Abstract

Over the last few decades, carbon emission has emerged as one of the biggest threats to our environment. In order to curb the emission of harmful greenhouse gases and safeguard the environment, Governments and regulators in different countries have implemented various policies. These policies often lead to redesigning of the entire supply chain. This thesis studies how the supply chain players strategically make decisions under the various policies implemented to curb harmful emissions.

The first essay considers a two-level supply chain model compromising two products with random demand, one of which is energy efficient. We develop three separate optimization models based on a game theoretic set-up between a supplier and a manufacturer, namely: (i) an integrated channel with cap-and-trade, (ii) a decentralized channel with cap-and-trade, and, (iii) co-ordination between the supply chain members. In the first and second models, we determine the optimal mix of the two different products from the manufacturer's perspective and the wholesale price of the raw materials from the supplier's perspective. Additionally, we study the coordination between supplier and manufacturer to improve their profits as well as supply chain. We establish the conditions that coordinate the decentralized supply chain based on the buyback and quantity flexibility contract offered by the supplier. Finally, we analyze the optimal product mix under different market scenarios and derive results that have important implications in determining a product portfolio under the cap-and-trade policy.

In the second essay, we study a manufacturer-retailer channel selling complementary green products under cap-and-trade policy and analyze strategic decision making in these settings. While the manufacturer faces government mandated cap-and-trade norm, the retailer

invests in corporate social responsibility while selling green products. In this problem, we conduct a comparative analysis of the players' decisions under centralized and decentralized scenarios and explore the role that cap-and-trade policy plays in influencing decision outcomes. Further, three contracts are proposed to improve channel performance, namely, two-part tariff, corporate social responsibility effort sharing and green cost sharing based contracts. The results show that collaboration between supply chain players through contracts supports green initiatives vis-à-vis the decentralized channel. However, given a choice of contracts, the channel prefers those where direct benefits accrue to the manufacturer since he incurs greening costs. The results also show that carbon markets play an important role in influencing green initiatives, particularly, under higher trading prices, where manufacturers are incentivized to improve their product offerings. Further, cap-and-trade policy also influences retailers to work towards building higher reputation and brand value by investing in higher CSR effort. From a retail price perspective, we find that consumers benefit under higher trading prices since the benefits of carbon surplus and higher revenues of the supply chain players, lead to lower prices for the consumers. This is in contrast to the decentralized channel outcomes or environmental taxation based studies, where greening or CSR costs get transferred to consumers in the form of higher prices.

The third essay investigates the government's intervention on the strategic decisions of supply chain members. In different channel structures, the members bear the carbon tax during production where a product's demand is influenced by the product's selling price and the carbon emission abatement level. We consider a supply chain problem with two competitive manufacturers and one retailer. Manufacturer 1 produces a standard product (product 1) and manufacturer 2 produces a green product (product 2), and sell these two products to customers

through a retailer. These two products can be substituted by each other. Based on this, we address four different game-theoretic models. First, we analyze the optimal strategies of the supply chain members for a given government tax and compare the strategic decisions for the two products to examine which one would be preferable. Additionally, we study the impact of different parameters on the channel members' strategic decisions and numerically compare the results of different models. Further, the government-objective function is formulated to determine the optimal per unit carbon tax by considering minimum environmental protection and maximum revenue seeking. Finally, we perform sensitivity analyses under eight different scenarios.