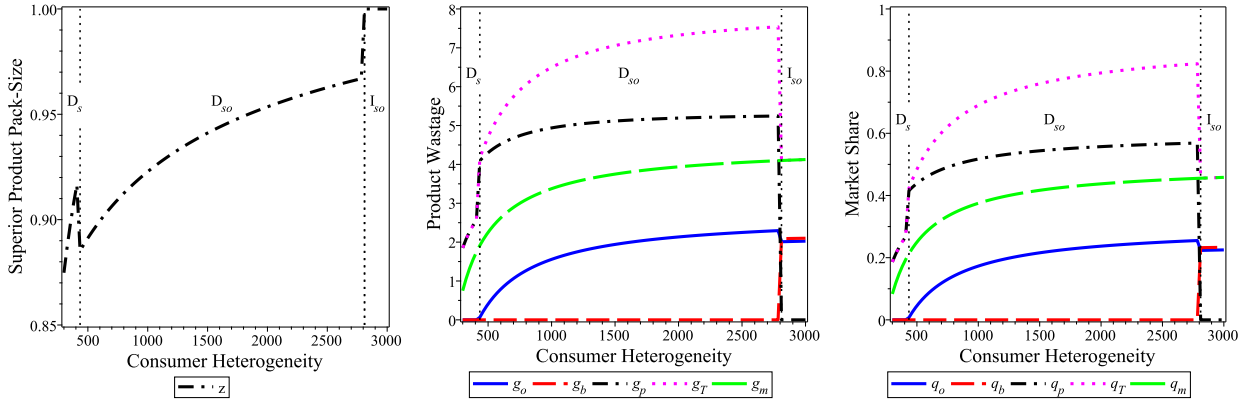
It is quite complex to determine the small firm's choice of the superior product pack-size in the DS channel using the equilibrium solution described in Propositions 2. To obtain insights into the small firm's market entry strategy using the equilibrium solutions described in Propositions 1 and 2 is intractable analytically. We solve the small firm's problem computationally to obtain relevant insights. (Refer to the online supplement for further details on the computational approach.)

4.4. Small Firm's Superior Product Pack-Size and Market Entry Strategy

We present our significant results in Figures 1-6 in the main paper and the online supplement. It is interesting to note that the small firm adopts the DS strategy even when $\theta_b > \theta_p$, and similarly, the STI channel even when $k_q > 1$ and the equilibrium strategy is Pareto optimal.

4.4.1. Implications of Consumer Heterogeneity

Figure 1 highlights the implications for the equilibrium solution in the DS channel and the small firm's market entry strategy from three perspectives: (i) the consumer heterogeneity parameter α, (ii) whether the superior and ordinary products co-exist in the market in the DS channel, and (iii) the small firm's choice of the STI channel versus the DS channel to enter the urban market.



Note: $\theta_o = 1, \theta_b = 2.5, \theta_p = 1.5, \delta = 0.1, k_n = 10, k_d = 0.25, k_q = 2, c_b^d = 1, c_p^d = 0.25, c_b^a = 0.5, c_p^a = 0.25, c_q = 1.5, c_z = 1.$

Figure 1 Small Firm's Competitive Strategies: Implications of Consumer Heterogeneity

Figure 1*a* shows that the small firm's superior product pack-size (weakly) increases in the consumer heterogeneity parameter α, given that the large firm's ordinary product either does not co-exist with the small firm's superior product in the market (D_s) or both products co-exist in the market (D_{so}). Below a certain threshold for α, say $\tilde{\alpha_1}$, the superior product pack-size relative to that of the ordinary product is sufficiently small to enhance the competitiveness of the superior product when the consumer valuation is lower. Thereby, the ordinary product does not co-exist in the market. Beyond the threshold $\tilde{\alpha_1}$, the competitiveness of the ordinary product is higher as the consumer valuation increases, ensuring that both products co-exist in the market.

The implications for the small firm's pack-size decisions are interesting to note in the neighborhood of the threshold $\tilde{\alpha_1}$. When the equilibrium solution corresponds to D_{so}, the small firm responds by reducing the superior product pack-size compared to that in D_s. A smaller pack-size

improves the small firm's competitiveness as the consumer product valuation increases when the large firm's ordinary product is competitive enough to co-exist in the market.

Figure 1*a* also shows that there exists another threshold for the consumer heterogeneity parameter, say $\tilde{\alpha}_2 \geq \tilde{\alpha}_1$, beyond (below) which the small firm adopts the STI (DS) channel to enter the market, i.e., I_{so} (D_s and D_{so}). In the STI channel, the superior product pack-size matches the ordinary product pack-size. When consumer heterogeneity and the consumers' willingness-to-pay for the products are sufficiently large, the superior product's competitiveness based on a smaller pack-size is not sufficient for the small firm to adopt the DS channel. Additionally, the large firm's wholesale price offer is also higher (not shown here for brevity), making the STI channel profitable for the small firm. These findings essentially highlight the small firm's competitive strategy based on its superior product pack-size choice.

Figure 1*b* shows that the wastage for both superior and ordinary products increases with consumer heterogeneity in the DS channel. The total wastage of the products, $g_T = g_o + g_p$, is even higher than that in the large firm's monopoly setting of the ordinary product, g_m (see the online supplement for further details). Increasing product wastage in the DS channel can be attributed to increasing pack-size of the superior product (Figure 1*a*) and increasing market shares of the products (Figure 1*c*) with the consumer heterogeneity. However, when the small firm adopts the STI channel, the product wastage reduces from that in the DS channel. In the STI channel, the total wastage, $g_T = g_o + g_b$, of the competing products is equal to that in the large firm's monopoly setting, g_m. This is due to the identical (unit) pack-sizes and the total market shares for the superior and ordinary products in the two settings (see Figures 1*a* and 1*c*).

The higher the consumer heterogeneity, the higher are the (retail) prices of the competing products (not shown here for brevity). Higher α signifies that the utility derived by the consumers and their willingness-to-pay for either of the products are higher. It not only does increase the market shares for the products (Figure 1*c*), but it also allows the firms to extract more consumer surplus by charging higher prices for the products. The implications for the equilibrium prices and market shares can be attributed to the large firm being the monopoly supplier of both products in the STI channel versus the duopoly competition in the DS channel.

(See Figure 3 in the supplement.) We observe that the firms' profitability, consumer surplus, and social welfare all increase as the consumer heterogeneity increases. While the large firm's profitability decreases in the DS channel, its profitability increases in the STI channel from that in the monopoly setting, implying Pareto optimality. The consumer surplus and social welfare decrease in the STI channel from that in the DS channel. The implications for the firms' profitability,

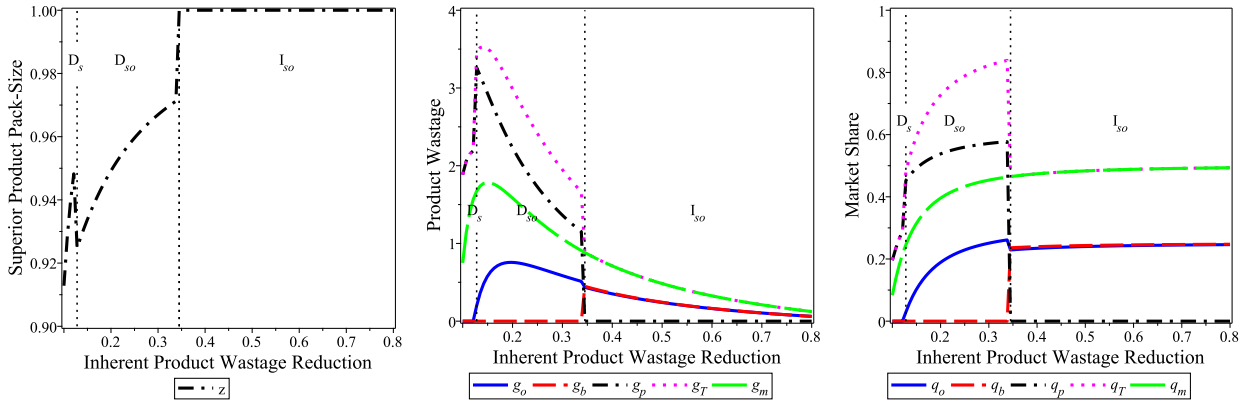
consumer surplus, and social welfare are attributed to the competitiveness of the superior product vis-à-vis the ordinary product in the STI channel versus that in the DS channel described above.

RESULT 1. *The threshold for the consumer heterogeneity parameter $\tilde{\alpha_2}$ beyond (below) which the small firm adopts the STI (DS) channel is such that $\partial\tilde{\alpha_2}/\partial\delta < 0$, $\partial\tilde{\alpha_2}/\partial k_n > 0$, and $\partial\tilde{\alpha_2}/\partial k_d > 0$.*

The higher (lower) the inherent product wastage reduction parameter δ, the higher (lower) is the likelihood of the small firm adopting the STI (DS) channel as the range for the consumer heterogeneity parameter α beyond (below) which the small firm prefers the STI (DS) channel increases. On the other hand, the higher (lower) the consumer responsiveness to pack-size parameter (k_n) and the pack-size based wastage reduction parameter (k_d), the lower (higher) is the likelihood of the small firm adopting the STI (DS) channel.

4.4.2. Implications of Inherent Product Wastage

Figure 2 demonstrates the implications of the inherent product wastage reduction parameter δ for the equilibrium solution in the DS channel and the small firm's market entry strategy.



Note: $\alpha = 300, \theta_o = 1, \theta_b = 2.5, \theta_p = 1.5, k_n = 100, k_d = 0.25, k_q = 2, c_b^d = 1, c_p^d = 0.25, c_b^a = 0.5, c_p^a = 0.25, c_q = 1.5, c_z = 1.$

Figure 2 Small Firm's Competitive Strategies: Implications of Inherent Product Waste Reduction

Figure 2*a* shows that the impact of the inherent product wastage reduction parameter δ for the small firm's pack-size decision and its market entry strategy are structurally similar to that of the consumer heterogeneity parameter α. In particular, (i) the superior product pack-size increases in the DS channel as the inherent product wastage reduces (D_s and D_{so}), (ii) the small firm responds to the co-existence of the large firm's ordinary product by lowering the superior product pack-size in D_{so} versus D_s, and (iii) the small firm adopts the STI (DS) channel when the inherent product wastage below (beyond) a threshold, i.e., when δ is beyond (below) a threshold.

The implications for product wastage are interesting to observe in the DS channel as they are not monotonic (Figure 2*b*). When the inherent product wastage is higher, i.e., δ is small, the small firm adopts the DS channel to enter the market, and the consumers do not adopt the large firm's ordinary product (D_s). In this case, product wastage increases in δ as the pack-size and market share for the superior product increase (Figure 2*c*). When the competing firms' products co-exist in the DS channel (D_{so}), the wastage of the superior product decreases. On the contrary, product wastage for the ordinary product first increases, and then it decreases in δ. In this case, the total of product wastage, $g_T = g_o + g_p$, decreases in δ. These findings show that the impact of the inherent product wastage is quite prominent for the small firm's pack-size decisions than that for the number of consumers that adopt one of the products. The total product wastage in the DS channel is higher than that in the large firm's monopoly setting, g_m. On the other hand, the total wastage, $g_T = g_o + g_b$, decreases when the small firm adopts the STI channel to enter the market as the pack-sizes for both products are identical. These findings emphasize the small firm's market entry strategy based on the product pack-size and wastage.

