WINPEC Working Paper Series No. E2410
January 2025

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Abstract:

In this study, we examine how ordinary taxes and earmarked taxes influence tax pass-through in a market experiment. We hypothesize that tax pass-through is lower for earmarked taxes than for ordinary taxes and that this difference depends on market conditions, specifically the balance between the trade surpluses for sellers and buyers. Our findings confirm that ordinary taxes result in full tax pass-through, whereas earmarked taxes result in less pass-through. Under earmarked taxes, sellers adjust the level of pass-through based on their trade surplus relative to the buyers' trade surplus. These results underscore the need to distinguish between tax types. The results of our study provide novel insights into the resource allocation effects of different tax types, offering significant implications for policymakers seeking to regulate goods with externalities through taxation.

Keywords: ordinary taxes; earmarked taxes; statutory incidence; market experiment

JEL Classification codes: H22; H25; H32

Declaration of Conflicting Interests: None

Funding: This work was supported by the Research Institute for Small and Medium Enterprise Management, Osaka University of Economics.

1 Introduction

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Policymakers often impose taxes in an effort to regulate consumption of goods that have externalities. For example, gasoline taxes aim to curb gasoline consumption and mitigate carbon dioxide emissions, while tobacco taxes aim to reduce the number of smokers.

However, the use of taxes to adjust consumption of goods poses a challenge to policymakers. The primary obstacle is the nature of indirect taxes. Unlike direct taxes, whereby taxpayers directly remit their payments to national or local governments, indirect taxes target the sellers of the goods. These sellers then remit the tax collected to the government. As a result, the sellers determine the prices of the goods. By adjusting the supply curve, sellers determine the extent to which the tax burden falls on the buyers' shoulders. This dynamic complicates policymakers' efforts to effectively adjust consumption.

Indirect taxes include both ordinary taxes and earmarked taxes, and the degree of tax pass-through, that is, the extent to which the seller passes on the tax burden to the buyer in the form of higher prices, varies based on the tax type. Numerous previous studies have posited that companies that support the aim of the taxes imposed on them can benefit society or the provision of public goods, and might even encourage tax compliance and deter tax evasion (e.g., Wenzel, 2005; Djanali and Sheehan-Connor, 2012; Alm et al., 2019). Such insights suggest that the perception of tax utility can shape taxpayer behavior and sentiment. Kallbekken et al. (2011) also found that tax aversion and a preference for fairness can significantly influence support for these taxes. Thus, if a seller views an earmarked tax as socially beneficial, its effect on supply might diverge from that of an ordinary tax.

Given that the tax pass-through level differs between ordinary taxes and earmarked taxes, the government can manipulate consumption through the application of particular types of taxes. For example, the government can select the tax type that is most effective in limiting the consumption of externality-laden goods. Understanding the changes in the level of tax pass-through caused by each tax type is vital, prompting an investigation into the effects of ordinary taxes and earmarked taxes on such shifts.

Further analysis highlights important differences between ordinary taxes and earmarked taxes, particularly in terms of how they affect tax pass-through, which depends

on market conditions. Because sellers determine the prices of goods, they can adjust the extent to which they pass on the tax burden based on how the benefits from trade are shared between buyers and sellers, which is reflected in their respective trade surpluses.

When the seller's surplus exceeds the buyer's at the market equilibrium price, the seller gains more benefit from the transaction than the buyer. In response, under earmarked taxes, sellers have some flexibility in accounting for social contributions, leading to a tax pass-through level of less than 100%. Therefore, the relative sizes of the economic surpluses of sellers and buyers can significantly influence the degree of tax pass-through in markets subject to earmarked taxes.

Our study yielded two primary findings. First, the change in the tax pass-through level differs depending on whether an ordinary tax or an earmarked tax is applied. Specifically, earmarked taxes lead to a lower level of tax pass-through, whereas ordinary taxes result in full tax pass-through. Second, the level of tax pass-through for both ordinary taxes and earmarked taxes differs depending on the market conditions. We found that ordinary taxes were subject to full pass-through regardless of the market conditions. However, the level of pass-through of earmarked taxes depended on the seller's surplus relative to the buyer's surplus, with sellers adjusting the level of tax pass-through accordingly.

The results of this study provide a novel contribution to the literature and have significant implications for economic policymaking. Historically, when exploring the level of tax pass-through, classical economic theory has focused on the question of economic incidence, that is, who ultimately bears the tax burden, and paid relatively little attention to statutory incidence, that is, who is legally responsible for remitting the tax to the government[5]. Despite their importance in relation to tax policy (Slemrod, 2019), it is only recently that empirical studies have begun to address these aspects (e.g., Slemrod, 1990; Fox, 2022).

