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Strategic Price Competition between Local Governments with the Brand Externalities of Reciprocal Gifts in the Hometown Tax Donation (Furusato Nozei) System in Japan

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Strategic Price Competition between Local Governments with the Brand Externalities of Reciprocal Gifts in the Hometown Tax Donation (Furusato Nozei) System in Japan

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Abstract

This study analyzes donation price competition between leader local governments with strong brand power and follower local governments with weak brand power, where multiple local governments offer similar local products as reciprocal gifts under the hometown tax donation (Furusato Nozei) system in Japan. We construct a strategic price competition model in which the strategic variables are donation prices and the timing of decision-making is sequential, with some governments acting first and others acting second in the presence of the brand externalities of reciprocal gifts.

Based on a theoretical model grounded in household utility maximization and local governments' net donation revenue maximization, we formulate donation price reaction functions and demonstrate the policy implications for surplus through a comparative static analysis. To validate this theoretical model, we estimate donation demand functions using spatial econometric analysis. In an analysis targeting governments in Hokkaido offering reciprocal gifts with the well-known Hokkaido brand, the coefficients indicating complementarity between reciprocal gifts are significant due to brand externalities. Consistent with the theoretical model's assumptions, the empirical analysis also suggests the existence of leader governments, confirming the structure of strategic price competition, where the donation price of leader governments influences that of follower governments.

The contributions of this study lie in its theoretical model of strategic price competition for the hometown tax donation system, comparative static

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analysis, and empirical verification of the existence of leader governments using spatial econometric analysis based on the haversine distance. We find that strengthening the brand power of reciprocal gifts is crucial for gaining a surplus.

JEL Classification: H71, H72, and H77

Keywords: Strategic price competition, Brand externalities, Spatial econometric analysis

1. Introduction

Given the offers of similar local products as reciprocal gifts under the hometown tax donation (Furusato Nozei) system in Japan, how do local governments set donation prices?[1] This is the central question of the present study[2]. Competition among local governments to attract donations has intensified around the hometown tax donation system, making donation pricing strategies and reciprocal gift branding crucial policy tools.

Setting donation prices too high increases the likelihood of failure to attract donations. When the donation demand curve has a negative slope with respect to the donation price, higher prices reduce donation demand. Uemura (2025, 2026) confirms that household donation demand curves exhibit negative coefficients with respect to donation prices.

"Brand externalities" may exist among local governments offering

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[1] We use the term 'donation price' to denote the unit donation amount per reciprocal gift.

[2] From September 2022 to September 2023, the author served as a member of the Sumoto City Hometown Tax Third-Party Committee. Sumoto City in Hyogo Prefecture, whose designation was revoked due to a violation of standards, sets its donation price levels based on information about the donation prices set by neighboring Awaji City and Minami-Awaji City, which offered similar local products from Awaji Island as reciprocal gifts. The author's investigative experience on this Third-Party Committee inspired the research question addressed in this study.

similar local products as reciprocal gifts. In this context, the donation prices of other local governments may influence the donation price set by some local governments. For example, even among multiple local governments offering products similar to local products as reciprocal gifts, a specific local government may attract many donations. One possible underlying factor is the strength of brand power. In such cases, leader governments offer reciprocal gifts when brand power is strong, and follower governments offer reciprocal gifts when brand power is weak.

Follower and leader governments may engage in strategic price competition based on information on each other's donation prices. In this study, we refer to the structure in which a local government sets its own donation price anticipating the reaction of other local governments' donation prices as "strategic price competition." Specifically, the first-mover leader government sets its donation price first and the second-mover follower government observes this price before setting its own optimal donation price. This study's distinctive feature lies in its analysis of donation price setting among local governments within the hometown tax donation system using a strategic price competition model involving sequential decision-making.

Table 1 around here

Strategic competition between firms is typically addressed in industrial organization theory (Tirole, 1988). Table 1 summarizes the classification of strategic competition models in industrial organization theory. The Cournot competition model involves simultaneous output decisions by each firm, whereas the Stackelberg competition model involves sequential output decisions by a first-mover leader that anticipates the reaction of a second-mover follower firm. For example, Fudenberg and Tirole (1984) analyze the first-mover advantage in a Stackelberg competition model where output is the strategic variable, examining how the leader firm's actions strategically induce the follower firm's response.