As a product's inherent wastage during consumption decreases, i.e., δ increases, the consumers derive more utility from each pack of a product and their willingness-to-pay for the products increases. It allows the firms to increase the product prices, resulting in higher profits for the firms and Pareto optimality situations (see Figure 4 in the supplement). Higher consumer utility also suggests increasing market shares for the competing products and higher consumer surplus. Overall, social welfare is higher when the small firm offers its superior product in either the STI channel or the DS channel than that in the large firm's monopoly setting.

Beyond a threshold for the inherent product wastage parameter δ, the STI channel is profitable for the small firm as the large firm's wholesale price offer for the superior product increases, and increasing the product pack-size does not affect the consumers adversely.

4.4.3. Implications of Consumer Responsiveness to Pack-Size

(See Figure 5 in the supplement.) We observe that the impact of the parameter k_n that captures consumer responsiveness to the small firm's superior product pack-size is not monotonic. When k_n is small in the DS channel, the superior product's pack-size decreases as k_n increases. Beyond a threshold, the pack-size increases. The market share and wastage of the superior (ordinary) product increase (decrease) in the parameter k_n. The total market share, $q_T = q_o + q_p$, and product wastage for the superior and ordinary products, $g_T = g_o + g_p$, increase in k_n. We also observe that the firms' profitability, consumer surplus, and social welfare increase as consumer responsiveness to superior product pack-size increases. These findings suggest that the small firm's competitiveness based

on the superior product pack-size is quite higher when the consumers are more responsive due to logistical constraints in storing and handling, i.e., when the parameter k_n is higher. The impact is more prominent on the small firm's superior product pack-size than the number of consumers that adopt either of the products and product wastage. It is particularly pronounced when the consumer responsiveness is higher.

When the consumers are less responsive to the product pack-size due to logistical constraints, i.e., when the parameter k_n is small, the small firm should enter the urban market by supplying its product to the large firm in the STI channel. In this case, the small firm's competitiveness from a smaller pack of its superior product is insufficient to supply the product to consumers in the market in the DS channel. On the other hand, when the consumers are more responsive to the product pack-size, the rural firm should enter the urban market using its own product brand in the DS channel and a smaller pack-size.

Our findings underscore the role of consumers' logistical constraints in influencing small rural firms' market entry strategies. The higher the consumers' logistical constraints, the higher is small firms' competitiveness, due to which they directly sell their superior value-added products in smaller packs to high-valuation consumers in urban markets.

4.4.4. Implications of Pack-Size-Driven Product Wastage Reduction

(See Figure 6 in the supplement.) We observe that the small firm's superior product pack-size decreases in the parameter k_d that captures the pack-size-driven product wastage reduction. While the market share of the superior (ordinary) product increases (decreases) in k_d, the implications for product wastage during consumption are not monotonic. The wastage increases in k_d for low values of k_d, and it decreases for high values of k_d. In our analysis, we observe that the firms' profitability, consumer surplus, and social welfare increase as the pack-size-driven product wastage decreases, i.e., k_d increases. These findings imply that the impact of the parameter k_d is more prominent for product wastage and the number of consumers that adopt either of the products than the small firm's pack-size decisions. Additionally, the impact is pronounced when k_d is higher. Consequently, the small firm enters the market by adopting the DS (STI) channel when the pack-size-driven product wastage reduction is higher (lower).

5. Reaching Urban and Semi-Urban Markets

5.1. Correlating Analytical Results and Small Firm Strategies in the Field Study

The rural firms in our field study supply their *superior* products to niche consumers in urban markets by adopting innovative approaches to choose their products, markets, sales and distribution channels, and marketing. The objective is to reduce product distribution costs, improve consumer

Product type	Small firm's product brand	Whether the product was supplied to large firms initially	Target market		Supply channel		Minimum pack-size		Firm's product distribution cost[!!]	Consumers' product access cost[!!!]	Consumer valuation[$]	Product wastage[$$]
			Urban	Semi-urban	Traditional retail	e-Retail	Urban	Semi-urban				
Honey	Mielo	No	Yes	Yes	Yes	Yes	230	230	1.39	2.2	0.78	4
Honey	Beelove	Yes	No	Yes	Yes	No	-	24	1.42	3.3	0.72	5.5
Honey	Phalam Sampada	No	Yes	Yes	Yes	No	240	72	1.54	2.6	0.83	6
Clarified butter	Sumul	No	Yes	Yes	Yes	Yes	260	260	1.27	1.8	0.88	1.1
Clarified butter	Ambika Dairy Farm	Yes	No	Yes	Yes	No	-	220	1.42	2.3	0.92	2.5
Milk	Gupta Dairy	No	No	Yes	Yes	No	-	10	1.33	1.2	0.90	3
Pomegranate	Passion Greens	No	Yes	Yes	Yes	No	140	140	1.29	1.6	0.73	3.5
Pomegranate	MIRI	Yes	Yes	Yes	Yes	Yes	-	43	1.35	2.1	0.66	5.5

Notes: Our approach to obtain distribution cost $\left(^{!!}\right)$, consumer access cost $\left(^{!!!}\right)$, consumer valuation $\left(^{\$}\right)$, and product wastage $\left(^{\$\$}\right)$ is described in detail in Table 4 in the online supplement.
Data provided throughout the paper are primary, and they are collated in consultation with the respective firms.

Table 2 Sample Data of Small Firms and their Strategic Choices

access and valuations of the products, and reduce product wastage. (A summary of the firms' approaches is provided in Table 1.) In this section, we discuss in detail specific approaches adopted by a subset of firms (See Table 2) and correlate them with the results presented in the previous sections. (More on the firms to follow in the online supplement.) We validate our findings with field experts from the firms. The insights obtained in this regard can be strengthened through empirical investigations. We adopt the following discussion to frame appropriate hypotheses for empirical studies.

Many firms expand their reach to urban markets and offer indigenous, *native* product flavors from rural markets under own brands. Mielo Honey and Phalam Sampada offer *natural* honey in various flavors such as guava, ginger, jujube, black plum, litchi, etc., against the traditional flavors of multi-flora, mustard offered by national brands of large urban firms, e.g., Dabur, Patanjali. Similarly, regional products such as raw-mango juice, sugarcane juice, *kokam*, *jaljeera* that originate from rural markets and are GI-tagged (Geographical Indications) in some cases are made available in urban markets by the firms. A limited variety of tomato and pomegranate produced by Passion Greens and Fuzhio is supplied only to niche urban consumers nurtured by the firms. To reduce product wastage post-sales and ease consumption, the firms offer their products to consumers with customized packaging using polythene packs, PET bottles, plastic bottles, or glass bottles, and in

various packs of 50 grams to 1.8 kilograms. They also cater to consumers with customized packaging requirements whenever necessary. It is observed that the firms' unique product portfolios and innovative product packaging practices have increased consumers' purchasing experience and the product valuations. It has enabled the firms to supply their products in varied packs over wider distribution networks in informal ways. The product brands Beelove, Ambika Dairy Farm, and MIRI were sold to large firms in the initial years after inception. With the increasing competitiveness of these brands in recent years, the firms are focusing on establishing own brands by switching to direct-sale channels.

Due to limited resource availability, rural brands such as Mielo Honey, Fuzhio, Phalam Sampada do not adopt modern marketing practices such as televised and print media marketing and celebrity branding. Instead, they use targeted marketing strategies in the existing distribution channels, and at times, by establishing direct-to-consumer channels to enhance consumer access to the products. For instance, they enhance awareness of their products in urban markets by selectively targeting consumer segments – e.g., schools and junior colleges, medical and health centers, senior citizen clubs, small and medium business houses, etc. They also promote the products using publicly available facilities such as public transport vehicles, auto-rickshaws, at public gathering places, etc. The firms reduce sales and distribution costs by adopting public transportation services or collaborating with local transporters and small warehouse service providers that large firms do not engage on account of mismatch with their scale. Passion Greens and Phalam Sampada share the space on their transport vehicles with many small firms in the neighborhood to reduce the logistics costs for the collaborating firms. It also provides the firms access to transportation facilities that otherwise would have been uneconomical for them individually. Additionally, to improve the consumer accessibility of the products in urban markets, these firms adopt direct distribution channels either by reaching out to consumers or by delivering to local retail shops without traditional distributors' involvement (see, e.g., Iyer and Palsule-Desai (2019)).

In our field study, we learn that the smaller scale of operations justifies the rural firms' choice of *informal* packaging, distribution, and marketing channels that large firms ignore in urban markets. This strategy enables the firms to enhance supply chain efficiency in distribution and capture demand and market share of urban consumers by improving their perception of the product through targeted marketing and direct supply. Large firms adopt similar strategies while entering rural markets *only* when their products' potential demand justifies the dual market strategy. This issue is less critical for small rural firms reaching urban markets since the latter markets are typically characterized by broader consumer tastes, greater market potential, and wider heterogeneity.

We also learn that consumer awareness about product processing and restoration, their variants, value proposition are lower for honey and fresh fruits than for milk and its product. Thereby, consumer prejudice against the former products is higher than the latter as can be seen from relatively lower consumer valuations in Table 2. The product brands Phalam Sampada, Sumul, Passion Greens adopt better CSR and marketing approaches such as focused advertising, promotions, sponsorship, etc. within the boundaries of their limited market reach to enhance consumer awareness, and thereby, facilitate reducing consumer prejudice against their products. Similarly, due to higher density and relatively lower consumption levels, packaging, storage, and handling of honey, contrary to milk and its value-added products, is relatively complex and requires specialized production approaches. The same is necessary for preserving the freshness of fruits. Therefore, product wastage during consumption is relatively higher for honey, tomato, and pomegranate. Nevertheless, it is interesting to observe that product wastage for Mielo honey and Passion Greens is relatively lower. This is due to non-traditional product packaging techniques – e.g., supplying the product in the consumers' personal containers, polyethylene bags, not storing the product in a pre-packed container, etc. – and supply of *whatever* quantity of the product is demanded by consumers.

It can be seen from Table 2 that consumers' product access cost for honey and pomegranate is relatively high compared to milk and value-added products. This is because the consumer base for honey and fresh fruits is relatively small, and firms sell their value-added products through limited retail outlets. Due to multi-channel supply strategies for product brands Mielo and Sumul, the consumers' access costs are lower than those for other brands. Consumers' access cost for product brands available only in semi-urban (rural) markets is higher than the brands available in both urban markets (for instance, Beelove versus Phalam Sampada). Similarly, larger firms' products can be easily made available to consumers than smaller firms', thus suggesting lower access costs (for instance, Ambika Dairy versus Gupta Dairy, Passion Greens versus MIRI).

Rural firms choose their target markets and supply channels considering consumers' product valuation and heterogeneity. The urban market for (natural) flavors of honey is quite heterogeneous compared to that for traditional honey. This is primarily due to lower awareness about the available variety of honey and its lower consumption among semi-urban consumers. In this case, the strategy for Mielo honey available in unique flavors in urban markets, compared to Beelove honey that was supplied to large urban firms in the initial years after the inception, can be easily explained. Similarly, the strategy of Phalam Sampada to offer a variety of ethnic and regional agricultural and food products directly in urban markets is not surprising (see Tandon (2019) for further

details). In the milk sector, Sumul brand offers a variety of value-added products such as ghee, ice-cream, chocolate, etc. in semi-urban markets, that several national players serve, e.g., Mother Dairy, Nestle, etc. with a comprehensive marketing and distribution strategy in collaboration with the GCMMF (see Chandra and Tirupati (2003) for further details). Ambika Dairy and Gupta Dairy only offer their milk products in the semi-urban markets on account of their limited product variety and supply capacity compared to relatively higher demand potential for superior products and better brand strength of the competitors.