Statutory taxes fall into two broad categories: ordinary taxes and earmarked taxes. Previous studies (e.g., Poterba, 1996; Ross and Lozano-Rojas, 2018) have found that

[5] Economic incidence has been examined in relation to diesel and fuel taxes (Kopczuk et al., 2013; Doyle and Samphantharak, 2008; Marion and Muehlegger, 2011), carbon taxes (Ganapari et al., 2009; Fabra and Reguant, 2014), tobacco taxes (Hanson and Sullivan, 2009; Harding et al., 2012),beer taxes (Shrestha and Markowitz, 2016), and sales taxes (Besley and Rosen, 1999; Carbonnier, 2007).

buyers typically bear the burden of ordinary taxes. Meanwhile, although there have been numerous studies on earmarked taxes, the findings regarding their impact on tax pass-through are inconsistent.

Previous studies have often overlooked the distinction between ordinary taxes and earmarked taxes when examining the effect of statutory incidence on tax pass-through levels. In real-world settings, isolating the impacts of these tax types is challenging because of the scarcity of identical goods that are subject to both types of taxes. However, laboratory experiments offer a controlled environment in which we can systematically investigate these distinctions. By simulating market conditions, these experiments can isolate specific variables, providing clearer insights into causal relationships. Therefore, we conducted a controlled market experiment to enable us to compare how ordinary and earmarked taxes influence tax pass-through levels with the aim of filling the existing research gap and providing actionable insights for policymakers.

In this study, we aimed to identify who ultimately bears the burden of indirect taxes and how these taxes affect resource allocation. Given that sellers set prices under indirect taxation, policymakers encounter challenges in regulating the consumption of goods with negative externalities. If sellers do not adjust prices as intended, increased demand can exacerbate issues such as environmental degradation. By employing experimental methods, we can systematically analyze these dynamics in a controlled setting, offering precise insights into the economic impacts of different tax structures. This approach not only clarifies the theoretical implications of tax incidence but also provides empirical evidence to guide effective policy formulation.

The remainder of this paper is organized as follows. Section 2 introduces our hypotheses, Section 3 describes the experimental procedure, Section 4 presents our empirical analysis, Section 5 describes and discusses the results, and Section 6 concludes, with suggestions for future research.

2 Hypotheses

In our laboratory experiments, we tested two hypotheses designed to shed new light on the impact of ordinary taxes and earmarked taxes on supply curve shifts.

Traditional economic theory suggests a change in the level of tax pass-through based

on the amount of tax imposed on a good. However, if a seller is subject to an earmarked tax on the goods they produce and sympathizes with the aim of the earmarked tax, the change in the level of tax pass-through might be less pronounced than that caused by an ordinary tax. For instance, previous studies by Andreoni (1988, 1989), Andreoni and Petrie (2004), and Landry et al. (2010) suggested that individuals derive utility from donations, and that companies are more likely to comply with taxes perceived to contribute to societal benefits, as noted in other studies (e.g., Wenzel, 2005; Djanali and Sheehan-Connor, 2012; and Alm et al., 2019). Therefore, we expect that if an earmarked tax is designated for social contribution, its impact on the level of tax pass-through will be less pronounced than that of an ordinary tax.

Hypothesis 1. *When a seller is subject to an ordinary tax, they pass on the entire tax burden to the buyer. However, when a seller is subject to an earmarked tax, they pass on part of the tax burden to the buyer and bear a portion of the tax burden themselves.*

Sellers can adjust their supply curves depending on the market in which they are participating. Specifically, if the seller's surplus is greater than the buyer's surplus, the seller is more likely to profit than the buyer. Therefore, the seller might have some leeway to consider social contributions and, as a result, the supply curve might exhibit undershifting in response to an earmarked tax. However, if the buyer's surplus is greater than the seller's surplus, the seller is less likely to profit than the buyer. Because sellers are not obtaining sufficient profits, they might not have any leeway to consider social contributions. Hence, the level of tax pass-through is expected to change in a way that fully reflects the imposition of an earmarked tax. This phenomenon is similar to that of the theory of equity, reciprocity, and competition proposed by Bolton and Ockenfels (2000), which posits that individuals are motivated not only by pecuniary gains but also by their relative standing and social preferences. Therefore, the relative sizes of the sellers' and buyers' surpluses influence the change in the tax pass-through level when an earmarked tax is imposed.

