A Dynamic Mechanism for Achieving Sustainable Quality Supply

Extended Abstract

(1) Problem definition: What is your research problem?

Several leading companies have realized the importance of sustainable quality supply and initiated programs to achieve it. While these programs share the same objective and face similar challenges, their details differ in terms of payment structure, contract length and supplier development strategy. This raises the questions of how a new comer to this endeavor should think about the design of such programs and how non-for-profit organizations (governments and NGOs) should help standardize and benchmark the design and foster the development. To shed light on these issues, this paper takes a system (or a social planner’s) perspective. We examine a stylized supply network consisting of one retailer and multiple economically weaker suppliers who work together to supply a quality product to the marketplace over a finite period of time. We use a dynamic mechanism design approach to identify critical contracting terms between the retailer and the suppliers to ensure sustainable quality supply in a multi-period model with double-sided asymmetric information and moral hazard. We also explore supporting strategies to facilitate the implementation of the mechanism.

(2) Academic / Practical Relevance: How is your research problem relevant to the OM research / practice community?

Sustained quality of materials and products is vital for all supply chains -- vital but difficult. For many supply chains serving markets in developed countries, certain key materials are sourced from underdeveloped economies and travel through many parties in different countries. With information asymmetry and unevenly distributed bargaining power along the supply chain, the suppliers at the sources, often small in size and financially constrained, may be poorly compensated; they thus may have difficulty making ends meet, let alone investing in their production processes to maintain or improve the quality of the materials. As a result,
the quality of the supply is at risk, which endangers the sustainability of the entire supply chain. Thus, it is crucial for companies to develop long-term reliable partnerships with their suppliers to ensure sustainable supplies of high-quality materials.

One body of thoughts suggests that sustainable practices is better carried out under mandatory than voluntary agreements. Consequently, the majority works in the fast developing literature on responsible operations examine ways to select and incentivize suppliers to be sustainable in the presence of external pressures such as auditing mechanisms, violation penalty, and brand damage. Another body of thoughts argues that offering suppliers long term contracts and investments can also incentivize suppliers for sustainable practice. The academic studies on the effectiveness of this approach, however, is scant. Our work appears to be among the first attempts to analyse how to design a long term supply chain partnership to achieve sustainability when the suppliers are voluntary to participate in the partnership. In particular, we investigate whether long term agreements can induce the optimal sustainability measure and supplier development investment. This focus is especially relevant when the initial supply chain condition is unfavourable for adopting sustainable practices but it will be if investments are properly made over time.

**Methodology:** What is the underlying research method?

Drawing from the common features of the existing sustainability programs, we first define a sustainability index as the key measure of the process characteristics that ensure social and environmental responsibility. We then use dynamic programming to identify the first-best sustainability index for each period and the optimal supplier-development investment. Next, we consider the decentralized system and construct a multi-period agreement to align the partners’ incentives for efficient information exchange and long-term commitment. The agreement specifies state-dependent sustainability indices and transfer payments in each period as long as all members stay in the agreement. The retailer decides whether to commit
to the agreement before the first period, yet the suppliers' participation is voluntary. Technically, we first generalize the single period AGV mechanism to multiple periods and then construct participation fees for both upstream and downstream firms to induce voluntary participation.

(4) Results: What are your key findings?

We show that the agreement we constructed induces truthful information exchange and achieves the system-wide optimal sustainability index in each period. The agreement is also self-enforceable and induces efficient supplier-development investments. Among all possible agreements, we select the one that appropriately shares the supply chain profit among partners, and term it the Sustainable Quality Supply Agreement (SQSA). We show that the transfer payments every period to each supplier under SQSA consists of a base-line payment for participation and a real-time, type-dependent payment for truthful information sharing and fair pay. This simple structure partly resembles the two-part payment structure commonly observed in practice and hence is easy to implement. While the type-dependent payment is not a static performance (score) based payment like in most existing sustainability programs, it rewards the best level of sustainability index that is possible to achieve under the given environment and thus economically accountable.

(5) Managerial Implications: How can academics/managers/decision makers benefit from your study?

Besides the insights on the payment structure summarized above, we also show that longer contract length, government support, supply chain transparency, pooled investments and knowledge sharing are all important instruments for successful implementation of SQSA. For instance, while knowledge sharing benefits all suppliers, pooled investments only benefit the earliest successes. Only when both pooled investment and knowledge sharing are adopted, the retailer is willing to invest in development projects with low success rates.