A smaller pack-size of the small firm's superior product is justified only when its competitiveness is lower, i.e., distribution costs and consumer product access cost are higher, and product wastage is higher. A small firm with higher competitiveness supplying its superior product in a larger pack-size can still be profitable. From Table 2, we note that Mielo honey exhibits superior competitiveness compared to Beelove and Phalam Sampada products, and it is available in a relatively larger pack-size. Similarly, one can explain milk and value-added products Sumul supplying in larger pack-sizes compared to those offered by Ambika Dairy and Gupta Dairy exhibiting relatively lower competitiveness. MIRI is available in smaller packs than Passion Greens. As the product awareness increases and the firm's product brand becomes increasingly competitive, the firm increases its product pack-size and market reach. Consequently, it is no longer surprising why the firms supplying Mielo and Beelove branded honey offered their products only in semi-urban markets in small pack-sizes in their early days since inception. In recent times, they match the product pack-sizes to that of urban firms' ordinary products and target broader markets. With increased access to superior packaging technology and material, product wastage during consumption for brands such as Phalam Sampada and Sumul has reduced. Therefore, these brands' are increasingly supplied in larger pack-sizes and broader markets.

Using our model, we provide a rationale for small firms' belief that their products' competitiveness is higher when the product pack-size is small. In summary, the increased competitiveness of a small firm's superior product on account of lower product access cost for consumers and lower distribution cost for the firm suggests offering the superior product in a smaller pack-size under own brand. This is in contrast with decreased competitiveness due to increased consumer prejudice and reduced product wastage, which suggests a larger superior product pack-size and supplying the product to a large urban firm.

5.2. Hypotheses

In Table 3, we describe a firm-product-market-channel combination that we believe would evolve among rural firms in the long run. Using our findings from the analytical model and the field study,

we characterize rural firms that would supply products under own brands in urban markets versus only in rural markets.

	Rural, Semi-Urban, and Urban Markets	Rural and Semi-Urban Markets
Product	Wider product portfolio Unique product flavors Products that offer rural tastes Variants not offered by national firms	Narrow product portfolio Common product variants Value-added products of local tastes Variants not offered by national firms
Sales channel	Good connect with urban retailers Access to niche customer segments Presence of direct sales channels	Good connect with local retailers Presence of direct sales channels
Distribution	Access to logistics services in urban markets Good connect with urban transporters Access to niche customers	Good connect in local markets Capability to implement efficient transport networks in local markets
Marketing	Good understanding of the needs of urban consumers Direct access to urban consumers	Not having good understanding of and direct access to urban consumers

Table 3 Characteristics of Rural Firms Supplying Own Product Brands in Rural, Semi-Urban, and Urban Markets

Rural firms' product-market-channel strategy described in Table 3 is quite relevant for firms with relatively larger supply capacities. We believe the firms that are too small in their supply capacity would continue to supply generic products and that only to large firms from urban regions.

Based on our findings, we propose a set of hypotheses that could be investigated by designing empirical studies within the framework of the problem context described in this paper:

- The relative profitability of *local* products from rural markets vis-à-vis widely available common products is more for small firms in urban markets than in rural markets.
- The relative profitability of *local* products from rural markets vis-à-vis widely available common products is more for small firms in direct sales channels than in the traditional channels involving intermediaries.
- An informal distribution network for products of rural flavors is more cost-efficient for small firms than large firms in urban markets.
- Improved access to niche customers in urban markets enhances the profitability of small firms offering products of rural flavors more than that of large firms.
- The profitability of rural firms offering products of rural flavors is more sensitive to knowledge about the needs and requirements of urban consumers than that for large firms from urban markets.

6. Conclusions

Zahra (1993) (pp. 324) states, "When rivalry is fierce, companies must innovate in both products and processes, explore new markets, find novel ways to compete, and examine how they will differentiate themselves from competitors." In this paper, we characterize small firms' competitive

strategies from rural markets in the food and agriculture industry in developing countries that will help similar firms decide whether to enter urban markets to improve their profitability. Small rural firms in developing economies such as India are increasingly offering superior products to consumers at the higher end of the valuation continuum by adopting innovative distribution strategies and supply chain structures. We enrich the existing literature in supply chain management by taking the viewpoint of a rural firm. The currently available studies particularly address firms' related issues from the consumers' perspectives using various competitive levers individually. Additionally, they predominantly focus on large firms from urban markets exploring avenues to improve their profits. In this regard, an alternative that is widely examined is the firms supplying products in rural markets. Our work distinctively provides insights into supply chain structures for rural firms with varied sizes, product offerings, target markets, and supply channels adopted. Small firms' innovative competitive model from rural markets is based on the strategy of serving urban markets from rural markets. It could provide substantial spillover benefits for rural markets and provides enough evidence for policy-makers to enhance rural development by promoting rural entrepreneurship. Small firms' market entry strategy in urban areas can increase the firms' profits, providing incentives to many firms to enter these markets. Their entrepreneurial contributions can provide impetus to rural development in developing economies.

Using our modeling framework, one can extend rural firms' decision-making scope. For instance, it would be interesting to examine small firms' multi-product incentives when product quality is endogenously determined. Endogenously creating market segments using multiple product brands with distinct quality levels will be equally enriching. Obtaining insights into a small firm's incentives to supply multiple products on its own and through an intermediary simultaneously will be helpful for managers in choosing a suitable distribution channel. Another critical aspect that requires particular attention is from the large firms' perspective as conceptualized in this paper—markets in developing countries such as India mark a significant presence of small firms. To ensure the small and medium enterprise sector's overall development, large firms' systematic and coordinated efforts are essential. In this regard, obtaining insights into large firms' role in achieving coordination among multiple small firms supplying a variety of products is quite critical. We leave many such important and contextually relevant features for future research.

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Reaching Urban and Semi-Urban Markets Using Superior Products: Dilemma of Small Firms from Rural Markets
Supplement

1. Proofs of the Results Presented in the Main Paper and Additional Technical Results

LEMMA 1. *Define*

$$w_{\min} = \frac{(\theta_b - \theta_o)(c_b^a + c_b^d + c_z)}{\theta_o}, \qquad w_{\max} = \alpha\delta^2(\theta_b - \theta_o)$$

Consider $w_{\min} \leq w_{\max}$ *and* $w \in [w_{\min}, w_{\max}]$*, the equilibrium retail prices and demands for the superior and ordinary products supplied in the market by the large firm in the STI channel are described as follows:*

$$p_b^*(w) = \frac{\alpha\delta^2\theta_b - c_b^a + c_b^d + c_z + w}{2}, \qquad p_o^*(w) = \frac{\alpha\delta^2\theta_o - c_b^a + c_b^d + c_z}{2}$$
$$q_b^*(w) = \frac{\alpha\delta^2(\theta_b - \theta_o) - w}{2\alpha\delta^2(\theta_b - \theta_o)}, \qquad q_o^*(w) = \frac{\theta_o w - (\theta_b - \theta_o)(c_b^a + c_b^d + c_z)}{2\alpha\delta^2\theta_o(\theta_b - \theta_o)}$$

Proof of Lemma 1. From (2), we obtain the following:

$$\frac{\partial\pi_b^I}{\partial p_b} = \frac{2p_o - 2p_b + \alpha\delta^2(\theta_b - \theta_o) + w}{\alpha\delta^2(\theta_b - \theta_o)}, \qquad \frac{\partial^2\pi_b^I}{\partial p_b^2} = -\frac{2}{\alpha\delta^2(\theta_b - \theta_o)}$$
$$\frac{\partial\pi_b^I}{\partial p_o} = -\frac{2\theta_b p_o - 2\theta_o p_b + (\theta_b - \theta_o)(c_b^a - c_b^d - c_z) + \theta_o w}{\alpha\delta^2\theta_o(\theta_b - \theta_o)}, \qquad \frac{\partial^2\pi_b^I}{\partial p_o^2} = -\frac{2\theta_b}{\alpha\delta^2\theta_o(\theta_b - \theta_o)}$$
$$\frac{\partial^2\pi_b^I}{\partial p_o p_p} = \frac{2\theta_b}{\alpha\delta^2(\theta_b - \theta_o)}$$

The determinant of the Hessian matrix is $4/[\alpha^2\delta^4\theta_o(\theta_b - \theta_o)] > 0$, implying that the function π_b^I is jointly concave in p_o and p_b. Hence, the first order KKT conditions are necessary and sufficient to prove the optimality of a solution. By solving $\partial\pi_b^I/\partial p_o = 0$ for p_o and $\partial\pi_b^I/\partial p_b = 0$ for p_b, we obtain $p_o^*(w, p_b) = -[-2\theta_o p_b + (\theta_b - \theta_o)(c_b^a - c_b^d - c_z) + \theta_o w]/(2\theta_b)$ and $p_b^*(w, p_o) = [2p_o + \alpha\delta^2(\theta_b - \theta_o) + w]/2$. Clearly, $p_o^*(w, p_b)$ monotonically increases in p_b, and $p_b^*(w, p_o)$ monotonically increases in p_o. By simultaneously solving $p_o^*(w, p_b)$ and $p_b^*(w, p_o)$, we obtain the solution $p_o^*(w)$ and $p_b^*(w)$, as described in Lemma 1, that is unique.

Substituting $p_b^*(w)$ and $p_o^*(w)$ in q_p^I and q_o^I, we obtain $q_b^*(w)$ and $q_o^*(w)$. $q_b^*(w)$ monotonically decreases in w and $q_o^*(w)$ monotonically increases in w. For $w < (\geq) w_{\max}$, $q_b^*(w) > (\leq) 0$. Similarly, For $w > (\leq) w_{\min}$, $q_o^*(w) > (\leq) 0$.

We obtain $w_{\max} - w_{\min} = (\theta_b - \theta_o)(\alpha\delta^2\theta_o - c_b^a - c_b^d - c_z)/\theta_o$. The solution $p_b^*(w)$ and $p_o^*(w)$ is feasible *iff* $w \geq w_{\min}$ and $w \leq w_{\max}$, emphasizing the necessity of the condition $w_{\min} \leq w_{\max}$. □

Proof of Proposition 1. For $c_q < \overline{c_q^I}$, it can be shown that $\overline{\alpha_b^I} < \check{\alpha}_b^I < \overline{\alpha_w} = \check{\alpha}_o^I < \underline{\alpha_b^I} < \overline{\alpha_o^I}$. On the other hand, for $c_q \geq \overline{c_q^I}$, it can be shown that $\overline{\alpha_b^I} \geq \check{\alpha}_b^I \geq \overline{\alpha_w} = \check{\alpha}_o^I \geq \underline{\alpha_b^I} \geq \overline{\alpha_o^I}$.

(i) Consider $c_q < \overline{c_q^I}$ and $\alpha > \overline{\alpha_o^I}$. From Lemma 1, we substitute $p_b^*(w)$ and $p_o^*(w)$ in $\pi_p^I(w; p_o, p_b)$ described in (1) to obtain

$$\pi_p^I(w) = \frac{(w - k_q c_q)\left[\alpha\delta^2(\theta_b - \theta_o) - w\right]}{2\alpha\delta^2(\theta_b - \theta_o)}$$
$$\frac{\partial \pi_p^I}{\partial w} = \frac{\alpha\delta^2(\theta_b - \theta_o) + k_q c_q - 2w}{2\alpha\delta^2(\theta_b - \theta_o)}, \qquad \frac{\partial^2 \pi_p^I}{\partial w^2} = -\frac{1}{\alpha\delta^2(\theta_b - \theta_o)} < 0$$

Clearly, $\pi_p^I(w)$ is strictly concave in w, and hence, a solution obtained by solving the first ordering condition is necessary and sufficient to show the optimality, provided the solution is feasible.