Hypothesis 2. *When the seller's surplus exceeds the buyer's surplus, an earmarked tax*

is more likely to result in a lower level of tax pass-through.

3 Experimental Procedure

A laboratory experiment was designed and conducted in an effort to determine whether the shift in the supply curve differed depending on whether it was an ordinary or an earmarked tax that was introduced.

Our experiment involved a double auction format using the induced value mechanism proposed by Smith (1976). This mechanism assigns private monetary values to participants, representing their maximum willingness to pay as buyers (buyer's induced value) or their minimum acceptable price as sellers (seller's induced value) for a single unit of the commodity. This allows experimenters to control for the participants' preferences and observe behaviors that reflect experimental conditions rather than personal biases. In our experiment, participants were explicitly informed that their induced values were strictly confidential and would vary across rounds and among participants.

We tested three treatments: **T1**, **T2**, and **T3**. In **T1**, we collected a tax of 100 Japanese yen (JPY) (approximately 1 United States dollar at the time of the experiment) from sellers, explaining that this tax would be redirected as research funding to the experimenters. We designated this tax as an ordinary tax and did not specify its purpose. In **T2**, we collected a tax of 100 JPY from sellers, explicitly stating that the tax would be donated to the Japanese Red Cross Society (JRCS). Because the purpose of the tax was clearly stated, we classified it as an earmarked tax. **T3** involved a market with no taxes, which served as the baseline case. It is important to note that we set the seller's induced value in **T1** and **T2** to be 100 JPY lower than in **T3,** while ensuring that the theoretical market conditions remained the same across all treatments. Therefore, if the entire tax burden is passed on to buyers in **T1** and **T2**, then **T1**, **T2**, and **T3** should result in the same equilibrium price.

Each treatment was conducted over four sessions, each involving 14 participants, all of whom were recruited from Waseda University. Recruitment guidelines were posted on the Waseda University student portal, where interested students applied to participate. We recruited a total of 168 fluent Japanese-speaking students (29 percent female), predominantly undergraduates from various majors. Our selection criteria were designed to avoid biases related to major, age, and gender, ensuring that no participant had

characteristics significantly different from those of the group. Students who had previously participated in this experiment were not allowed to participate again.

The experiment was conducted in a laboratory at Waseda University from February 2018 to December 2018. We used z-Tree (Fischbacher, 2007) to design the experiment.

When participants entered the laboratory, they sat in randomly assigned seats separated by partitions that hid the computer screens of the participants in the adjacent seats. After all participants were seated, we distributed a manual containing instructions, which was also read to the participants using computerized voice software.

We then conducted two practice rounds to verify the operation of the computer program and the participants' understanding of the instructions. The 14 participants in each session were randomly divided into seven buyers and seven sellers. During the practice rounds, participants had the opportunity to act as both a buyer and a seller, and the results from these rounds did not affect their rewards. At the end of the practice rounds, participants were asked if they had any questions. Following this, 10 rounds of the experiment were conducted, with participants randomly assigned to the roles of buyer or seller in each round.

When trading began, a computer screen displayed each participant's role (buyer or seller) along with their induced value, which was hidden from the other participants. Participants were allowed to make or accept offers as long as they would not incur a loss. Specifically, buyers could make purchase offers at prices equal to or lower than their induced values, while sellers could make sale offers at prices equal to or higher than their induced values. Similarly, buyers could accept sale offers and sellers could accept purchase offers at prices that met these criteria. Both buyers and sellers had the option of withdrawing their offers by pressing the 'Cancel' button and submitting new offers. A deal was struck when a buyer accepted a sale offer or a seller accepted a purchase offer, after which they exited the market. When either all participants had struck deals or the four-minute time limit had expired, a new round commenced with a new set of buyers, sellers, and induced values.

During each round, participants received full market information except for other participants' induced values. All other participants' offers were visible on the right-hand side of the screen. When a deal was struck, the price of the accepted offer was displayed

as the closing transaction price on the screens of participants who had not yet completed a transaction. The screen also displayed the number of buyers and sellers remaining in the market.

The total profits obtained from the 10 rounds, along with a 500 JPY participation fee, were paid to participants at the conclusion of the session. The profit obtained in each round was defined as the difference between the induced value and the closing transaction price. Participants received an average payment of approximately 2300 JPY. Each session lasted for approximately 90 minutes. Following the experiment, donations were made to the JRCS.