While these models treat output as a strategic variable, other models consider price as a strategic variable. The Bertrand competition model involves simultaneous price determination by each firm, whereas strategic price competition models feature sequential price determination by the leader firm based on the follower firm's reaction. Models that treat price as a strategic variable and incorporate sequential decision-making by leader and follower firms include those of Braid (1986) and Anderson (1987). Both analyze the price reaction function, in which the first-mover leader sets the price and the second-mover follower responds. The strategic price competition model used in this study belongs to the sequential price competition strand of literature.

This study's strategic price competition model treats the donation price offered by a local government as a strategic variable and assumes sequential decision-making by local governments in the presence of brand externalities. Households determine their donation demand using the hometown tax donation portal websites by considering the donation prices presented by local governments. Therefore, models that treat production quantity as a strategic variable are unsuitable for analyzing hometown tax donation systems. Furthermore, while the Bertrand competition model uses price as its strategic variable, it assumes simultaneous decision-making by multiple economic agents. This prevents us from capturing the sequential reality in which leader governments with strong brand power set donation prices first, followed by follower governments.

Therefore, this study adopts a Bertrand- Stackelberg competition model; that is, a strategic price competition model that treats donation prices as a strategic variable and expresses the sequential decision-making of local governments. Applying this strategic price competition model to the hometown tax donation system is also useful for clarifying policy implications. Applying this model which focuses on brand externalities of reciprocal gifts, to the analysis of the hometown tax donation system is a novel contribution of this study.

This study derives donation demand functions for leader and follower governments based on the household utility maximization problem and the local government net donation revenue maximization problem. Then, it presents the follower government's donation price reaction function when the leader government sets the donation price. By obtaining the optimal donation price for the leader government under the follower government's donation price reaction function, we present a theoretical model of an asymmetric strategic price competition structure within the hometown tax donation system. Furthermore, by formulating donor, government, and total surpluses, we derive policy implications through a comparative static analysis.

Whether an interrelationship of reciprocal gifts based on strategic price competition structures exists within the hometown tax donation system requires verification through empirical analysis. Therefore, taking brand externalities into account, we analyze data on governments in Hokkaido that offer locally produced goods with national recognition as reciprocal gifts to estimate the donation demand function of follower governments. This empirical analysis which verifies the existence of leader governments through estimation of follower governments' donation demand function in the hometown tax donation system is another contribution of this study.

This empirical analysis employs spatial econometric analysis that incorporates distance weights. Anselin's (1988) systematization of spatial econometric models forms the foundation for subsequent applied research. In the area of local finance, Case, Rosen, and Hines (1993) demonstrate the existence of spatial interdependence in fiscal policies between neighboring states using US state government data. Yamamoto (2018) also provides a comprehensive review of the research on fiscal competition among local Japanese governments.

In estimating the donation demand function for follower governments in this study, we measure spatially weighted donation prices using the haversine distance, given that the analysis involves governments within a vast area of Hokkaido. Applying spatial econometric analysis using the haversine distance to research the hometown tax donation system is the final contribution of this study.

The remainder of this study is structured as follows. Section 2 presents the theoretical model. Section 3 conducts a comparative static analysis based on the theoretical model. Section 4 estimates the donation demand functions. Section 5 summarizes the results, presents policy implications, outlines future research directions, and concludes with a discussion.

2. Theoretical Model of Leader and Follower Governments

In our theoretical model, multiple local governments offering similar local products as reciprocal gifts are divided into two types: leader governments providing reciprocal gifts with strong brand power and follower governments providing reciprocal gifts with weak brand power. These two types of local governments engage in entrepreneurial activities and collaborate with reciprocal gift providers to offer local products as reciprocal gifts.

Follower governments have a reaction function that determines their optimal donation price given the leader government's donation price. Leader governments determine their own optimal donation prices while considering follower governments' reaction functions. This constitutes an asymmetric strategy in which the leader chooses a strategy and the follower reacts. Below, we present a theoretical model of the optimization behavior of households and local governments.

First, drawing on the quasi-linear utility function of Singh and Vives' (1984) differentiated goods model, which analyzes corporate strategies regarding complementary or substitute relationships between goods, we assume that households have the following quasi-linear utility function U. [3]

$$U = y + a_L Q_L + a_F Q_F - \frac{b_L}{2} Q_L^2 - \frac{b_F}{2} Q_F^2 + cQ_L Q_F \qquad (1)$$

Here, Q_L represents the demand for donations to the leader government, Q_F represents the demand for donations to the follower government, and y represents consumption other than donation demand, which is the numerator. a_L and a_F are the marginal utility parameters for each donation demand, whereas b_L and b_F indicate diminishing returns for each donation demand.