It can be easily verified that $\hat{w}^I$ from (5) satisfies $\partial \pi_p^I / \partial w = 0$. We obtain $\hat{w}^I - w_{\min} = \left[(\alpha\delta^2\theta_o - 2c_b^a - 2c_b^d - 2c_z)(\theta_b - \theta_o) + \theta_o k_q c_q\right] / (2\theta_o) \geq (<)\, 0$ *iff* $\alpha \geq \overline{\alpha_o^I}$. $w_{\max} - \hat{w}^I = \left[\alpha\delta^2(\theta_b - \theta_o) - k_q c_q\right]/2 \geq (<)\, 0$ *iff* $\alpha \geq (<)\, \overline{\alpha_b^I}$. Clearly, $w_{\max} - w_{\min} = (\theta_b - \theta_o)(\alpha\delta^2\theta_o - c_b^a - c_b^d - c_z) / \theta_o \geq (<)\, 0$ *iff* $\alpha \geq (<)\, \overline{\alpha_w} = (c_b^a + c_b^d + c_z) / (\delta^2\theta_o)$. Recall that $\overline{\alpha_b^I} < \overline{\alpha_w} < \overline{\alpha_o^I}$ for $c_q < \overline{c_q^I}$. Thereby, assuming $c_q < \overline{c_q^I}$ and $\alpha > \underline{\alpha_o^I}$, we obtain $w_{\min} < \hat{w}^I < w_{\max}$, and the solution w^I is indeed optimal. We obtain (6) and (7) by substituting (5) in Lemma 1.

Now consider $c_q \geq \overline{c_q^I}$ and $\alpha > \overline{\alpha_b^I}$. Recall that $\overline{\alpha_b^I} \geq \overline{\alpha_w} \geq \overline{\alpha_o^I}$ for $c_q \geq \overline{c_q^I}$. The rest is straightforward from $c_q < \overline{c_q^I}$ and $\alpha > \overline{\alpha_o^I}$.

(ii) Consider $c_q < \overline{c_q^I}$ and $\alpha \leq \overline{\alpha_o^I}$. The analysis procedure follows from Lemma 1 and it parallels that described above for $\alpha > \overline{\alpha_o^I}$. From the optimality conditions described above for $\alpha > \overline{\alpha_o^I}$, the equilibrium solution is such that $q_o = 0$ in (1) and (2). (It implies that the large firm offers only the small firm's superior product in the market in the STI channel.) We obtain $\pi_p^I(w; p_p) = (w - k_q c_q)(\alpha\delta^2\theta_b - c_b^a - p_b) / (\alpha\delta^2\theta_b)$ and $\pi_b^I(p_p; w) = (p_b - c_b^d - c_z - w)(\alpha\delta^2\theta_b - c_b^a - p_b) / (\alpha\delta^2\theta_b)$. Clearly, $\pi_b^I(p_p; w)$ is concave in p_b and the profit-maximizing price is equal to $(\alpha\delta^2\theta_b - c_b^a + c_b^d + c_z + w)/2$. The small firm's profit function is $\pi_p^I(w) = (w - k_q c_q)(\alpha\delta^2\theta_b - c_b^a - c_b^d - c_z - w) / (2\alpha\delta^2\theta_b)$ with the maxima occurring at $\check{w}^I = (\alpha\delta^2\theta_b - c_b^a - c_b^d - c_z + k_q c_q)/2$. The solution is feasible, i.e., $\check{w}^I \leq w_{\min}$ *iff* $\alpha \leq \underline{\alpha_b^I}$. Recall that $\overline{\alpha_b^I} < \check{\alpha}_b^I < \underline{\alpha_b^I} < \overline{\alpha_o^I}$ for $c_q < \overline{c_q^I}$. The rest is straightforward, and hence, omitted.

(iii) Consider $c_q \geq \overline{c_q^I}$ and $\alpha \leq \overline{\alpha_b^I}$. From (i), the optimal solution is such that $q_b = 0$ in (1) and (2). (It implies that the small firm's superior product is not available in the market.) We obtain $\pi_b^I(p_o) = (p_o - c_b^d - c_z)(\alpha\delta^2\theta_o - c_b^a - p_o) / (\alpha\delta^2\theta_o)$. Clearly, $\pi_b^I(p_o)$ is concave in p_o and the profit-maximizing price is equal to $(\alpha\delta^2\theta_o - c_b^a + c_b^d + c_z)/2$ and the corresponding demand is $(\alpha\delta^2\theta_o - c_b^a - c_b^d - c_z) / (2\alpha\delta^2\theta_o) \geq 0$ for $\alpha \geq \check{\alpha}_o^I$. Recall that $\check{\alpha}_o^I \leq \overline{\alpha_b^I}$ for $c_q \geq \overline{c_q^I}$. The rest is straightforward, and hence, omitted.

The uniqueness of the equilibrium solution follows from the monotonicity property. □

Proof of Proposition 2. The proof parallels that for Proposition 1. For $c_q < \overline{c_q^D}$, it can be shown that $\overline{\alpha_p^D} < \check{\alpha}_p^D < \check{\alpha}_o^D < \overline{\alpha_o^D}$. On the other hand, for $c_q \geq \overline{c_q^D}$, it can be shown that $\overline{\alpha_p^D} \geq \check{\alpha}_p^D \geq \check{\alpha}_o^D \geq \overline{\alpha_o^D}$.

(i) Consider $c_q < \overline{c_q^D}$ and $\alpha > \overline{\alpha_o^D}$. From (3) and (4), we obtain

$$\begin{aligned}
\frac{\partial \pi_p^D}{\partial p_p} &= -\frac{-zn_t\delta_t p_o + 2\delta n_t p_p - \alpha z n_t \delta_t \delta\left(\delta_t\theta_p - \delta\theta_o\right) - zn_t\delta_t c_b^a + \delta c_p^a - \delta n_t c_p^d - \delta n_t c_q - z^2\delta n_t c_z}{\alpha z n_t \delta_t \delta\left(\delta_t\theta_p - \delta\theta_o\right)} \\
\frac{\partial^2 \pi_p^D}{\partial p_p^2} &= -\frac{2}{\alpha z \delta_t^2\left(\delta_t\theta_p - \delta\theta_o\right)} < 0 \\
\frac{\partial \pi_b^D}{\partial p_o} &= \frac{-2zn_t\delta_t^2\theta_p p_o + \delta^2 n_t\theta_o p_p - zn_t\delta_t^2\theta_p c_b^a + zn_t\delta_t^2\theta_p c_b^d + \delta^2\theta_o c_p^a + zn_t\delta_t^2\theta_p c_z}{\alpha z n_t \delta_t \delta^2\theta_o\left(\delta_t\theta_p - \delta\theta_o\right)} \\
\frac{\partial^2 \pi_b^D}{\partial p_o^2} &= -\frac{2\delta_t\theta_p}{\alpha\delta^2\theta_o\left(\delta_t\theta_p - \delta\theta_o\right)} < 0
\end{aligned}$$

Clearly, $\partial\pi_p^D$ and $\partial\pi_b^D$ are concave in p_p and p_o, respectively. Hence, the first order KKT conditions are necessary and sufficient to prove the optimality of a solution. By solving, $\partial\pi_p^D/\partial p_p = 0$ for p_p and $\partial\pi_b^D/\partial p_o = 0$ for p_o, we obtain

$$\begin{aligned}
p_p^*\left(p_o; z\right) &= -\frac{-zn_t\delta_t p_o - \alpha z n_t\delta_t\delta\left(\delta_t\theta_p - \delta\theta_o\right) - zn_t\delta_t c_b^a + \delta c_p^a - \delta n_t c_p^d - \delta n_t c_q - z^2\delta n_t c_z}{2\delta n_t} \\
p_o^*\left(p_p; z\right) &= \frac{\delta^2 n_t\theta_o p_p - zn_t\delta_t^2\theta_p c_b^a + zn_t\delta_t^2\theta_p c_b^d + \delta^2\theta_o c_p^a + zn_t\delta_t^2\theta_p c_z}{2zn_t\delta_t^2\theta_p}
\end{aligned}$$

$p_p^*\left(p_o; z\right)$ monotonically increases in p_o, and $p_o^*\left(p_p; z\right)$ monotonically increases in p_p. By simultaneously solving $p_p^*\left(p_o; z\right)$ and $p_o^*\left(p_p; z\right)$, we obtain the solution $\hat{p}_p^D\left(z\right)$ and $\hat{p}_o^D\left(z\right)$, as described in (12) and (13), that is unique. $\hat{q}_p^D\left(z\right)$ and $\hat{q}_o^D\left(z\right)$ can be easily obtained by substitution.

$\hat{q}_p^D\left(z\right)$ and $\hat{q}_o^D\left(z\right)$ monotonically increase in α. Define $\overline{\alpha_p^D}$ such that $\hat{q}_p^D \geq (<)\, 0$ for $\alpha \geq (<)\, \overline{\alpha_p^D}$. Similarly, define $\overline{\alpha_o^D}$ such that $\hat{q}_o^D \geq (<)\, 0$ for $\alpha \geq (<)\, \overline{\alpha_o^D}$. We obtain

$$\overline{\alpha_o^D} - \overline{\alpha_p^D} = \frac{\left(4\delta_t\theta_p - \delta\theta_o\right)\left[zn_t\delta_t^2\theta_p\left(c_b^a + c_b^d\right) - \delta^2\theta_o\left(c_p^a + n_t c_b^d\right) - zn_t\left(\delta_t^2\theta_p - z\delta^2\theta_o\right)c_z - n_t\delta^2\theta_o c_q\right]}{2zn_t\delta_t^2\delta^2\theta_o\theta_p\left(\delta_t\theta_p - \delta\theta_o\right)}$$

It is immediate that $\overline{\alpha_o^D} \geq (<)\, \overline{\alpha_p^D}$ for $c_q \geq (<)\, \overline{c_q^D}$. Thereby, the equilibrium solution described in (12)-(15) is feasible *iff* $\alpha > \max\left\{\overline{\alpha_p^D}, \overline{\alpha_o^D}\right\}$. The rest is straightforward, and hence, omitted.

(ii) Consider $c_q < \overline{c_q^D}$ and $\alpha \leq \overline{\alpha_o^D}$. The analysis procedure parallels that described above for $\alpha > \max\left\{\overline{\alpha_p^D}, \overline{\alpha_o^D}\right\}$. From the equilibrium solution described above, the equilibrium solution in this case is such that $q_o = 0$ in (3) and (4). (It implies that the large firm does not offer its ordinary product in the market in the DS channel.) We obtain $\pi_p^D\left(p_p, z\right) = \left(p_p - c_p^d - c_q - c_z z^2\right)\left(\alpha z n_t\delta_t^2\theta_p - c_b^a - n_t p_p\right)/\left(\alpha z n_t\delta_t^2\theta_p\right)$. Clearly, $\pi_p^D\left(p_p, z\right)$ is concave in p_p and the profit-maximizing price is equal to $\check{p}_p^D$ as described in (16). The correspond demand is equal to $\check{q}_p^D\left(z\right)$ as described in (**??**)$\left(z\right)$ that is feasible, i.e., $\check{q}_p^D\left(z\right) \geq 0$ *iff* $\alpha \leq \check{\alpha}_p^D$. Recall that $\overline{\alpha_p^D} < \check{\alpha}_p^D < \overline{\alpha_o^D}$ for $c_q < \overline{c_q^D}$. The rest is straightforward, and hence, omitted.