Table 1 shows the induced values for all 10 rounds in T1 and T2, while Table 2 shows the indued values for all 10 rounds in T3. The parameters in T3 were derived by subtracting 100 JPY from the sellers' parameters in each round in T1 and T2. Therefore, if the sellers in T1 and T2 passed on the entire tax burden of 100 yen to the buyers, the equilibrium price and quantity would be the same as those in T3.

Table 1: Induced values (JPY) by round (T1 and T2)

Round	Induced values							
1	Buyer	1400	1300	1200	1100	1000	1000	1000
	Seller	500	600	700	800	800	1000	1000
2	Buyer	1100	1100	1000	900	900	700	700
	Seller	300	400	500	600	700	700	800
3	Buyer	1700	1600	1500	1400	1100	1100	900
	Seller	800	900	1000	1100	1200	1200	1300
4	Buyer	900	800	700	500	400	300	100
	Seller	0	100	200	200	500	600	800
5	Buyer	1200	1100	1100	1000	1000	800	600
	Seller	300	400	500	600	700	800	1100
6	Buyer	1600	1500	1400	1400	1300	1200	1100
	Seller	700	800	800	900	1000	1100	1200
7	Buyer	800	800	800	800	600	600	600
	Seller	200	200	200	200	200	600	600
8	Buyer	1400	1400	1400	1300	1300	1100	900
	Seller	600	700	700	1100	1100	1100	1200
9	Buyer	1000	1000	1000	700	600	500	400
	Seller	300	300	300	400	400	400	400
10	Buyer	1000	1000	1000	700	600	500	400
	Seller	400	400	400	500	500	500	500

Table 2: Induced values (JPY) by round (T3)

Round	Induced values							
1	Buyer	1400	1300	1200	1100	1000	1000	1000
	Seller	600	700	800	900	900	1100	1100
2	Buyer	1100	1100	1000	900	900	700	700
	Seller	400	500	600	700	800	800	900
3	Buyer	1700	1600	1500	1400	1100	1100	900
	Seller	900	1000	1100	1200	1300	1300	1400
4	Buyer	900	800	700	500	400	300	100
	Seller	100	200	300	300	600	700	900
5	Buyer	1200	1100	1100	1000	1000	800	600
	Seller	400	500	600	700	800	900	1200
6	Buyer	1600	1500	1400	1400	1300	1200	1100
	Seller	800	900	900	1000	1100	1200	1300
7	Buyer	800	800	800	800	600	600	600
	Seller	300	300	300	300	300	700	700
8	Buyer	1400	1400	1400	1300	1300	1100	900
	Seller	700	800	800	1200	1200	1200	1300
9	Buyer	1000	1000	1000	700	600	500	400
	Seller	400	400	400	500	500	500	500
10	Buyer	1000	1000	1000	700	600	500	400
	Seller	500	500	500	600	600	600	600

4 Empirical Analysis

We compared the impact of ordinary taxes and earmarked taxes on the change in the tax pass-through level. As mentioned above, in T1, a tax of 100 yen was collected from sellers for ‘return to the research fund,’ while in T2, a tax of 100 yen was collected for ‘donation to the JRCS.’ In addition, because the valuations of all sellers were set 100 yen lower in T1 and T2 than in T3, the equilibrium prices and quantities were the same under all treatments if the seller passed on 100% of the tax burden to the buyer. Therefore, if the seller made a profit of more than 100 yen compared with T3, the seller made the buyer pay more than their own tax burden. This is overshifting. Meanwhile, if there was no profit for the seller compared with T3, there was a full pass-through, and if there was a profit of less than 100 yen for the seller compared with T3, there was undershifting.