The interaction term $cQ_L Q_F$ in this model represents the interdependence between donations to leader and follower governments. The sign of parameter c determines whether donations to the two types of governments are complementary or substitutes. Balachander and Ghose (2003) empirically analyze "brand externalities," where strengthening the brand power of one product has spillover effects on other products. In this study's model, because donations include the consumption of reciprocal gifts, when $c > 0$, the consumption of reciprocal gifts by the two local governments is complementary, and when $c < 0$, it is substitutive.

The budget constraint is set as follows, where I is household disposable income for donations.

$$I = y + P_L Q_L + P_F Q_F \qquad (2)$$

The donation price for the leader government is P_L, and that for the follower government is P_F. The first-order conditions for the household-constrained utility maximization problem are

$$a_L - b_L Q_L + cQ_F - P_L = 0 \qquad (3)$$

[3] Previous studies by Uemura (2025, 2026) present economic models of hometown tax donations system, assuming optimization behavior based on quasi-linear utility functions for households and maximization of net donation income for local governments. This study's model can be positioned as an extension of these, as it introduces the distinction between leader and follower governments.

$$a_F - b_F Q_F + c Q_L - P_F = 0. \qquad (4)$$

We can rearrange these equations to obtain the donation demand functions for the leader government Q_L and follower government Q_F[4]:

$$Q_L = \alpha_L - \beta_L P_L - \gamma P_F \qquad (5)$$

$$Q_F = \alpha_F - \beta_F P_F - \gamma P_L. \qquad (6)$$

Here, we organize them as $\alpha_L \equiv (a_L b_F + a_F c)/\Delta$, $\beta_L \equiv b_F/\Delta$, $\alpha_F \equiv (a_F b_L + a_L c)/\Delta$, $\beta_F \equiv b_L/\Delta, \gamma \equiv c/\Delta$, and $\Delta \equiv b_L b_F - c^2$. Below, we assume $\alpha_L > 0, \beta_L > 0$, $\alpha_F > 0, \beta_F > 0$, and $\Delta > 0$. $\Delta > 0$ are the conditions guaranteeing that the utility function is concave and that the optimal donation demand is uniquely determined. The constant terms of these demand functions (α_L, α_F) represent the baseline demand level for donations, while the coefficients (β_L, β_F) represent the sensitivity to donation prices.

Here, we consider the meaning of the interrelationship between the donations of the leader and follower governments γ. When $\gamma < 0$ and the follower government's donation price P_F is high (low), the leader government's donation demand Q_L increases (decreases). Because $\beta_F > 0$, the follower government's donation demand Q_F decreases (increases). Therefore, the reciprocal gifts of the two local governments are substitute goods. When $\gamma > 0$ and the follower government's donation price P_F is high (low), the leader government's donation demand Q_L decreases (increases). Because $\beta_F > 0$, the follower government's donation demand also decreases (increases). Therefore, reciprocal gifts offered by the two local governments are complementary.

For example, when both types of local government offer similar local products as reciprocal gifts, these gifts share the same brand power. An external brand effect exists, where enhancing the brand power of one local government's reciprocal gifts positively affects the brand power of another local government's reciprocal gifts. In this case, their respective reciprocal gifts are complementary

[4] Since households have quasi-linear utility functions, income effects do not appear in the donation demand functions.

goods, and $\gamma > 0$ can be considered established. Because we analyze local governments offering similar local products as reciprocal gifts, we assume below that the reciprocal gifts provided by local governments are complementary ($\gamma > 0$). At this point, an increase in the donation price of one local government reduces the donation demand of the other local government due to brand externalities, as the donation demand function shows.

Second, we assume that local governments maximize their net donation income. The net donation income for the leader government Π_L and the follower government Π_F are

$$\Pi_L = (P_L - m_L)Q_L - f_L \qquad (7)$$

$$\Pi_F = (P_F - m_F)Q_F - f_F \qquad (8).$$

Here, m represents marginal costs such as shipping and publicity expenses, while f represents fixed costs such as personnel expenses.

We solve the optimization problems for the leader and follower governments. For analytical convenience, we use backward induction. First, we solve the follower government's optimization problem, and then substitute its reaction function into the leader government's optimization problem to solve it. Given the leader government's donation price P_L, we set up the follower government's net donation income maximization problem.

$$\max_{p_F} \quad \Pi_F = (P_F - m_F)(\alpha_F - \beta_F P_F - \gamma P_L) - f_F \qquad (9)$$

By organizing the first-order conditions, we obtain reaction function P_F^* indicating the optimal contribution price for the follower government.

$$P_F^* = \frac{\alpha_F - \gamma P_L}{2\beta_F} + \frac{m_F}{2} \qquad (10)$$

The first and second terms represent the effect of the leader government's donation price P_L and the effect of marginal cost m, respectively. Therefore, when the reciprocal gifts are complementary goods ($\gamma > 0$), an increase in the leader government's donation price negatively affects the follower government's donation price P_F.