(iii) Consider $c_q \geq \overline{c_q^D}$ and $\alpha \leq \overline{\alpha_p^D}$. From (i), the equilibrium solution is such that $q_p = 0$ in (3) and (4). (It implies that the small firm's superior product is not available in the market.) We obtain $\pi_b^D(p_o) = (p_o - c_b^d - c_z)(\alpha\delta^2\theta_o - c_b^a - p_o)/(\alpha\delta^2\theta_o)$. Clearly, $\pi_b^D(p_o)$ is concave in p_o and the profit-maximizing price is equal to $(\alpha\delta^2\theta_o - c_b^a + c_b^d + c_z)/2$ and the corresponding demand is $(\alpha\delta^2\theta_o - c_b^a - c_b^d - c_z)/(2\delta^2\theta_o) \geq 0$ for $\alpha \geq \check{\alpha}_o^D$. Recall that $\check{\alpha}_o^D \leq \overline{\alpha_p^D}$ for $c_q \geq \overline{c_q^D}$. The rest is straightforward, and hence, omitted.

The uniqueness of the equilibrium solution follows from the monotonicity property. □

LEMMA 2. *The bounds* $\check{\alpha}_b^I, \check{\alpha}_o^I, \overline{\alpha_b^I}, \overline{\alpha_o^I}$, *and* $\underline{\alpha_b^I}$ *decrease in* δ. *The bound* $\overline{c_q^I}$ *is independent of* δ.

Proof of Lemma 2. The proof is straightforward from the definitions of $\check{\alpha}_b^I, \check{\alpha}_o^I, \overline{\alpha_b^I}, \overline{\alpha_o^I}, \underline{\alpha_b^I}$, and $\overline{c_q^I}$, described in Proposition 1, and hence, omitted. □

LEMMA 3. *Given the superior product pack-size* $z \in (0,1]$, *the bounds* $\check{\alpha}_p^D, \check{\alpha}_o^D, \overline{\alpha_p^D}$, *and* $\overline{\alpha_o^D}$ *decrease in* δ. *The bound* $\overline{c_q^D}$ *is independent of* δ.

Proof of Lemma 3. By substituting $\delta_t(z) = \delta[1 + k_d(1-z)]$ and $n_t(z) = 1 + k_n(1-z)$ in $\check{\alpha}_p^D, \check{\alpha}_o^D, \overline{\alpha_p^D}, \overline{\alpha_o^D}$, and $\overline{c_q^D}$, described in Proposition 2, we obtain the following:

$$\check{\alpha}_p^D = \left\{c_p^a + [1 + (1-z)k_n]\left(c_p^d + c_q + z^2 c_z\right)\right\} / \left\{z\delta^2\theta_p[1 + (1-z)k_d]^2[1 + (1-z)k_n]\right\}$$

$$\check{\alpha}_o^D = \left(c_b^a + c_b^d + c_z\right)/(\delta^s\theta_o)$$

$$\overline{\alpha_p^D} = \Big\{-z\theta_p[1 + (1-z)k_d]^2[1 + (1-z)k_n]\left(c_b^a + c_b^d\right) - [-2(1-z)k_d\theta_p + \theta_o - 2\theta_p]c_p^a - [1 + (1-z)k_n] \times \Big\{[-2(1-z)k_d\theta_p + \theta_o - 2\theta_p]\left(c_p^d + c_q\right) + zc_z\left[(1-z)^2\theta_p k_d(2 + k_d) + z\theta_o - 2z\theta_p + \theta_p\right]\Big\}\Big\} / \Big\{2z\delta^2\theta_p[1 + (1-z)k_d]^2[1 + (1-z)k_n][(1-z)k_d\theta_p - \theta_o + \theta_p]\Big\}$$

$$\overline{\alpha_o^D} = \Big\{z[1 + (1-z)k_d][1 + (1-z)k_n][-2(1-z)k_d\theta_p + \theta_o - 2\theta_p]\left(c_b^a + c_b^d\right) + \theta_o c_p^a - [1 + (1-z)k_n] \times \Big\{-\theta_o c_p^d - \theta_o c_q + zc_z\{(1-z)k_d[2(1-z)k_d\theta_p - \theta_o + 4\theta_p] - z\theta_o - \theta_o + 2\theta_p\}\Big\}\Big\} / \Big\{z\delta^2\theta_o[1 + (1-z)k_d][1 + (1-z)k_n][-(1-z)k_d\theta_p + \theta_o - \theta_p]\Big\}$$

$$\overline{c_q^D} = \Big\{z\theta_p[1 + (1-z)k_d]^2[1 + (1-z)k_n]\left(c_b^a + c_b^d\right) - \theta_o c_p^a - [1 + (1-z)k_n] \times \Big\{\theta_o c_p^d - zc_z\{(1-z)\theta_p k_d[2 + (1-z)k_d] - z\theta_o + \theta_p\}\Big\}\Big\} / \{\theta_o[1 + (1-z)k_d]\}$$

The rest is straightforward, and hence, omitted. □

2. Computational Approach: Endogenously Determined Superior Product Pack-Size

In this section, we describe our computational approach to determine the small firm's profit-maximizing superior product pack-size in the DS channel based on the (Nash) equilibrium solution described in Proposition 2. The small firm's problem P_p^D is described as

$z^D = \arg\max_{z\in[0,1]} \left\{\hat{\pi}_p^D(z), \check{\pi}_p^D(z)\right\}$. Here, $\hat{\pi}_p^D(z) = \pi_p^D\left(\hat{p}_p^D(z), \hat{p}_o^D(z), z\right)$ is obtained by substituting $\hat{p}_p^D(z)$ and $\hat{p}_o^D(z)$ in the small firm's profit function $\pi_p^D(p_p, z; p_o)$ described in (3). Similarly, $\check{\pi}_p^D(z) = \pi_p^D\left(\check{p}_p^D(z), z\right)$ is obtained by substituting $\check{p}_p^D(z)$ in $\pi_p^D(p_p, z) = \left(p_p - c_p^d - c_q - c_z z^2\right)\left(\alpha z n_t \delta_t^2 \theta_p - c_b^a - n_t p_p\right)/\left(\alpha z n_t \delta_t^2 \theta_p\right)$. In view of the structural results presented in Proposition 2, the small firm's problem P_p^D is divided into three sub-problems as follows: (i) P_p^{D1} : $\max_z \hat{\pi}_p^{D1} = \pi_p^D\left(\hat{p}_p^D(z), \hat{p}_o^D(z), z\right)$ s.t. $\alpha \geq \max\left\{\overline{\alpha_p^D}, \overline{\alpha_o^D}\right\}, z \geq 0, z \leq 1$, (ii) P_p^{D2} : $\hat{\pi}_p^{D2} = \arg\max\left\{\hat{q}_o^D(z) = 0, \alpha \geq \max\left\{\overline{\alpha_p^D}, \overline{\alpha_o^D}\right\}, z \geq 0, z \leq 1\right\}$, and (iii) P_p^{D3} : $\check{\pi}_p^D = \max_z \pi_p^D\left(\check{p}_p^D(z), z\right)$ s.t. $c_q \leq \overline{c_q^D}, \alpha \geq \check{\alpha}_p^D, \alpha \leq \overline{\alpha_o^D}, z \geq 0, z \leq 1$. Clearly, $\pi_p^D = \max\left\{\hat{\pi}_p^{D1}, \hat{\pi}_p^{D2}, \check{\pi}_p^D\right\}$ and $z^D = \arg\max_z \left\{\hat{\pi}_p^{D1}, \hat{\pi}_p^{D2}, \check{\pi}_p^D\right\}$.

One may note that the equilibrium solution for the small firm's problem P_p^{D2} corresponds to the firm's entry-deterrent strategy against the large firm. In this case, the small firm's choice of the superior product's retail price is barely sufficient to make the large firm supplying its ordinary product in the market uneconomical.

The parameter values that we consider to examine the impact of consumer heterogeneity, α, (demonstrated in Figure 1) are as follows: $\theta_o = 1, \theta_b = 2.5, \theta_p = 1.5, \delta = \{0.1, 0.2, 0.3\}, k_n = \{10, 50, 100\}, k_d = \{0.25, 0.5, 1\}, k_q = 2, c_b^d = 1, c_p^d = 0.25, c_b^a = 0.5, c_p^a = 0.25, c_q = 1.5, c_z = 1$. Also, $\alpha = 300$ to 3000 in steps of 27.

The parameter values that we consider to examine the impact of inherent product wastage reduction, δ, (demonstrated in Figure 2) are as follows: $\alpha = \{300, 500, 1650, 3000\}, \theta_o = 1, \theta_b = 2.5, \theta_p = 1.5, k_n = \{10, 50, 100\}, k_d = \{0.25, 0.5, 1\}, k_q = 2, c_b^d = 1, c_p^d = 0.25, c_b^a = 0.5, c_p^a = 0.25, c_q = 1.5, c_z = 1$. Also, $\delta = 0.1$ to 0.8 in steps of 0.007.

The parameter values that we consider to examine the impact of consumer responsiveness to pack-size, k_n, (demonstrated in Figure 5) are as follows: $\alpha = \{300, 500, 1650, 3000\}, \theta_o = 1, \theta_b = 2.5, \theta_p = 1.5, \delta = \{0.1, 0.2, 0.3\}, k_d = \{0.25, 0.5, 1\}, k_q = 2, c_b^d = 1, c_p^d = 0.25, c_b^a = 0.5, c_p^a = 0.25, c_q = 1.5, c_z = 1$. $k_n = 0$ to 100 in steps of 1.

The parameter values that we consider to examine the impact of pack-size-driven wastage reduction, k_d, (demonstrated in Figure 6) are as follows: $\alpha = \{300, 500, 1650, 3000\}, \theta_o = 1, \theta_b = 2.5, \theta_p = 1.5, \delta = \{0.1, 0.2, 0.3\}, k_n = \{10, 50, 100\}, k_q = 2, c_b^d = 1, c_p^d = 0.25, c_b^a = 0.5, c_p^a = 0.25, c_q = 1.5, c_z = 1$. $k_d = 0$ to 1 in steps of 0.01.

3. Consumer Surplus and Social Welfare

Consumer surplus and social welfare in the STI Channel: The (consumer) surplus experienced by the consumers of the superior product is described as follows: $S_p^I = \int_{\underline{u_p^I}}^{\alpha} N_p^I/\alpha \cdot du =$

$[p_o - p_b + \alpha\delta^2(\theta_b - \theta_o)][\alpha\delta^2(\theta_b - \theta_o)\theta_b - 2(\theta_b - \theta_o)c_b^a - \theta_b(p_b + p_o) + 2\theta_o p_b] / \left[2\alpha\delta^3(\theta_b - \theta_o)^2\right]$. Similarly, the surplus experienced by the consumers of the ordinary product is described as $S_o^I = \int_{\underline{u_o^I}}^{u_p^I} N_o^I/\alpha \cdot du = [\theta_o p_b - \theta_b p_o - (\theta_b - \theta_o)c_b^a]^2 / \left[2\alpha\delta^3\theta_o(\theta_b - \theta_o)^2\right]$. The social welfare is defined as $W^I = \pi_p^I(p_o, p_b, w) + \pi_b^I(p_o, p_b, w) + S_p^I + S_o^I$.

