Sustainable or Not? Role of Valuation Uncertainty and Operational Flexibility in Product Line Design

Introduction
The accelerated growth of consumer awareness of responsible consumption in recent years has given rise to increasing demand for sustainable food products (e.g., organic, eco-friendly, fair trade and so on). According to Customer Reports, over 70 percent of consumers in the United States consider whether a product is sustainable when making purchase decisions. Most notably, the sales of organic food in the United States reached a historical record of $43.3 billion in 2015. Hence, sustainability has become an important quality dimension of food products, complementing the traditional quality dimension, such as taste. Major food companies have scrambling to reinvent themselves in the product space to adapt to trends in the marketplace. In the context of the packaged-food industry, the paper explores product line strategies in the face of uncertain market conditions and their implications for consumers’ welfare.

Problem Features
While food companies are aware of the existence of the sustainability-conscious segment in their customer base, they are yet unsure of those customers’ valuation of the sustainability dimension (e.g., willingness-to-pay) now and in the future. Making it more challenging, food companies’ investment in product R&D and production capacity can take years before reaching fruition. Many companies find themselves having to making product R&D commitment on the taste dimension and sustainability dimension of its product line before the uncertainty about customer valuation is resolved. Oftentimes, they do, however, have the flexibility of producing and selling the products in favorable market conditions or shelving some of the products in unfavorable market conditions.
Furthermore, the costs of delivering on two dimensions of quality, namely, taste and sustainability are coupled: the need to adhere to sustainability standards increases both the development (R&D cost) and production (e.g., ingredient and manufacturing) costs. Hence, a coupling cost component links the two quality dimensions for both types of costs. Depending on whether the production cost or the development cost is the more dominating cost factor, we classify products as production-intensive (PIP) or development-intensive (DIP).

Our inclusion of the valuation uncertainty and and the differentiation of R&D and production costs enriches literature the multi-dimension product line design (e.g. Krishnan and Zhu 2006, Chen 2001) by exploring role of market uncertainty and operational flexibility in product line strategies.

Model
We model a profit-maximizing monopolist serving two segments of customers: a conventional segment that values only traditional quality and a sustainable segment that values both the traditional and sustainable qualities. The firm develops and produces one or more products to serve the two segments. Customers’ valuation of traditional quality is known and identical for both segments. We model the sustainable segment’s valuation on sustainability with a two-point distribution.

Development and production costs are increasing and quadratic in the quality level of each dimension. Furthermore, commitment to the sustainable dimension would increase the cost of the traditional dimension, which reflects the incompatibility of the two quality dimensions of food products. We use a coupling coefficient to reflect the challenge of improving quality along both dimensions. Our model setting also allows us to continuously vary the relative intensity of production cost vs. development cost.
We derive the firm’s optimal product line development and deployment strategy, where: the development strategy determines the product line length and quality commitments prior to the realization of valuation uncertainty; the deployment strategy instructs the firm of his pricing and hence production quantity decisions post the realization of valuation uncertainty.

By comparing with a benchmark case where both the product line development and production decisions are made after the realization of valuation uncertainty, we identify trade-offs that any development and production strategy in our model has to balance:

1. Segmentation mis-match: consumption of one or more customer segments decreases
2. Development waste: products are developed but not produced

Results

Due to the decoupling of the development and production decisions, the firm can have up to five distinct optimal strategies leading to various levels of segmentation mis-match and development waste. In general, volatility in the valuation of sustainability is the main driver of development waste, yet benefits the firm’s profit. The balance between a moderate volatility and a high expected valuation causes the firm to develop a longest product line so that the segmentation mis-match is minimized but development waste is maximized. The cost coupling component generates the opposite forces and is the sole inducer of the mis-match/waste trade-off for PIPs. Interestingly, the environment where (a) the conventional segment is small; (b) products are DIP and (c) the coupling component is small, presents a unique opportunity to the firm: it should offer a product with sustainable quality to the conventional segment for moderate expected value and high volatility of the sustainability valuation. Thus, it is the interplay of all features in our model that drives the firm’s optimal strategy and the resulting customer consumption and welfare.
References