Next, considering the follower government's reaction function P_F^*, we solve the leader government's net donation income maximization problem.

$$\max_{p_L} \quad \Pi_L = (P_L - m_L)\{\alpha_L - \beta_L P_L - \gamma P_F^*\} - f_L$$

$$= (P_L - m_L)\left\{\alpha_L - \beta_L P_L + \gamma\left(\frac{\alpha_F - \gamma P_L}{2\beta_F} + \frac{m_F}{2}\right)\right\} - f_L \qquad (11)$$

By organizing the first-order conditions, we obtain reaction function P_L^* indicating the optimal donation price for the leader's government.

$$P_L^* = \frac{\alpha_L\beta_F - \alpha_F\gamma/2 + (D - \beta_F\gamma)\, m_L/2}{D} \qquad (12)$$

Here, $D = 2\beta_F\beta_L - \gamma^2 > 0$ is the stability condition for this model. The first term in the numerator, $\alpha_L\beta_F$, represents the effect of the demand level. The second term, $\alpha_F\gamma/2$, represents the effect of the interdependence between the gifts offered by the leader and follower governments. The third term, $(D - \beta_F\gamma)\, m_L/2$, represents the effect of the marginal cost.

Third, we formulate the donor surplus and government surplus [5]. Donors are households; however, because households in this model are treated as representative households without residential attributes, the donor surplus is distinguished based on the recipient's local government. The leader (or follower) government's donor surplus is the surplus of households that donate to the leader (or follower) government. Meanwhile, local government surplus is the leader and follower governments' surplus.

The intercepts of the donation demand functions for the leader and follower governments, assuming a linear demand function; that is, the maximum price when no price is set (P_L^{max} and P_F^{max}), are

$$P_L^{max} = \frac{\alpha_L - \gamma P_F}{\beta_L} \qquad (13)$$

[5] As households in this model are donors with donation demand functions, we use the term "donor surplus" instead of the conventional economic term "consumer surplus" for clarity..

$$P_F^{max} = \frac{\alpha_F - \gamma P_L}{\beta_F}. \qquad (14)$$

Using these data, we can obtain the donor surplus for the leader and follower governments (CS_L, CS_F).

$$CS_L = \frac{1}{2}(P_L^{max} - P_L)Q_L = \frac{1}{2}\left(\frac{\alpha_L - \gamma P_F}{\beta_L} - P_L\right)Q_L = \frac{Q_F^2}{2\beta_L} \qquad (15)$$

$$CS_F = \frac{1}{2}(P_F^{max} - P_F)Q_F = \frac{1}{2}\left(\frac{\alpha_F - \gamma P_L}{\beta_F} - P_F\right)Q_F \qquad (16)$$

In the model developed in this study, the net donation revenue Π represents the local government surplus. Accordingly, we treat the net donation revenue as the measure of the local government surplus in the following analysis. By aggregating the donor and government surplus for both the leader and follower governments, we can formulate the total surpluses TS_L and TS_F ($j = L, F$):

$$TS_j = CS_j + \Pi_j. \qquad (17)$$

3. Comparative Static Analysis of Donation Prices and Surpluses

This section presents a comparative static analysis of the theoretical model described in the previous section. We omit the equations below when the partial derivatives can be easily obtained and are presented for complex cases.

3.1. Comparative Static Analysis of the Donation Price Response Functions

First, we conduct comparative statics on the follower government's donation price reaction function, P_F^*. First, an increase in the follower government's baseline donation demand level α_F clearly leads to a rise in the follower government's donation price ($\partial P_F^*/\partial \alpha_F = 1/(2\beta_F) > 0$). Second, an increase in the slope of the follower government's demand function β_F leads to a decrease in the donation price because the demand function is downward-sloping with respect to donation price [6].

$$\frac{\partial P_F^*}{\partial \beta_F} = -\frac{\alpha_F - \gamma P_L}{2\beta_F^2} < 0 \qquad (18)$$