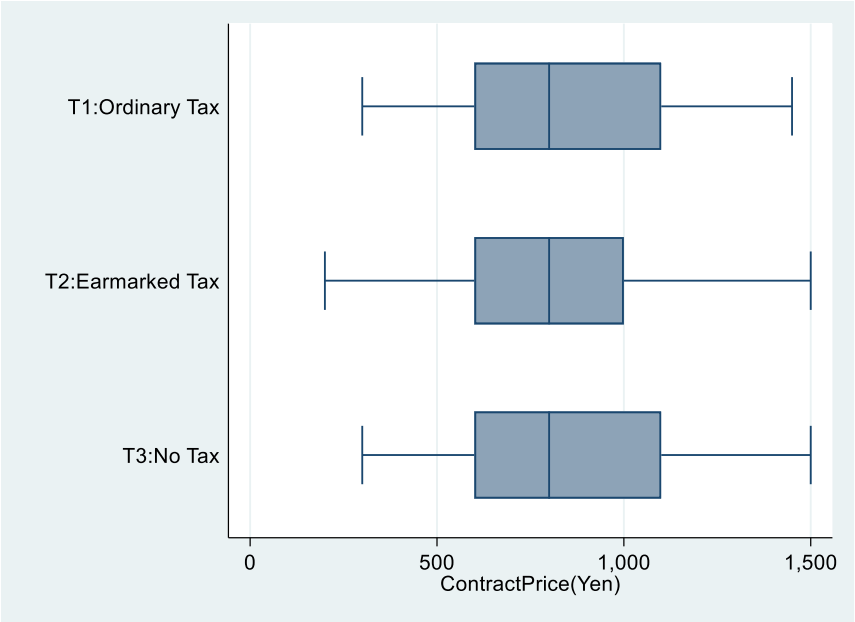

Figure 1 : Contract prices under various treatments

Figure 1 shows a box plot of the contract prices for each condition. It can be seen that prices under earmarked taxes tended to be lower than those under ordinary taxes. This suggests that earmarked taxes effectively incentivize traders to negotiate lower prices.

Table 3 presents the data derived from the experiment. The entries shown in **Table 3** are at the round level and include the average price and its standard deviation, quantity traded, total buyer and seller profits per period, and a measure of efficiency. It can be seen from **Table 3** that on average, in round 1, 21 trades occurred at an average trading price of 925.52 yen (standard deviation 98.76 yen), total buyer and seller profits were 1355.5 yen and 694.5 yen, respectively, and traders captured 98 percent of the available profits.

It can be seen from **Table 3** that sellers subjected to an earmarked tax earned less profits than those subject to an ordinary tax. Furthermore, there were more transactions under an earmarked tax than under an ordinary tax, and efficiency was higher under an earmarked tax than under an ordinary tax. This suggests that an earmarked tax can avoid overshifting in the tax pass-through level.

This is likely because an earmarked tax is associated with a specific social benefit, making sellers more willing to accept the burden despite the resulting loss. In addition, these results show that static equilibrium tendencies are determined not only by the

intersection of the demand and supply curves but also by the shapes of those curves.

Table 3: Experimental data

	Market Round									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T1. Ordinary Tax (N=56)									
Average Price	930.47	763.3	1217.77	506.25	865.25	1156.52	560	1128.15	591.81	659.05
Standard Deviation	207.03	94.66	148.58	92	88.42	103.25	97.31	117.2	95.73	107.48
Quantity	19	20	18	16	20	23	24	19	22	17
Profits:										
Buyers	1130.25	1183.5	1270	875	1073.75	1425	1040	1091.25	1295	1049
Sellers	819.75	791.5	530	1125	1326.25	1050	1160	958.75	805	551
Efficiency	0.93	0.99	0.9	1	1	0.99	0.96	0.98	1	1
	T2.Earmarked Tax (N=56)									
Average Price	925.95	751.66	1191.23	459.93	820	1102.04	563	1091.55	605.45	653.73
Standard Deviation	161.53	109.92	161.36	135.52	109.31	101.04	91.65	139.91	108.59	93.61
Quantity	22	21	17	16	21	24	20	20	22	19
Profits:										
Buyers	1130.25	1183.5	1270	875	1073.75	1425	1040	1091.25	1295	1049
Sellers	587.25	746.25	387.75	939.75	1155	712.25	1315	757.75	880	530.25
Efficiency	0.82	0.96	0.83	0.91	0.93	0.85	1.02	0.88	1.04	0.99
	T3. No Tax(N=56)									
Average Price	927.52	780.15	1225.43	493.47	829.47	1170.82	517.55	1129.36	594.59	622
Standard Deviation	98.76	81.1	119.63	121.54	97.49	98.56	109.75	144.86	91.79	64.2
Quantity	21	20	16	17	19	23	20	19	22	20
Profits:										
Buyers	1355.5	1099.25	1298.25	902.75	1210	1367.75	1162.25	1110.5	1279.75	1190
Sellers	694.5	875.75	676.75	1047.25	1140	1132.25	1087.75	964.5	820.25	410
Efficiency	0.98	0.99	0.99	0.98	0.98	1	0.98	0.99	1	1
	Theoretical Paremeters									
Theoretical Price	1000	800	1250	450	850	1200	600	1200	500	600
Theoretical Buyer Profit	1000	1000	1200	1100	1150	1200	800	800	1800	1300
Theoretical Seller Profit	1100	1000	800	900	1250	1300	1500	1300	300	300

To conduct an accurate analysis, it is necessary to use the ordinary least squares method because several factors, including income, gender, and other socioeconomic characteristics, can influence rent allocation decisions. These data allow us to control for these individual-specific attributes and to explore the impact of the two types of taxes on the change in the level of tax pass-through.

