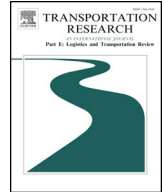




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## Decentralization or integration: Distribution channel selection under environmental taxation

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### ABSTRACT

This study reveals that the environmental tax gets less stringent when the manufacturer's distribution channel becomes more decentralized. Contrary to the classic double marginalization problem, the first implication is that a monopolistic manufacturer benefits from decentralization when its technology is sufficiently polluting. Secondly, with two competing manufacturers, both are more likely to decentralize in equilibrium when their technologies are more polluting. Under certain conditions, decentralized manufacturers may enjoy higher profits thanks to tax cuts without affecting social welfare or consumer surplus. Various extensions of the base models confirm the robustness of the analytical results.

### 1. Introduction

The development of global economy has given rise to many environmental issues. For instance, climate change is one of the most important environmental problems spurring numerous discussions from both practitioners and academia. Furthermore, air pollution, water pollution and solid wastes, among many others, also cause serious environmental deterioration without proper care and intervention. Confronted with such environmental issues, governments have implemented various policies to curb pollution. In particular, environmental taxation, which directly follows the “Polluter-Pays Principle”, has been strongly supported by most OECD and EU countries (Morin and Orsini, 2015).

Taking carbon taxes as an example: they have been widely implemented in European countries such as Denmark, Finland, Germany, Ireland, Italy, Netherlands, Norway, Slovenia, Sweden, Switzerland and UK (Andersen, 2010). As reported by the European Environment Agency (2006), taxation has been the most widely used environmental policy in Europe. In Asia, carbon taxes have been imposed by Japan and India (SBS, 2016). Specifically, Japan implemented a carbon tax in October 2012, and the tax revenue is used to subsidize clean energy and energy saving projects. In July 2010, India introduced a nationwide carbon tax of 50 rupees per metric ton of coal, which has been increased to 100 rupees per metric ton in 2014. In North America, some US states (Oregon, New York and Washington) and Canadian provinces (Alberta, British Columbia and Quebec) have implemented carbon taxes. Besides carbon taxes, there exist other forms of environmental taxes such as landfill fees and water pollution taxes (OECD, 2001).

In this paper, we refer to environmental taxes as generic environment-related taxes imposed on industrial pollution such as air pollution, water pollution and landfill wastes. We focus on discussing how distribution channel structures vary under such environmental taxation in the context of supply chain management. It is well-known that channel decentralization suffers from double marginalization (Spengler, 1950). We attempt to reveal a benefit of decentralization under endogenous environmental tax policies,

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where the government sets a tax rate to maximize social welfare. We aim to address the following research questions: How does the government's taxation policy vary under different distribution channel structures? Do distribution channel strategies change when the government imposes an environmental tax? What is the impact of environmental taxation on the equilibrium channel strategies under supply chain competition? How do competition intensity and technology polluting level affect distribution channel structures?

The main findings are as follows. The environmental tax becomes less stringent when the distribution channel becomes more decentralized. The reason is that a more decentralized channel tends to produce less due to double marginalization, and thereby is less polluting. This has important implications on manufacturers' channel strategies. First, contrary to the classic double marginalization problem, a monopolistic manufacturer can benefit from decentralization when its technology is sufficiently polluting. Second, with two competing manufacturers, both are more likely to decentralize in equilibrium when their technologies are more polluting. Moreover, manufacturers' higher profits under decentralization stem from the tax cut for the less polluting industry structure, which does not affect social welfare or consumer surplus as long as their technologies are polluting enough that environmental taxation remains necessary.

The rest of the paper is organized as follows. Section 2 reviews the previous literature related to this paper. Section 3 analyzes distribution channel strategies in a single supply chain. Section 4 presents extensions and discussions with linear environmental damage, integration efficiency, transport emission, quadratic taxation, an environmentally-friendly manufacturer, and by allowing subsidies. Section 5 further extends the analysis to the case of two competing supply chains. Section 6 concludes the paper.