Third, when the marginal cost of follower governments m_F increases, the donation price rises to absorb the increased cost ($\partial P_F^*/\partial m_F = 1/\{2(1-g_F)\} > 0$). Furthermore, the marginal cost of leader governments m_L has no effect ($\partial P_F^*/\partial m_L = 0$). Finally, when the interdependence between the leader and follower governments' reciprocal gifts γ increases, the leader government's donation price has a greater impact on follower governments, prompting them to lower their donation price to secure demand. Note that

$$\frac{\partial P_F^*}{\partial \gamma} = -\frac{P_L}{2\beta_F} < 0. \qquad (19)$$

Next, we conduct comparative statics on the leader government's donation price reaction function, P_L^*. First, when gifts are complementary ($\gamma > 0$), a higher baseline donation demand level α_F of the follower government causes the leader government's donation price to decrease ($\partial P_L^*/\partial \alpha_F = -\gamma/(2D) < 0$). Second, when gifts are complementary ($\gamma > 0$), an increase in the follower government's demand function intercept α_L causes the leader government's donation price to rise ($\partial P_L^*/\partial \alpha_L = \beta_F \gamma / D > 0$).

Third, the partial derivative with respect to the slope of the follower government's demand function β_F is

$$\frac{\partial P_L^*}{\partial \beta_F} = \frac{(\alpha_F \beta_L - \alpha_L \gamma)\gamma + m_L \gamma^3/2}{D^2}. \qquad (20)$$

The denominator is positive; however, the sign is indeterminate because the sign of the numerator is indeterminate. Fourth, the effect of the slope of the leader government's demand function β_L on the leader government's donation

[6] We verify whether the numerator $(\alpha_F - \gamma P_L)$ is positive. For the follower government's donation demand $Q_F = \alpha_F - \beta_F P_F - \gamma P_L$ to be positive, $\alpha_F - \gamma P_L > \beta_F P_F$ must be true. Because $\beta_F > 0$ and $P_F > 0$ hold, the numerator $(\alpha_F - \gamma P_L)$ is positive.

price is also indeterminate.

$$\frac{\partial P_L^*}{\partial \beta_L} = \frac{(\alpha_F \beta_F \gamma - 2\alpha_L \beta_F^2) + \beta_F^2 \gamma m_L}{D^2} \qquad (21)$$

Fifth, the partial derivative of marginal cost m is as follows, and its sign is indeterminate:

$$\frac{\partial P_L^*}{\partial m_L} = \frac{\beta_F \beta_L - \beta_F \gamma/2 - \gamma^2/2}{D}. \qquad (22)$$

Sixth, the partial derivative of the interrelationship between reciprocal gifts γ is as follows, and because the sign of the numerator is indeterminate, the sign is indeterminate.

$$\frac{\partial P_L^*}{\partial \gamma} = \frac{(4\alpha_L \beta_F \gamma - 2\alpha_F \beta_F \beta_L - \alpha_F \gamma^2) - \beta_F(2\beta_F \beta_L + \gamma^2) m_L}{2D^2} \qquad (23)$$

Table 2 summarizes these results, where "+" and "-" indicate the sign of the partial derivative; "Undetermined" indicates cases where the sign is indeterminate; and "None" indicates cases where the partial derivative cannot be calculated because the relevant equation does not include the parameter. Furthermore, "(+)" and "(-)" denote the sign assuming a complementary relationship between reciprocal gifts ($\gamma > 0$).

Table 2 around here

3.2. Comparative Static Analysis of Surpluses

This subsection conducts a comparative static analysis of the surpluses.

First, the partial derivative of surplus with respect to intercept α_F of the follower government's donation demand function is

$$\frac{\partial CS_F}{\partial \alpha_F} = \frac{Q_F}{\beta_F} > 0 \qquad (24)$$

$$\frac{\partial \Pi_F}{\partial \alpha_F} = P_F - m_F > 0 \qquad (25)$$

$$\frac{\partial CS_L}{\partial \alpha_F} = -\frac{\gamma}{4\beta_F}(P_L^{max} - P_L) < 0 \qquad (26)$$

$$\frac{\partial \Pi_L}{\partial \alpha_F} = -\frac{\gamma}{2\beta_F}(P_F - m_F) < 0, \qquad (27)$$

Therefore, an increase in the follower government's baseline donation demand level increases its donor surplus CS_F. Regarding the partial derivative of the government surplus Π_F, because the local government's revenue-expenditure structure must satisfy $P_F \geq m_F$, the sign is positive. Consequently, the partial derivative of the follower government's total surplus is also positive ($\partial TS_F/\partial \alpha_F > 0$). However, when reciprocal gifts are complementary ($\gamma > 0$), an increase in the follower government's baseline donation demand level decreases the leader government's donor surplus CS_L and government surplus Π_L. Therefore, the partial derivative of the leader government's total surplus is also negative ($\partial TS_L/\partial \alpha_F < 0$).

