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Does industrial waste taxation contribute to reduction of landfilled waste? Dynamic panel analysis considering industrial waste category in Japan

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ABSTRACT

Waste taxes, such as landfill and incineration taxes, have emerged as a popular option in developed countries to promote the 3Rs (reduce, reuse, and recycle). However, few studies have examined the effectiveness of waste taxes. In addition, quite a few studies have considered both dynamic relationships among dependent variables and unobserved individual heterogeneity among the jurisdictions. If dependent variables are persistent, omitted variables cause a bias, or common characteristics exist across the jurisdictions that have introduced waste taxes, the standard fixed effects model may lead to biased estimation results and misunderstood causal relationships. In addition, most existing studies have examined waste in terms of total amounts rather than by categories. Even if significant reductions in total waste amounts are not observed, some reduction within each category may, nevertheless, become evident.

Therefore, this study analyzes the effects of industrial waste taxation on quantities of waste in landfill in Japan by applying the bias-corrected least-squares dummy variable (LSDVC) estimators; the general method of moments (difference GMM); and the system GMM. In addition, the study investigates effect differences attributable to industrial waste categories and taxation types. This paper shows that industrial waste taxes in Japan have minimal, significant effects on the reduction of final disposal amounts thus far, considering dynamic relationships and waste categories.

1. Introduction

Waste taxes, such as landfill and incineration taxes, have emerged as a popular option in developed countries to promote the 3Rs (reduce, reuse, and recycle). Most member states of the European Union (EU) have introduced landfill taxes (BIO Intelligence Service, 2012). For example, the United Kingdom has introduced a landfill tax since 1996. The standard rate that applies to all active waste has been raised annually, and the rate amounts to 80 pounds (127 dollars) per ton as of 2014.[1] Some countries, such as Demark and France, have gone further to implement incineration taxes.

In areas where the central government is not involved in waste taxes, some local governments have introduced such taxes of their own volition. For example, 20 states in the United States have introduced landfill taxes (Kinnaman, 2006). In Italy, landfill taxes have been implemented at the regional level since 1996, and the tax rate varies by region (BIO, 2012; Mazzanti et al., 2012). A similar pattern emerges for Japan's industrial waste taxes. More than half of Japan's prefectures enforce industrial waste taxation, which the tax base refers to as transporting waste to intermediate treatment facilities and landfills at the prefecture level, though the Japanese government is not involved in such enforcement.

Many economic studies have assessed the effectiveness of unit-based pricing on the curbside collection of municipal solid waste (Kinnaman, 2009). However, few studies have examined the effectiveness of landfill taxes or incineration taxes. In addition, quite a few studies have considered both dynamic relationships among dependent variables and unobserved individual heterogeneity among the jurisdictions. If dependent variables are persistent, omitted variables cause a bias, or common characteristics exist across the jurisdictions that have introduced waste taxes, the standard fixed effects model, which is a popular estimation in panel data analysis, may lead to biased estimation results and misunderstood causal relationships. In addition, most existing studies have examined waste in terms of total amounts rather than by categories. Even if significant reductions in total waste amounts

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[1] The British pound is converted into US dollars assuming an exchange rate of approximately 1 pound to 1.59 dollars (the average rate in 2013).

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Table 1
Trend of enforcement of industrial waste taxation and total amounts of industrial waste generated and disposed of in landfills in Japan. *Source*: Ministry of the Environment and Ministry for Internal Affairs and Communications.

	2000FY	2001FY	2002FY	2003FY	2004FY	2005FY	2006FY	2007FY	2008FY	2009FY
Number of prefectures enforcing Industrial waste taxation										
Type A	0	0	1	1	2*	2	2	2	2	2
Type B	0	0	0	3	9*	13	18	19	19	19
Type C	0	0	0	0	0	6	6	6	6	6
Total	0	0	1	4	11*	21	26	27	27	27
Total amount of industrial waste generated (thousand tons)										
	406,037	400,243	393,234	411,623	417,156	421,677	418,497	419,425	403,661	389,746
Total amount of industrial waste disposed in landfills (thousand tons)										
	45,000#	42,000#	39,561	30,440	25,827	24,229	21,799	20,144	16,701	13,591

* Although industrial waste taxes in a part of prefectures were enforced in January 2004, they are counted in 2004FY in accordance with this analysis method noted later.
\# Approximation.

are not observed, some reduction within each category may, nevertheless, become evident.