## 2. Related literature

Two streams of literature are closely related to our research, the first stream on supply chain channel design, and the second stream on environmental policies and market structures. Extensive research has been carried out on supply chain channel design. The pioneering work of [McGuire and Staelin \(1983\)](#) revealed that intermediaries can serve as competition buffers, i.e., decentralization mitigate product market competition. In equilibrium, they showed that the integrated channels always occur and the decentralized channels arise when the products are highly substitutable. [Moorthy \(1988\)](#) revisited channel design and found that the equilibrium channel strategies do not depend on demand substitution (as in [McGuire and Staelin \(1983\)](#)) or complementarity, but depend on whether the price decisions are strategic substitutes or complements at both channel levels.

Building upon the aforementioned research, [Bhardwaj and Balasubramanian \(2005\)](#) generalized the work of [McGuire and Staelin \(1983\)](#) with managerial incentives and found that mixed channels can also arise in equilibrium. [Cao et al. \(2010\)](#) extended the model of [McGuire and Staelin \(1983\)](#) by adding demand uncertainty. [Anderson and Bao \(2010\)](#) compared integrated and decentralized channels and focused on the effect of the number of supply chains. Considering upstream collusion, [Piccolo and Reisinger \(2011\)](#) showed that the discount factor can affect the manufacturers' channel structures. Unlike these studies, we examine channel strategies when the government imposes an environmental tax on the production of the manufacturer(s). Our research reveals that environmental taxes can significantly change the equilibrium channel strategies.

Some studies discussed channel strategies with non-price competition. With quality competition, [Zhao et al. \(2009\)](#) found that both manufacturers only choose integration in equilibrium. [Liu and Tyagi \(2011\)](#) showed that product positioning competition can significantly relax the ensuing price competition and make the retailers decentralize upward in equilibrium. Considering displayed-quantity competition, [Zhou and Cao \(2014\)](#) demonstrated that various channel structures can arise in equilibrium. Instead of adding non-price competition, we concentrate on the effect of environmental taxation on distribution channel design. We find that, even in a single supply chain, the manufacturer benefits much more from decentralization than from integration when its technology is sufficiently damaging to the environment. Furthermore, with two competing supply chains, we demonstrate that the manufacturers are more likely to decentralize in equilibrium when their technologies are more environmentally damaging.

Within a single supply chain, [Desai et al. \(2004\)](#) and [Arya and Mittendorf \(2006\)](#) also found that a manufacturer can benefit from channel decentralization. They examined channel strategies in a multi-period setting where the time-inconsistency problem can be alleviated by decentralization. Differing from these two studies, we show that, even in a single period, the manufacturer's profit from the decentralized channel can be significantly higher than that from the integrated channel under environmental taxation. Some other studies focused on dual-channel supply chain design, including [Balasubramanian \(1998\)](#), [Chiang et al. \(2003\)](#), [Cattani et al. \(2006\)](#), [Arya et al. \(2008\)](#), [Xu et al. \(2010\)](#), [Xia et al. \(2013\)](#), and [Pun \(2013\)](#). Unlike these studies, we concentrate on single-channel distribution strategies.

The second branch of literature related to this paper is on environmental policies and market structures, dating back to [Lee \(1975\)](#) and [Smith \(1976\)](#), which revealed that market structures have an important effect on the efficiency of environmental taxation. Following their works, many other studies revisited the relationship between market structures and environmental taxation. [Oates and Strassmann \(1984\)](#) examined the efficiency of environmental taxation in a mixed market consisting of various types of organizations such as private and public firms. [Conrad and Wang \(1993\)](#) compared pollution taxes and abatement subsidies under three market structures: perfect competition, oligopolistic competition and a dominant firm with a competitive fringe. More relevantly, [Markusen et al. \(1993\)](#) discussed environmental taxation in a two-market, two-firm model where firms locate their plants endogenously. They demonstrated that the social cost can be very high if environmental taxation ignores market endogeneity. With oligopolistic competition, [Katsoulacos and Xepapadeas \(1996\)](#) found that the optimal emissions tax could exceed marginal environmental damage under an endogenous market structure. Similarly, [Lee \(1999\)](#) revisited environmental taxation under an endogenous oligopolistic market structure and found that the equilibrium number of firms in a market may differ from the socially optimal number of firms.

[Althammer and Bucholz \(1999\)](#) discussed how market structures impact the second-best choice of the environmental tax. [Cato](#)

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