However, it is difficult to estimate such a relationship based on experimental data, because not all participants traded in every round. To address this situation, Heckman (1979) developed a two-step selection model that treats truncation as an omitted-variable problem. In the first step, we estimated a random effects probit model as follows:

$$E_{it} = \beta T2_{it} + \rho T3_{it} + X'_{it}\alpha + \delta Z_{it} + \gamma_t + u_{it}, \quad (1)$$

where E_{it} takes a value of 1 if subject i executes a trade in round t and a value of 0 otherwise, $T2_{it}$ takes a value of 1 if subject i is in group T2 (the earmarked tax group) and receives a treatment in round t, and $T3_{it}$ takes a value of 1 if subject i is in group T3 (the no tax group) and receives a treatment in round t.

X_{it} includes subject-specific characteristics such as gender, having a part-time job, and past volunteering and donation experience. 'Male' is a gender dummy that takes a value of 1 if the participant is male and 0 otherwise. 'Parttime' is a dummy variable that takes a value of 1 if the participant has a part-time job and 0 otherwise. The aim of this study was to examine the effects of a tax explicitly designated for donations. Therefore, we included two explanatory variables: Donation Experience and Volunteer Experience. 'DonationExperience' took a value of 1 if the participant had donated in the past and 0 otherwise. Similarly, 'VolunteerExperience' took a value of 1 if the participant had volunteered in the past and 0 otherwise.

Heckman's two-step selection model requires exclusion restriction. Therefore, following List (2004), we created a variable Z_{it}, which was used as an exclusion restriction, indicating that participants received an induced value that placed them in the market. For sellers (buyers), this dichotomous variable took a value of 1 if the induced value was less (greater) than the equilibrium price. γ_t represents the round effect controlling for learning over the market session, and u_{it} is an error term.

In the second step, the inverse Mills ratio was obtained as follows

$$P_t^* - P_{it}^S = \beta T2_{it} + \rho T3_{it} + X_{it}'\beta + \sigma\lambda\left(X_{it}'\hat{\alpha} + \hat{\delta}Z_{it}\right) + \gamma_t + v_{it}. \quad (2)$$

To obtain the difference in terms of treatment between the neoclassical price prediction (P_t^*) and the executed market price (P_{it}^S), we used $P_t^* - P_{it}^S$ as the dependent variable. $T2_{it}$, $T3_{it}$, and X_{it} were the same as in the first step regressors.

$\lambda(X_{it}'\hat{\alpha} + \hat{\delta}Z_{it})$ represents the estimated inverse Mills ratio, while γ_t represents the round effect controlling for learning over the market session and the difference in the market parameters. v_{it} is an error term.

5 Results and Discussion

In this section, we discuss the two results we obtained. First, we investigated whether

the change in the tax pass-through level differed depending on whether it was an ordinary tax or an earmarked tax that was applied. Second, we examined how the magnitude of the buyers' and sellers' surpluses affected the change in the tax pass-through level when an earmarked tax was imposed.

5.1. Effects of ordinary taxes and earmarked taxes on supply shifts

Table 3 shows the empirical estimates using separate regression specifications. Column (1) of **Table 3** shows the results of the first-stage probit analysis used to identify the effects of ordinary taxes and earmarked taxes on trade execution. There were no differences between the effects of an ordinary tax and an earmarked tax on trade execution because none of the coefficients was statistically significant at the 5% level. Column (2) in **Table 3** shows the results of the second-stage regression estimates. These results suggest that, conditional on making a trade, the difference between the neoclassical price prediction (P_t) and the executed market price (P_{it}) under an earmarked tax treatment is positive and statistically significant at the 5% level, indicating that buyers under an earmarked tax treatment pay a higher price than those under an ordinary tax treatment.

Individuals who have contributed socially in the past may be more responsive to earmarked taxes. Therefore, the interaction terms between an earmarked tax and a dummy variable for past donations, and between an earmarked tax and a dummy variable for past volunteering were included as explanatory variables. Column (2) of **Table 3** shows that the interaction terms between an earmarked tax and the dummy variable for past donations, and between an earmarked tax and the dummy variable for past volunteering were statistically insignificant at the 5% level. This indicates that sellers with previous experience in relation to either donating or volunteering are no more likely to increase their burden in terms of the earmarked tax than those without such previous experience. Therefore, the response to an earmarked tax does not depend on the inherent utility sellers derive from social contribution, but rather suggests a strong possibility that the framing effect associated with social contribution in the form of an earmarked tax is occurring.