Therefore, this study analyzes the effects of industrial waste taxation on quantities of waste in landfill in Japan by applying the bias-corrected least-squares dummy variable (LSDVC) estimators (Kiviet, 1995); the general method of moments (difference GMM) (Arellano and Bond, 1991); and the system GMM (Arellano and Bover, 1995; Blundell and Bond, 1998). In addition, the study investigates effect differences attributable to industrial waste categories and taxation types.[2] Industrial waste is generated as a byproduct by economic activity. In Japan, most of the generated waste passes through intermediate disposal sites such as incinerators before it is brought to landfills. The rate of landfilled waste relative to the total amount of industrial waste generated has gradually decreased, and was about only 3.5% in 2009. However, the total amount of industrial waste disposed of in landfills is still nearly 10 million tons (Table 1), and therefore it is not negligible.

This paper proceeds as follows. Section 2 outlines industrial waste taxes in Japan. Section 3 provides an overview of existing relevant studies on waste taxes. Section 4 explains the estimation methods and data used in the analysis. Section 5 presents the estimation results, and Section 6 offers concluding remarks.

2. Industrial waste taxation in Japan

Currently, 27 out of Japan's 47 prefectures enforce industrial waste taxes following their introduction in the Mie Prefecture in 2002. Industrial waste taxation is an objective tax that includes two elements: raising financial resources and promoting incentives for adhering to the 3Rs principle, with proper industrial waste disposal methods. The three types of taxation employed at the prefecture level are described below.

Type A taxation involves declaration payments made by waste generators. Waste generators are taxed on their direct transport of waste to landfills and to intermediate treatment facilities except recycling facilities. This type of industrial waste taxation is based on declarations by the waste generators. Two prefectures use this type of taxation by imposing a tax of 1000 yen (10 dollars) per ton of waste transported to landfills.[3] This tax rate is common among the three types of industrial waste taxation in Japan. Unique to Type A, however, a specific coefficient is multiplied for waste transported to intermediate treatment facilities, considering the environmental impact of final disposal. For example, an additional tax rate of 100 yen (1 dollar) per ton is imposed on transporting the waste to incinerators. Type A taxation is said to generate the strongest incentive for waste reduction among the three types of taxation because waste generators are taxed on direct waste transport to both landfills and intermediate treatment facilities except recycling facilities (Morotomi, 2003).

Type B taxation is a special levy on contractors involved in the final disposal of waste. This tax is similar to the landfill tax in the United Kingdom and other countries, and it is now the most popular type of industrial waste taxation in Japan. In this type of taxation, waste generators, including intermediate treatment facilities, are taxed on the amount of waste transported to landfills. This type of taxation has two major characteristics: It is based on transporting waste only to landfills, and final disposal contractors must levy the tax on waste generators on behalf of a prefecture's government. All prefectures that have introduced this type of industrial waste taxation have applied a tax of 1000 yen (10 dollars) per ton.[4] Type B taxation costs the least among the three types of taxation because the tax is only applied to waste transported to landfills. However, Type B is widely considered to provide weaker incentives for waste reduction than Types A and C, although we can still expect a reduction of waste sent to landfills (Morotomi, 2003).

Type C is also a special levy on intermediate disposal contractors with incinerators and final disposal contractors. This type of industrial waste taxation, implemented in six prefectures on Kyushu Island, exhibits two major characteristics. First, waste generators are taxed on transporting waste not only to landfills but also to incinerators. Second, intermediate disposal contractors with incinerators are also taxed on transporting waste (e.g., post-incineration ashes) to landfills. All prefectures that have introduced this type of taxation have placed taxes of 1000 yen (10 dollars) per ton on transporting waste to landfills and 800 yen (8 dollars) per ton on transporting waste to incinerators. It is anticipated that this type of tax will generate incentives to reduce the amount of waste stronger than those of Type B, but weaker than those of Type A.

Table 1 shows that the number of prefectures enforcing industrial waste taxation increased for several years prior to 2007, but has remained steady thereafter. Table 1 also shows trends in the total amounts of industrial waste generated and disposed of in Japan's landfills over the past decade. As indicated, in this time frame, the total amount of industrial waste generated in Japan has remained almost constant, while the total amount of industrial waste disposed in landfills has gradually decreased. Given this pattern, this paper analyzes whether industrial waste taxation contributes to the observed reduction of landfilled waste in Japan.

[2] In Japan, industrial waste includes both hazardous and nonhazardous waste, particularly, ash, sludge, waste oil, waste acid, waste alkali, waste plastics, and others, identified by a cabinet order among all the wastes left as a result of business activity.

[3] The Japanese yen is converted into US dollars assuming an exchange rate of approximately 100 yen to 1.02 dollars (the average rate in 2013).

[4] Some prefectures introduced industrial waste taxation at a lower level, and followed by a gradual increase to 1000 yen per ton.