Second, the partial derivative of surplus with respect to the slope of the follower government's demand function β_F is

$$\frac{\partial CS_F}{\partial \beta_F} = -\frac{1}{2}\left(P_F^{max\,2} - P_F^2\right) < 0 \qquad (28)$$

$$\frac{\partial \Pi_F}{\partial \beta_F} = -(P_F - m_F)P_F < 0 \qquad (29)$$

$$\frac{\partial CS_L}{\partial \beta_F} = \frac{\gamma}{4\beta_F}(P_L^{max} - P_L)P_F^{max} > 0 \qquad (30)$$

$$\frac{\partial \Pi_L}{\partial \beta_F} = \frac{\gamma}{2\beta_F}(P_L - m_L)P_F^{max} > 0. \qquad (31)$$

Therefore, when the slope of the follower government's donation demand function increases, both the follower government's donor surplus CS_F and government surplus Π_F decrease. Thus, the sign of the partial derivative of the total surplus for follower governments is also negative ($\partial TS_F/\partial \beta_F < 0$). However, when reciprocal gifts are complementary ($\gamma > 0$), an increase in the slope of the follower government's donation demand function increases both the donor surplus CS_L and the government surplus Π_L for the leader government. Therefore, the sign of the partial derivative of the total surplus for the leader government is also positive ($\partial TS_L/\partial\beta_F > 0$).

Third, the partial derivative of the surplus with respect to the follower government's marginal cost m_F is

$$\frac{\partial CS_F}{\partial m_F} = -\frac{Q_F + (P_F^{max} - P_F)\beta_F}{4} < 0 \qquad (32)$$

$$\frac{\partial \Pi_F}{\partial m_F} = -\frac{Q_F}{2} < 0 \qquad (33)$$

$$\frac{\partial CS_L}{\partial m_F} = -\frac{\gamma(P_L^{max} - P_L)}{4} < 0 \qquad (34)$$

$$\frac{\partial \Pi_L}{\partial m_F} = -\frac{\gamma(P_F - m_F)}{2} < 0. \qquad (35)$$

Therefore, when the follower government's marginal cost increases, both the follower government's donor surplus CS_F and government surplus Π_F decrease. However, when the reciprocal gift is complementary ($\gamma > 0$), both the leader government's CS_L donor surplus and government surplus Π_L decrease. Thus, the total surplus of both local governments also decreases ($\partial TS_F/\partial m_F < 0$, $\partial TS_L/\partial m_F < 0$).

Forth, the partial derivative of surplus with respect to the intercept α_L of the leader government's demand function is

$$\frac{\partial CS_L}{\partial \alpha_L} = \frac{Q_L}{\beta_L} > 0 \qquad (36)$$

$$\frac{\partial \Pi_L}{\partial \alpha_L} = P_L - m_L > 0. \qquad (37)$$

When the leader government's baseline donation demand level increases, the leader government's donor surplus CS_L and government surplus Π_L increase. Therefore, the sign of the partial derivative of the leader government's total surplus is positive ($\partial TS_F/\partial\alpha_L > 0$). Note that the leader government's baseline donation demand level does not affect the follower government's surplus

$(\partial CS_F/\partial \alpha_L = \partial \Pi_F/\partial \alpha_L = \partial TS_F/\partial \alpha_L = 0)$.

Fifth, the partial derivative of surplus with respect to the slope of the leader government's demand function β_L is

$$\frac{\partial CS_L}{\partial \beta_L} = -\frac{Q_L^2}{2\beta_L^2} - \frac{Q_L P_L}{\beta_L} < 0 \qquad (38)$$

$$\frac{\partial \Pi_L}{\partial \beta_L} = -(P_L - m_L) < 0. \qquad (39)$$

When the slope of the leader government's donation demand function increases, both the leader government's donor surplus CS_L and government surplus Π_L decrease. Consequently, the sign of the partial derivative of the leader government's total surplus is also negative $(\partial TS_L/\partial \beta_L < 0)$. Note that the slope of the leader government's donation demand function does not affect the follower government's surplus $(\partial CS_F/\partial \beta_L = \partial \Pi_F/\partial \beta_L = \partial TS_F/\partial \beta_L = 0)$.