Result 1. *When an ordinary tax is imposed, sellers pass on the entire tax burden to the buyers. Conversely, when an earmarked tax is imposed, sellers pass on part of the tax*

burden to the buyers and bear a portion of the tax burden themselves.

This finding might provide a satisfactory explanation for undershifting. Fullerton and Metcalf (2002) noted that undershifting occurs when the increased tax burden is transferred to labor through a reduction in either wages or other factors of production. It is important to gain a better understanding of when sellers choose to reduce wages for their workers instead of passing on the tax burden to buyers. Imposing earmarked taxes can impact the behavior and attitudes of taxpayers, and potentially become a factor in why sellers opt to pay lower wages to their employees.

5.2. Effect of an earmarked tax on supply shifts depending on the market

Next, we examined how the relative sizes of the sellers' and buyers' surpluses influence the change in the tax pass-through level when an earmarked tax is imposed.

The datasets were separated into two groups. One represented a market in which the buyer's surplus was greater than the seller's surplus, termed a 'buyer advantage market.' The other represented a market in which the buyer's surplus was less than the seller's surplus, termed a 'seller advantage market.' Buyer and seller advantage markets were determined using the parameters of buyers and sellers without imposing taxes, as shown in **Table 2**. In this context, the market was considered a buyer advantage market when the buyers' surplus exceeded the sellers' surplus in rounds 1, 5, 6, 7, and 8. Conversely, the market was considered a seller advantage market when the buyers' surplus was less than the sellers' surplus in rounds 3, 4, 9, and 10. Round 2 was excluded because the buyers' and sellers' surpluses were identical.

Table 4 shows the empirical estimates. Column (1) in **Table 4** shows the results of a first-stage probit analysis of the seller advantage market. It can be seen that there are no differences between the effects of an ordinary tax and an earmarked tax on trade execution because none of the coefficients are statistically significant at the 5% level. Column (2) in **Table 4** shows the results of the second-stage regression estimates for the seller advantage market. The coefficients are statistically significant at the 5% level and these results suggest that, conditional on making a trade, buyers under the earmarked tax treatment pay a higher price than buyers under the ordinary tax treatment. Based on these

results, sellers in a seller advantage market might pass part of the tax burden on to the buyer and continue to bear a portion of the tax burden themselves.

Column (3) of **Table 4** shows the results of a first-stage probit analysis of the buyer advantage market. There is no difference between the effects of an ordinary tax and an earmarked tax on trade execution because none of the coefficients are statistically significant at the 5% level. Column (4) of **Table 4** shows the results of the second-stage regression estimates for the buyer advantage market. The coefficients are statistically significant at the 5% level and these results suggest that conditional on making a trade, buyers under an earmarked tax treatment pay the same price as buyers under an ordinary tax treatment. Based on these results, a buyer advantage market might result in full tax pass-through.

We conducted a statistical test to evaluate whether the coefficients differed between the seller advantage market and the buyer advantage market and found that they differed significantly at the 5% level.

These results indicate that undershifting is more likely to occur when the seller's surplus is greater than the buyer's surplus. When a seller makes an earmarked tax payment, they feel a sense of accomplishment, which to some extent outweighs the loss experienced through bearing the tax burden.

Result 2. *Undershifting is more likely to occur when the seller's surplus exceeds the buyer's surplus.*

