[*INFLUENCE OF THE CAP-AND-TRADE POLICY ON GREEN TECHNOLOGY INVESTMENT IN SUPPLY CHAIN CONSIDERING SALE MARKET AND CARBON MARKET RISK CORRELATION*]

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Overview

In this paper, we study the impact of the cap-and-trade policy on a two-tier supply chain consisting of one manufacturer, who sets the wholesale price of a product, produces it and sells it to a retailer, inevitably generating carbon emissions as a byproduct, and one retailer, who sets the retail price of the product, purchases it from the manufacturer, and sells it to the market. The manufacturer, as the carbon emitter, directly bears the carbon price and can strategically make one-time green technology investments to reduce emissions ex ante. We consider a crucial and realistic issue: the correlation between the risks in the sales market and the carbon market. We solve the model and find that the incentivizing effect of carbon price on investment and its diffusion along the supply chain are jointly determined by the market size and risk correlation. Specifically, in a sufficiently large market, high investment becomes worthwhile, i.e. the scale investment effect dominates, thus promoting investment. However, if there is a strong negative risk correlation, the manufacturer can adapt production to avoid high emission costs, i.e. the scale investment effect dominates, thus suppressing investment. Determined by the interaction between the scale investment effect and the production flexibility effect, the cap-and-trade policy effectively promotes green technology investments only in a sufficiently large market with no strong negative risk correlation or in a small market with a strong positive risk correlation. Furthermore, an increase in the carbon price may counterintuitively lead to lower product wholesale and retail prices.

Methods

Sales market. Assume that market demand is stochastic.

Carbon Market. Given that our research focuses on a single manufacturer, we simplify the model by excluding the quota trading process. The quota price in the carbon market is considered as a random variable. This model incorporates the correlation between the risks in the sales market and the carbon market, assuming that there is a certain correlation between the stochastic factor of market demand and carbon price.

Retailer. Assume that the retailer possesses monopolistic market power.

Manufacturer. During production, the manufacturer generates carbon emissions. Prior to commencing production, the manufacturer can strategically invest in green technologies to reduce emissions ex ante, increasing the product greenness.

This research explores the impact of the cap-and-trade policy on green technology investment in supply chain, analyzing how changes in carbon price propagate through the supply chain to the sales market. The specific profit allocation between the manufacturer and retailer is not the primary focus. To simplify the calculations, we initially assume that the manufacturer possesses full bargaining power.

Results

Proposition 1. In a sufficiently large market with no strong negative risk correlation or in a small market with a strong positive risk correlation, an increase in the carbon price can promote investments in green technology for development-intensive products.

The impact of carbon price fluctuations on investment is determined by the interaction between **the scale investment effect** and **the production flexibility effect**. When the carbon price rises, the burden of emission costs increases, motivating investment. In a sufficiently large market, high investment becomes worthwhile with **the scale investment effect** dominating, thus promote investment. However, if there is a strong negative risk correlation, the manufacturer can adapt production to avoid high emission costs, leading **the production flexibility effect** to dominate and suppressing the investment incentive; and vice versa.

Proposition 2. In a sufficiently large market with no strong negative risk correlation or in a small market with a strong positive risk correlation, the retail price decreases in the carbon price.

Fluctuations in the carbon price primarily affect the portion of the retail price attributed to environmental costs. On one hand, an increase in the carbon price directly raises environmental costs. On the other hand, it induces changes in the investment, indirectly affecting environmental costs. According to **Proposition 1**, in a sufficiently large market with no strong negative risk correlation or in a small market with a strong positive risk correlation, the increased carbon price promotes investment. In such cases, the increase in product greenness significantly reduces environmental costs, thus leading to decrease the retail price. In other scenarios, the results are opposite.

Conclusions

Considering the risk correlation between the sales market and the carbon market, the scale investment effect and production flexibility effect, both determined by market characteristics, have influence on the incentivizing effect of carbon price on green technology investment across various supply chains. In the formulation and implementation of the cap-and-trade policy, it is essential to consider enterprise heterogeneity, including industry characteristics and the scale of the sales market.