Sixth, the partial derivative of the surplus with respect to the leader government's marginal cost, m_L is

$$\frac{\partial CS_L}{\partial m_L} = -\frac{Q_L}{2} < 0 \qquad (40)$$

$$\frac{\partial \Pi_L}{\partial m_L} = -Q_L < 0. \qquad (41)$$

As the leader government's marginal cost increases, both the leader government's donor surplus CS_L and government surplus Π_L decrease. Consequently, the leader government's total surplus decreases $(\partial TS_L/\partial m_L < 0)$. Note that the leader government's marginal cost does not affect the follower government's donor surplus $(\partial CS_F/\partial m_L = \partial \Pi_F/\partial m_L = \partial TS_L/\partial m_L = 0)$.

Finally, the partial derivative of surplus with respect to the interdependence between reciprocal gifts γ is

$$\frac{\partial CS_F}{\partial \gamma} = \frac{P_L Q_F}{\beta_F} > 0 \qquad (42)$$

$$\frac{\partial \Pi_F}{\partial \gamma} = (P_F - m_F)P_L > 0 \qquad (43)$$

$$\frac{\partial CS_L}{\partial \gamma} = \frac{P_F Q_L}{\beta_L} > 0 \qquad (44)$$

$$\frac{\partial \Pi_L}{\partial \gamma} = (P_L - m_L) P_F > 0. \qquad (45)$$

Therefore, as the interdependence between reciprocal gifts increases, the surplus of both the follower and leader governments increases. Consequently, the sign of the partial derivative of the total surplus for both governments is also positive ($\partial TS_F/\partial \gamma > 0$, $\partial TS_L/\partial \gamma > 0$).

Table 3 summarizes these results.

Table 3 around here

3.3. Policy Implications of the Comparative Static Analysis

This section presents the comparative static analysis of the donation price reaction functions and surpluses. This subsection summarizes the policy implications of the comparative static analysis.

First, when the baseline demand level (intercept α_F) of the follower government's donation demand function increases, the follower government's donation price rises. However, when a complementary relationship exists for reciprocal gifts ($\gamma > 0$), the leader government's donation price decreases. Consequently, the follower government surplus increases, whereas the leader government surplus decreases. Because the baseline demand level indicates brand strength, strengthening brand power is politically important for follower governments' surplus, but negatively impacts leader governments' surplus. Furthermore, the baseline demand level (intercept) of the leader government's donation demand function (α_L) does not affect the follower government's donation price or surplus. Rather, it increases the leader government's donation price, thereby increasing its surplus. Therefore, strengthening brand power is also important for the leader governments. Many local governments' efforts to enhance the brand power of reciprocal gifts are likely related to an increasing government surplus.

Second, when the slope of the follower government's donation demand function (price sensitivity β_F) increases, the follower government's donation price decreases, reducing its surplus. Meanwhile, when a complementary relationship with reciprocal gifts ($\gamma > 0$) exists, the leader government's surplus increases. Conversely, when the slope of the leader government's donation demand function (price sensitivity β_L) increases, the leader government's surplus decreases, but with no effect on the follower government's donation price or surplus. Through brand externalities, a relationship exists between the follower and leader governments' donation prices. Strategically setting the donation price is important for the follower government because it affects its own government surplus.

Third, when the follower government's marginal cost m_F increases, the follower government's donation price increases, thereby reducing its surplus. When there is a complementary relationship with reciprocal gifts, the leader government's surplus also decreases. Conversely, although the impact on donation prices is unclear when the leader government's marginal cost m_L increases, its surplus decreases. Therefore, increased costs for local governments imply a reduction in the government surplus, indicating that decreasing marginal costs is a critical challenge for local governments.

Fourth, when the interdependence among reciprocal gifts γ increases, the donation price of follower governments decreases, and the surplus of both the follower and leader governments increase. Thus, when the brand externalities of reciprocal gifts strengthen, the surpluses of both follower and leader governments increase. This finding suggests the importance of developing reciprocal gift brand strategies at the regional level that transcend the administrative boundaries of individual local governments.

The comparative static analysis in this section confirms that the structure of the donation price competition involving leader and follower governments has a complex economic mechanism based on strategic interactions between local governments. In the strategic price competition model, brand strength enhancement, donation price setting, the degree of marginal cost, and the interrelationship between reciprocal gifts alter the follower and leader governments' surplus through the donation price reaction function. Because local governments can use several policy parameters to improve these surpluses, the results have policy implications for acquiring government surpluses.

4. Empirical Analysis of the Follower Governments' Donation Demand Function

The preceding sections present a theoretical model expressing the strategic behavior of two types of local governments—leader and follower—and conduct a comparative static analysis. We theoretically examine the economic effects and policy implications of policy parameters such as the basic demand for reciprocal gifts, price sensitivity, the interrelationship between reciprocal gifts, and marginal cost.