Consumer surplus and social welfare in the DS Channel: The (consumer) surplus experienced by the consumers of the superior product is described as follows: $S_p^D = \int_{\underline{u_p^D}}^{\alpha} N_p^D/\alpha \cdot du = \left[\delta\left(n_t p_p + c_p^a\right) - z n_t \delta_t (p_o + c_b^a) - \alpha z n_t \delta_t \delta(\delta_t\theta_p - \delta\theta_o)\right]\left[(\delta_t\delta\theta_p - 2\delta^2\theta_o)\left(n_t p_p + c_p^a\right) + z n_t \delta_t^2 \theta_p (p_o + c_b^a)\right.$ $\left. -\alpha z n_t \delta_t^2 \delta\theta_p(\delta_t\theta_p - \delta\theta_o)\right] / \left[2\alpha z^2 n_t^2 \delta_t^2 \delta^2(\delta_t\theta_p - \delta\theta_o)^2\right]$. Similarly, the surplus experienced by the consumers of the ordinary product is described as $S_o^D = \int_{\underline{u_o^D}}^{u_p^D} N_o^D/\alpha \cdot du = \left[\delta^2\theta_o\left(n_t p_p + c_p^a\right) - z n_t \delta_t^2\right.$ $\left.\theta_p(p_o + c_b^a)\right]^2 / \left[2\alpha z^2 n_t^2 \delta_t^2 \delta^3 \theta_o(\delta_t\theta_p - \delta\theta_o)^2\right]$. The social welfare is defined as $W^D = \pi_p^D(p_p, z; p_o) + \pi_b^D(p_o; p_p, z) + S_p^D + S_o^D$.

Consumer surplus and social welfare in the monopoly setting of the large firm: While determining the equilibrium market entry strategy for the small firm, we also provide insights into the implications of the small firm's choices by comparing the equilibrium solution with the market performance when the large firm is a monopoly supplier offering *only* the ordinary product in the market. The equilibrium solution in the monopoly setting of the large firm is described, using subscript m, as follows: $p_m = (\alpha\delta^2\theta_o - c_b^a + c_b^d + c_z)/2$, $q_m = (\alpha\delta^2\theta_o - c_b^a - c_b^d - c_z)/(2\alpha\delta^2\theta_o)$, $\pi_m = (\alpha\delta^2\theta_o - c_b^a - c_b^d - c_z)^2/(2\alpha\delta^2\theta_o)$, and $g_m = (1-\delta)(\alpha\delta^2\theta_o - c_b^a - c_b^d - c_z)/(2\alpha\delta^3\theta_o)$. Accordingly, $S_m = (\alpha\delta^2\theta_o - c_b^a - c_b^d - c_z)^2/(8\alpha\delta^3\theta_o)$, and $W_m = (1+2\delta)(\alpha\delta^2\theta_o - c_b^a - c_b^d - c_z)^2/(8\alpha\delta^3\theta_o)$

4. Diverse Characteristics of Rural Firms in the Field Study

Table 4 presents an overview of diversity among the firms that participated in our field study. We also describe our approach for obtaining model parameters, discussed in Section 3, using real-world data from the field study.

	Minimum			Maximum			Average			Standard deviation			Correlation[!]		
	Com.	Agri.	Fruits	Com.	Agri.	Fruits	Com.	Agri.	Fruits	Com.	Agri.	Fruits	Com.	Agri.	Fruits
Profit	83	2,926	1,001	196,597	15,970	17,325	23,613	8,703	10,865	44,197	5,428	6,524	N/A	N/A	N/A
Fraction of product sold under own brand	0.30	0.39	0.30	1.00	1.00	1.00	0.65	0.65	0.58	0.26	0.26	0.27	-0.13	0.06	-0.56
Unit selling price[&]	1.49	1.40	1.42	2.44	1.44	1.92	1.88	1.41	1.67	0.29	0.02	0.20	-0.15	0.95	-0.11
Pack-size[%%]	0.19	136.41	140.44	6,804.48	743.07	1,579.03	1,987.27	341.53	504.87	1,552.69	283.95	620.18	-0.16	-0.95	-0.47
Distribution cost[!!]	1.18	1.27	1.18	1.67	1.54	1.64	1.37	1.47	1.33	0.15	0.06	0.19	-0.15	-0.92	-0.76
Consumer access cost[!!!]	0.15	0.13	0.42	3.50	5.20	2.10	0.56	0.56	0.65	0.27	0.31	0.25	-0.29	-0.99	-0.03
Consumer valuation[$]	0.64	0.63	0.65	0.83	0.92	0.77	0.71	0.67	0.71	0.04	0.03	0.04	0.18	0.85	0.08
Product wastage[$$]	0.14	0.25	0.36	12.86	2.57	5.57	4.46	0.43	1.14	3.77	0.20	1.10	-0.24	-0.95	-0.62

Notes: Notation "Com." stands for commodity, and "Agri." stands for agricultural products.

[&]Unit selling price is the ratio of the average retail price of the small firm's product brand and the procurement price offered by a bulk buyer for its brand.

[%%]Pack-size is defined in terms of the ratio of the superior product's retail price and that of the highest selling national product in the region.

[!!]Distribution cost is described as the ratio of storage and transportation cost for the superior product and that for the ordinary product supplied to a bulk buyer, weighted against the traditional and e-retailer channels.

[!!!]Consumer access cost is described as the ratio of the average distance traveled by a consumer to buy the rural firm's product to that for the urban firm's product.

[$]Consumer valuation for the small firm's product brand is defined as the ratio of the average price of the product brand and that of the *next* popular national brand of an urban firm. The higher the valuation, the lower is the prejudice against the superior product.

[$$]Product wastage is described as the average percentage loss of the product in a week after purchase.

[!]Correlation is between the firm's profit and the respective variable (e.g., pack-size) mentioned in the table.

Table 4 A Snapshot of Diverse Characteristics of Rural Firms in India in 2019

5. Firm's Profitability: An Example

For one of the honey producers that participated in our field study, its persistence with the superior product competing with ordinary products of urban firms is particularly driven by unequal profitability from the two types of products. Table 5 demonstrates the dichotomy in the firm's profitability depending on its choice of the sales channel, product pack-sizes, and target markets. For confidentiality purposes, we do not disclose the identity of the firm. For this firm, we note that its product brand's profit margin in the traditional channel compared to the e-retail channel is more in the local market for given product pack-size. On the contrary, the e-retail channel is more

profitable than the traditional channel in the urban market for a given pack-size. The profit margin is higher in the semi-urban market than the urban market in the traditional and e-retail channels for given product pack-size. The traditional and e-retail channels yield more profit margin in the large pack-size category than the small pack-size in the urban markets. On the contrary, the firm's profit margin is higher in the semi-urban market and the large pack-size category in the e-retail channel compared to the small pack-size category in the traditional channel. While the profitability of the products in large pack-sizes is usually higher, we observe that consumer demand for the products in large pack-sizes, compared to small pack-sizes, depends on the product's variant in general.

	Traditional retail supply channel				e-Retail supply channel			
	Small pack		Large pack		Small pack		Large pack	
	Semi-urban market	Urban market	Semi-urban market	Urban market	Semi-urban market	Urban market	Semi-urban market	Urban market
Retail price[!]	210.00	210.00	690.00	690.00	210.00	210.00	621.00	621.00
Commission charges	42.00	63.00	138.00	207.00	8.40	8.40	24.84	24.84
Shipping and transportation cost	8.33	11.11	7.67	10.50	25.00	25.00	35.00	35.00
Handling cost	-	21.00	-	69.00	28.00	56.00	64.00	101.00
Total logistics cost	50.33	95.11	145.67	286.50	61.40	89.40	123.84	160.84
Taxes and interest cost[@]	9.06	17.12	26.22	51.57	11.05	16.09	22.29	28.95
Other expenses	5.92	9.73	7.97	9.19	1.39	2.78	4.17	4.17
Total distribution cost	65.31	121.96	179.86	347.26	73.84	108.27	150.30	193.96
Material cost[&]	68.09	68.09	224.10	224.10	68.09	68.09	224.10	224.10
Net profit	76.60	19.95	286.04	118.64	68.07	33.64	246.60	202.94
Profit margin[#]	36.48	9.50	41.45	17.19	32.41	16.02	39.71	32.68

Notes: All figures are in Indian Rupees, except the profit margins, which are in percentage. For confidentiality purposes, we do not disclose the identity of the firm – one of the honey producers described in Table 2 – that kindly provided the data.

Large firms with a national presence in India procure honey from the firm at INR 90-110 per kilogram and offer a competitive retail price for their national brands.

[@]Interest costs are due to product delivery on credit by the firm to retailers. [!]Retail price is equal to MRP (Maximum Retail Price printed on a product pack) after adjusting for consumer discount. [&]Material cost includes the product, bottling, and packaging costs. [#]Profit margin is in terms of net profit as a fraction of the retail price.

Table 5 Product Profitability for a Representative Firm Depending on Product Pack-Size, Target Market, and Supply Channel Adopted

6. Additional Details on Firms Mentioned in the Main Paper

A proprietary firm Honey Bee Web, established in 2018 in Khargone, Madhya Pradesh – the second largest state by area and the fifth largest state by population from central India – specializes in

consulting and promoting beekeeping in addition to procuring, processing and supplying a variety of processed honey under its brand Mielo honey (see https://mielo-honey.business.site.). While its sales has amounted to more than one tonne of honey in the first year of inception, it is set to achieve sales of more than five tonnes from the second year onward. Beelove Honey from Neemuch, Madhya Pradesh, is a for-profit firm established in 2018 with more than ten member farmers from three neighboring states – Uttar Pradesh, Rajasthan, and Haryana (see http://picdeer.org/dhakad7407). Since its inception, the firm has developed its own supply network to produce, procure, and supply a variety of processed honey in neighboring markets. In the first year, the firm traded more than five tonnes of honey; this quantity has increased to more than ten tonnes in the second year. Phalam Sampada Producer Company Limited from Chhindawara, Madhya Pradesh, a for-profit company incorporated in 2014, procures a variety of agricultural and food products such as honey, millet, mango, black plum, gooseberry, etc. from more than 600 farmers and directly supplies their value-added variants to consumers in rural and urban markets (see https://phalam-sampada-producer-coltd.business.site/).

Surat District Co-Operative Milk Producers' Union Ltd., established in 1951, in Surat, Gujarat – the fifth largest state by area, the ninth largest state by population, and one of the most prosperous states from Western India – supplies a multitude of value-added products of milk under both Sumul and Amul brands. The Sumul brand is managed by the Surat union, and the Amul brand is managed by the Gujarat Co-operative Milk Marketing Federation Limited (GCMMF) – an umbrella organization for eighteen member unions, including the Surat union. Each member union – firm, as referred to in this paper – operates on the principle of eliminating middlemen and ensuring equitable distribution of benefits to rural milk producers, and consequently, to urban milk consumers (see http://sumul.com/). Ambika Dairy Farm and Gupta Dairy from the outskirts of Indore, the largest and most populous city in Madhya Pradesh, on the other hand, supply a limited variety of value-added products of milk, e.g., pasteurized and processed milk, *ghee* (clarified butter), *paneer* (a variety of cheese), etc. in the surrounding regions since their inception in 1971 and 2002 respectively. The former firm has increased its trade volume to more than 185,000 litres of milk annually by associating with almost 25 farmers, and the latter has achieved sales of more than 75,000 litres of milk per year with 11 farmers in collaboration.