Table 4: Effects of ordinary taxes and earmarked taxes on supply curve shifts

	First-Stage Probit	Second-Stage OLS	First-Stage Probit	Second-Stage OLS
	(1)	(2)	(1)	(2)
T2:Earmaked Tax	0.104	20.531**	0.105	29.763**
	(0.088)	(8.177)	(0.088)	(9.656)
T3:No Tax	0.015	9.801	0.005	10.056
	(0.119)	(8.185)	(0.000)	(8.172)
Male	0.013	-0.869	0.037	4.490
	(0.083)	(7.480)	(0.089)	(7.942)
PartTimeJob	0.107	-0.845	0.111	-0.532
	(0.080)	(7.492)	(0.080)	(7.540)
DonationExperience	-0.019	2.379	-0.011	4.613
	(0.037)	(3.485)	(0.046)	(4.383)
VolunteerExperiece	0.080	-2.072	0.091	1.135
	(0.080)	(7.403)	(0.082)	(7.574)
DonationExperience*Earmarked Tax			-0.023	-6.101
			(0.071)	(6.618)
VolunteerExperiece*Earmarked Tax			-0.144	-34.497
			(0.199)	(18.296)
Induce	0.005**		0.005**	
	(0.000)		(0.000)	
Constant	-0.242	68.899**	-0.264	63.014**
	(0.153)	(13.796)	(0.155)	(14.084)
Round Effects	✓	✓	✓	✓
Observations	1,680	1,680	1,680	1,680
Cencered Observations	1,193	1,193	1,193	1,193
Uncencered Observations	487	487	487	487

Note: this table shows the estimation results for hypothesis I. The dependent variable is the difference between the neoclassical price prediction and the executed market price. The standard errors are clustered at the group level to adjust for serial correlation.

Table 5: Effects of ordinary taxes and earmarked taxes on supply shifts in the markets

	Sellers Advantage		Buyers Advantage	
	First-Stage Probit	Second-Stage OLS	First-Stage Probit	Second-Stage OLS
	(1)	(2)	(3)	(4)
T2:Earmaked Tax	-0.044	36.114**	0.059	12.171
	(0.148)	(11.607)	(0.140)	(13.738)
T3:No Tax	-0.107	13.592	0.106	-4.009
	(0.141)	(11.672)	(0.137)	(13.797)
Male	-0.109	-11.856	0.035	-1.687
	(0.131)	(10.715)	(0.130)	(12.640)
PartTimeJob	0.068	2.463	0.087	7.287
	(0.129)	(10.521)	(0.124)	(12.709)
DonationExperience	-0.074	-5.700	-0.006	1.523
	(0.060)	(5.010)	(0.059)	(5.935)
VolunteerExperiece	0.163	3.437	0.136	-9.025
	(0.130)	(10.583)	(0.125)	(12.648)
Induce	0.005**		0.005**	
	(0.000)		(0.000)	
Constant	0.013	-69.770**	-0.405	62.834**
	(0.198)	(19.433)	(0.191)	(19.972)
Round Effects	✓	✓	✓	✓
Observations	672	672	672	672
Cencered Observations	485	485	472	472
Uncencered Observations	187	187	200	200

Note: this table shows the estimation results for hypothesis II. The dependent variable is the difference between the neoclassical price prediction and the executed market price. The standard errors are clustered at the group level to adjust for serial correlation.

6 Conclusions

In this study, we conducted an experiment in a controlled laboratory setting to quantitatively analyze whether there are differences in the effects of ordinary taxes and earmarked taxes on the level of tax pass-through.

Our analysis revealed that ordinary taxes lead to complete tax pass-through, whereas earmarked taxes result in undershifting. This is because sellers experience a sense of accomplishment when making an earmarked tax payment. Consequently, this difference in the psychological impact of ordinary taxes and earmarked taxes might result in different prices for goods depending on the tax type. Furthermore, undershifting is more likely to occur when the seller's surplus exceeds that of the buyer.

Our findings have important practical implications for policymakers aiming to ensure equitable resource allocation. An earmarked tax can be effective when policymakers wish to levy taxes that do not increase a buyer's tax burden. For instance, fuel companies often pass the burden of a gasoline tax on to their buyers. Therefore, imposing an earmarked tax on these companies is an excellent strategy to prevent most of the tax burden being transferred to buyers. However, earmarked taxes may not be suitable when the objective is to curb demand in markets with negative externalities. This is because earmarked taxes lead to undershifting, which results in lower prices and increased consumption.

There are two potential avenues for future research in this field. First, an earmarked tax might prevent overshifting, even if sellers possess a high level of market power. For instance, previous studies have pointed out that overshifting is more likely to occur in oligopolistic markets, where sellers have significant market power (e.g., Myles, 1995; Delipalla and Owen, 2001). Therefore, it would be worthwhile investigating whether an earmarked tax in an oligopolistic market prevents overshifting. Second, although we designated the JRCS as the recipient of the earmarked tax revenue in this experiment, allowing subjects to choose the destination of the earmarked tax revenue might have a greater influence on the level of tax pass-through. Both of these issues are crucial from the perspective of fairness in relation to the imposition of taxes.

Acknowledgment

We thank Geoff Whyte, MBA, from Edanz (https://jp.edanz.com/ac) for editing a draft of this manuscript.

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