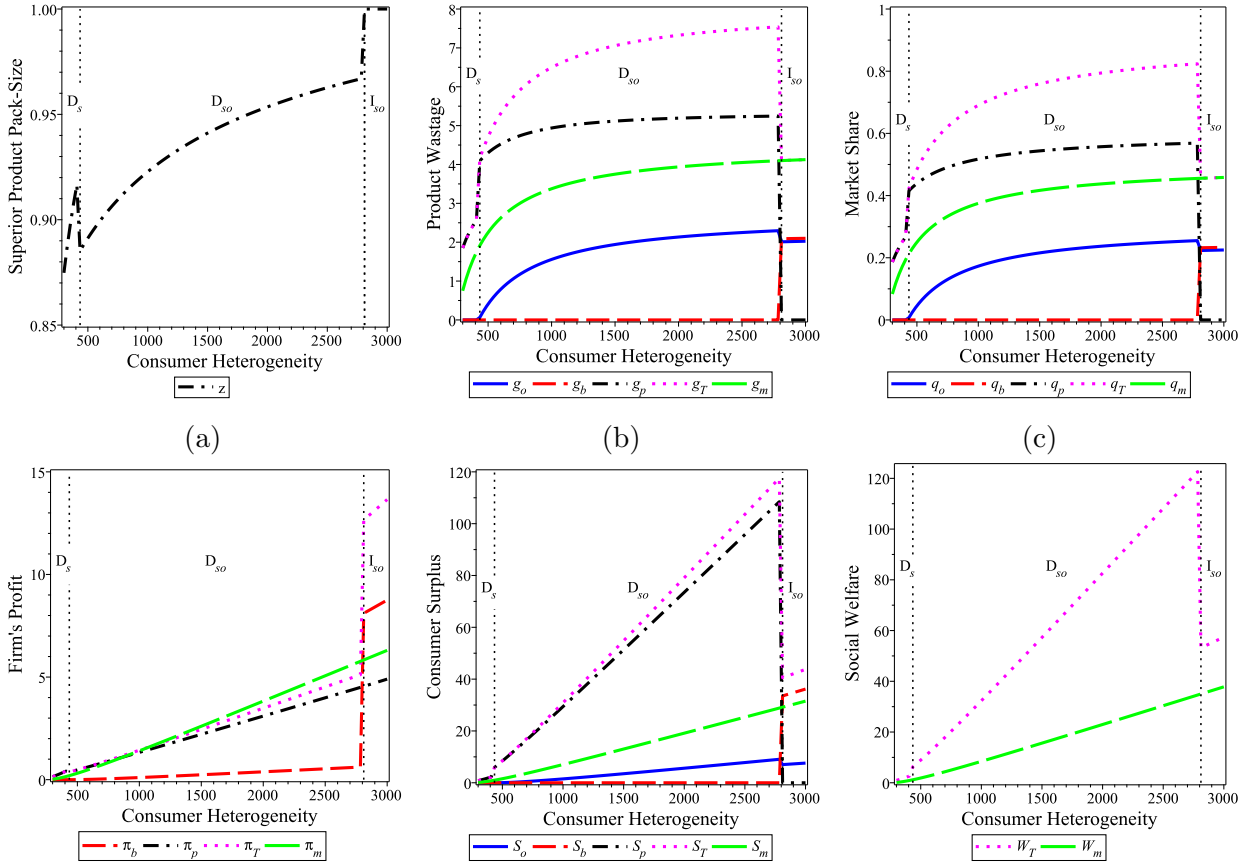
Passion Greens Farmtech Private Limited, registered under the Company's Act in 2011 in Gwalior, Madhya Pradesh, functions with the authorized capital of one million Indian Rupees.[7]

[7] see https://economictimes.indiatimes.com/company/passion-greens-farmtech-private-limited-/U01403MP2011PTC025524 (Accessed on February 28, 2020)

The firm specializes in agriculture business and allied activities, and it supplies specially-grown pomegranate of different variety under own brand – Passion Greens – in the open-market. Vrutti, established in 2002, works with small and marginal farmers to build a wealthy, resilient and responsible farming community and covers over 130,000 farming families across India (see https://vrutti.org). They market agricultural produce of the associated farmers collectively under the brand MIRI – Made in Rural India – in the southern part of India.

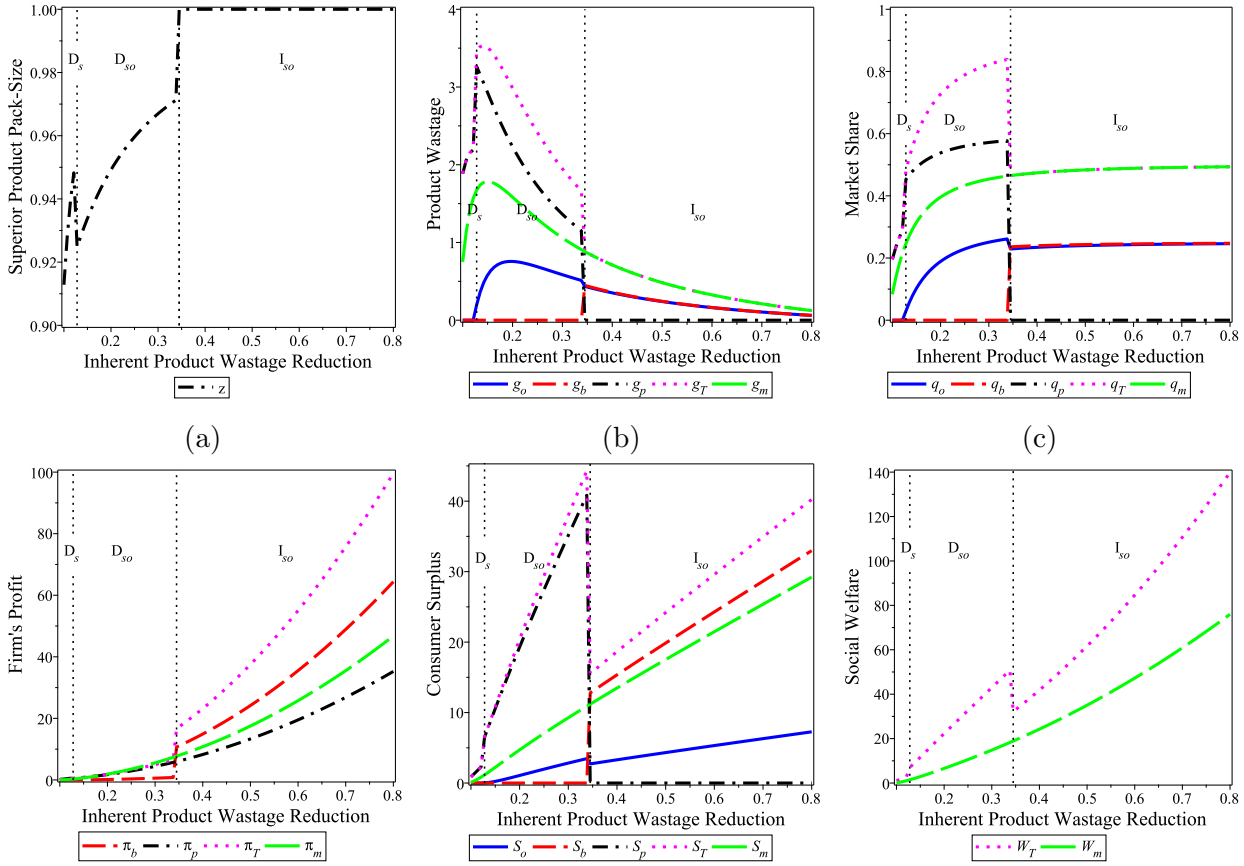
7. Equilibrium Solution: Implications of Model Parameters

In this section, we describe the implications of our critical model parameters for the equilibrium solution in Figures 3-6.



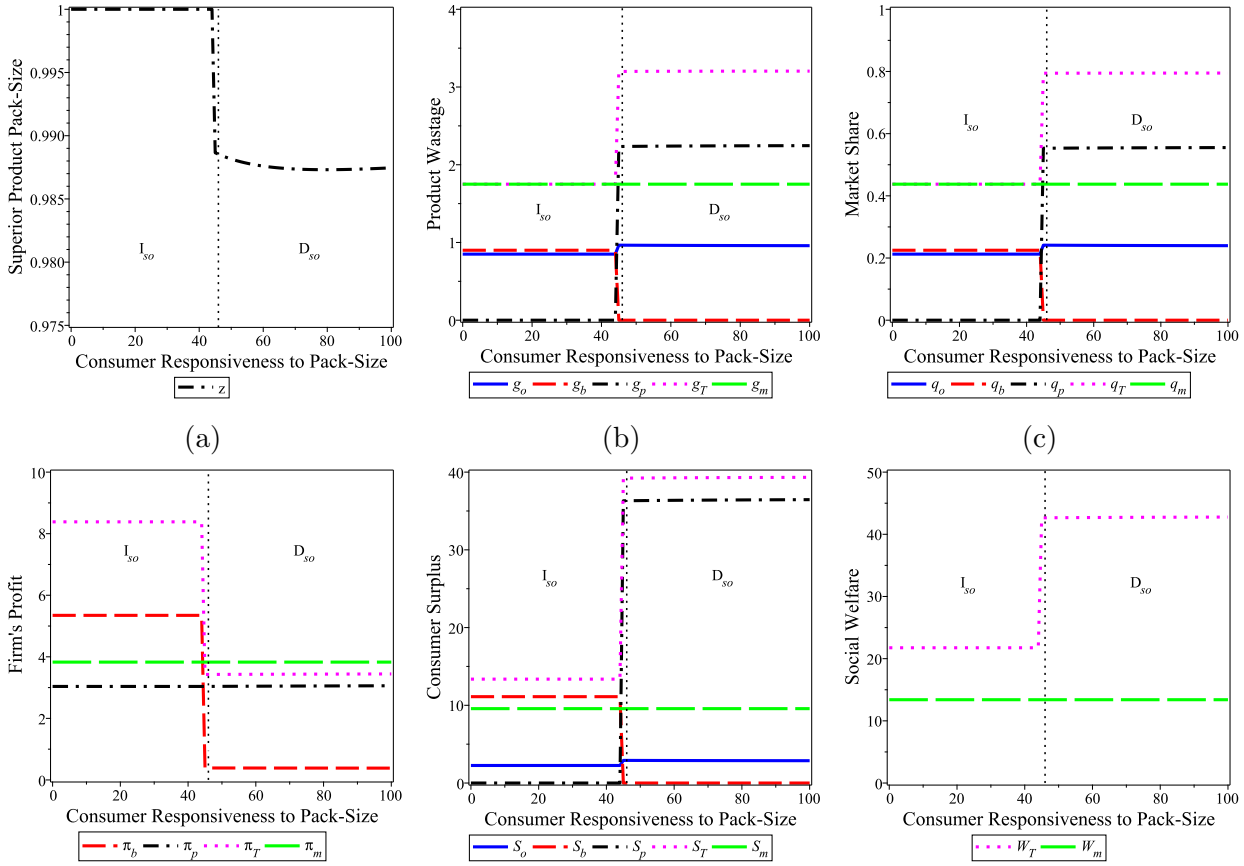
Note: $\theta_o = 1, \theta_b = 2.5, \theta_p = 1.5, \delta = 0.1, k_n = 10, k_d = 0.25, k_q = 2, c_b^d = 1, c_p^d = 0.25, c_b^a = 0.5, c_p^a = 0.25, c_q = 1.5, c_z = 1.$

Figure 3 Small Firm's Competitive Strategies: Implications of Consumer Heterogeneity



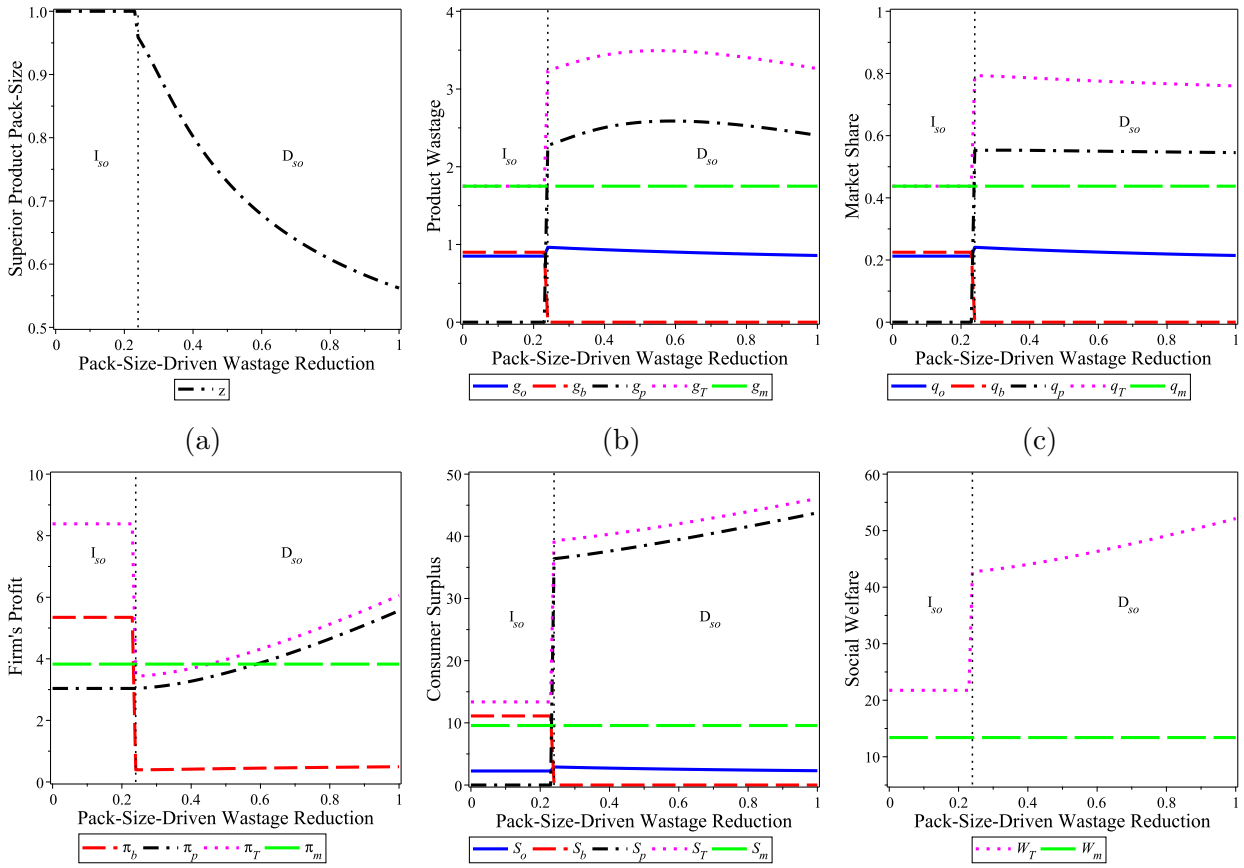
Note: $\alpha = 300, \theta_o = 1, \theta_b = 2.5, \theta_p = 1.5, k_n = 100, k_d = 0.25, k_q = 2, c_b^d = 1, c_p^d = 0.25, c_b^a = 0.5, c_p^a = 0.25, c_q = 1.5, c_z = 1.$

Figure 4 Small Firm's Competitive Strategies: Implications of Inherent Product Waste Reduction



Note: $\alpha = 500, \theta_o = 1, \theta_b = 2.5, \theta_p = 1.5, \delta = 0.2, k_d = 0.1, k_q = 2, c_b^d = 1, c_p^d = 0.25, c_b^a = 0.5, c_p^a = 0.25, c_q = 1.5, c_z = 1.$

Figure 5 Small Firm's Competitive Strategies: Implications of Consumer Responsiveness to Pack-Size



Note: $\alpha = 500, \theta_o = 1, \theta_b = 2.5, \theta_p = 1.5, \delta = 0.2, k_n = 10, k_q = 2, c_b^d = 1, c_p^d = 0.25, c_b^a = 0.5, c_p^a = 0.25, c_q = 1.5, c_z = 1.$

Figure 6 Small Firm's Competitive Strategies: Implications of Pack-Size-Driven Product Wastage Reduction

8. Pack-Size-Based Superior Product Distribution Cost

This section examines the impact of a small firm's product distribution cost that the product pack-size may govern on its market entry strategy. As demonstrated in Section 5 for a firm in our field study, a small firm can alter its profitability by appropriately choosing its target market (semi-urban versus urban), pack- size, and distribution channel (traditional retail versus e-retail) (see Table 5). Thereby, within the framework of our problem context, we consider that the small firm's superior product distribution cost is a function of the product pack-size.

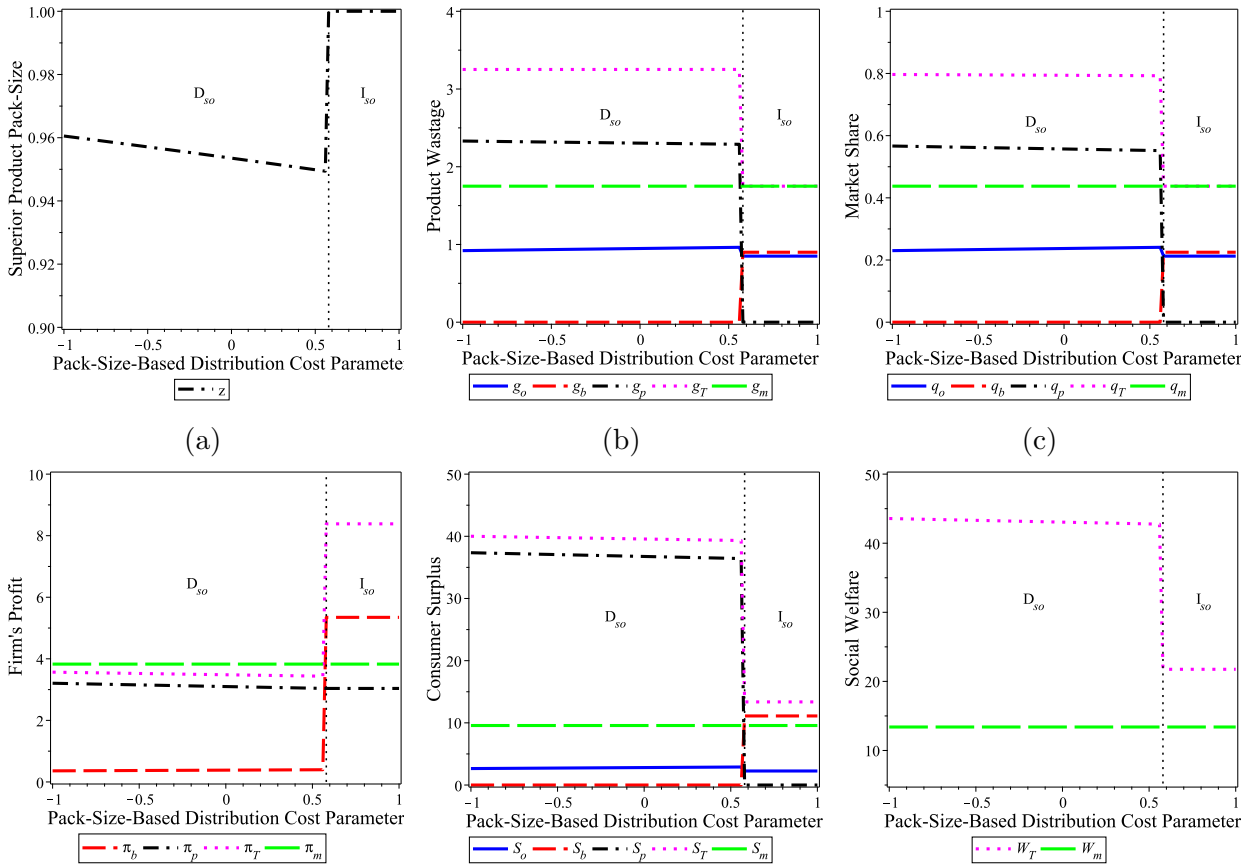
Let's define the small firm's product distribution cost $c_p^d = \dot{c}_p^d\,(1 + k_c z)$, where $k_c\,[-1, 1]$. Here k_c is the parameter of *pack-size-based distribution cost*. It reflects that the firm's product distribution cost increases (decreases) in the superior product pack-size when $k_c > (<)\,0$. The lower (higher) the value of the parameter k_c, the higher is the pack-size-based distribution cost advantage for the small firm.

When $k_c = 0$, the small firm's product distribution cost is constant. In this case, we obtain the structural and qualitative results discussed in the main paper and the supplement previously. When $k_c \neq 0$, the model analysis to determine the small firm's market entry strategy in equilibrium parallels that presented previously in the main paper and the supplement. For brevity, we demonstrate the impact of the parameter k_c for the equilibrium solution in Figure 7.

Figure 7*a* demonstrates that the superior product pack-size decreases in the parameter k_c in the DS channel. It is interesting to note that the impact is monotonic irrespective of whether $k_c < 0$ or $k_c > 0$. The higher (lower) the pack-size-based distribution cost advantage for the small firm, i.e., k_c is lower (higher), the higher (lower) is the superior product pack-size chosen by the small firm. This result immediately suggests that adopting the DS (STI) channel is profitable for the small firm when the pack-size-based distribution cost reduction is higher (lower).

Figure 7*b* shows that the superior (ordinary) product wastage decreases (increases) for the superior and ordinary products. The total product wastage, g_T, decreases as the cost advantage decreases. The implications for the product wastage can be attributed to increasing superior product-pack size, and decreasing (increasing) market share for the ordinary (superior) product (see Figure 7*c*). The aggregate market share decreases. The products' retail prices increase in the parameter k_c (not shown here for brevity). When the small firm's pack-size-based distribution cost advantage is low, the profit for the small (large) firm is small (high) (see Figure 7*d*). Similarly, the consumer surplus for the superior (ordinary) product decreases (increases) with k_c (see Figure 7*e*). Consequently, the total consumer surplus and social welfare decrease (see Figure 7*f*).

These findings bring out interesting insights into the implications of the pack-size-based distribution cost advantage for the small firm. Higher cost advantage has positive implications for the



Note: $\alpha = 500, \theta_o = 1, \theta_b = 2.5, \theta_p = 1.5, k_n = 10, k_d = 0.25, k_q = 2, c_b^d = 1, \dot{c}_p^d = 0.25, c_b^a = 0.5, c_p^a = 0.25, c_q = 1.5, c_z = 1.$

Figure 7 Small Firm's Competitive Strategies: Implications of Pack-Size-Driven Product Distribution Cost

number of consumers that adopt at least one of the products, firms' profits, consumer surplus, and social welfare. However, it results in higher wastage of the products during consumption.