Whether such strategic price competition exists within the hometown tax donation system requires verification through an empirical analysis using real data. Therefore, this section estimates local governments' donation demand functions to verify the practical validity of the theoretical model presented above.

Ideally, we would estimate the donation demand functions for both leader and follower governments. However, the number of leader governments driving the reciprocal gift market is generally small, making data acquisition difficult. Considering that follower governments are likely to be more numerous than leader governments and that data acquisition is easier, we limit the estimation to the donation demand function for follower governments.

As in the theoretical model, the explanatory variables for the donation demand function of follower governments are the follower government's own donation price, P, and the leader government's donation price relative to the follower government, P_L. As these may be endogenously determined, we adopt a two-stage least squares (2SLS) approach using instrumental variables. The instrumental variables are the donation prices from the previous year, and the first-stage estimation equation is as follows, where the subscript -1 indicates the previous year.

$$ln(P_i) = \delta_0 + \delta_1 ln(P_{i,-1}) + \varepsilon_i \qquad (46)$$

$$ln(P_{L,i}) = \eta_0 + \eta_1 ln(P_{L,i,-1}) + \epsilon_i \qquad (47)$$

Here, the constant terms are δ_0 and η_0, the coefficients are δ_1 and η_1, and the error terms are ε and ϵ. The second stage estimates the donation demand function for follower governments, using the estimates obtained from the first-stage equation ($\widehat{ln(P_i)}$, $\widehat{ln(P_{L,i})}$).

While the theoretical model in the previous section used an additive demand function, we assume a log-linear estimation specification so that the estimated coefficient can be interpreted as elasticities. Assuming constant elasticity, when households optimize their behavior based on a CES utility function, we can derive a log-linear demand function. The log-linear specification should be interpreted as a local approximation consistent with the qualitative comparative statics derived from the theoretical model. Therefore, we perform estimations using the following log-linear donation demand function:

$$ln(Q_i) = \theta_0 + \theta_1 \widehat{ln(P_i)} + \theta_2 \widehat{ln(P_{L,i})} + \mu_i \qquad (48)$$

Here, Q represents the number of donations made by follower government i, θ_0 is the constant term, and μ is the error term. As this is a log-linear estimation equation, the coefficients θ_1 and θ_2 indicate self-price elasticity and cross-price elasticity, respectively.

The own-price elasticity θ_1 indicates the rate of decrease in the number of donations made by follower governments when the donation price P increases, and typically has a negative sign ($\theta_1 < 0$). The cross-price elasticity θ_2 indicates the response of follower governments' donation counts to changes in leader governments' donation prices. It is positive ($\theta_2 > 0$) when the reciprocal gifts are substitutes and negative ($\theta_2 < 0$) when they are complements. Therefore, the sign of the coefficient θ_2 allows us to empirically determine the nature (substitutability or complementarity) of reciprocal gifts between local governments.

From the Ministry of Internal Affairs and Communications' "Summary of Survey Results on the Current Status of Hometown Tax Donations," we obtain data in Hokkaido for the fiscal years 2024 and 2023. The items in quotation marks below indicate the local government data items. The number of attachments from follower governments, the dependent variable, Q is the "Number of Attachments" for FY2024. The follower government's own donation amount P is calculated by dividing the "Donation Amount" for FY2023 and FY2024 by the "Number of Attachments." The donation amount of the leader government to follower government P_L is measured as follows.

At this point, we must determine which local government has become the leader. Because the determination of leader governments also has endogeneity, we consider that leader governments are decided in the previous fiscal year, 2023, and influence the donation demand function of follower governments in fiscal year 2024. Therefore, we rank the local governments in Hokkaido by their donation amounts in fiscal year 2023 and assume that the top local governments are the leader governments. As donation amount rankings for the hometown tax donation system are frequently reported, follower governments are likely to recognize the leader government as one within Hokkaido that has a high donation amount and shares the same Hokkaido brand.

For Hokkaido in fiscal year 2023, Monbetsu City received the top donation amount, followed by Shiranuka Town, Bekkai Town, Nemuro City, and Teshikaga Town. Assuming that these local governments are leader governments, we calculate the leader government's donation price P_L for the follower governments. For example, the model in which Monbetsu City and Shiranuka Town are the leader governments is called the "2-leader model," while the model in which Monbetsu City, Shiranuka Town, and Betsukai Town are the leader governments is called the "3-leader model," and so on.

When multiple leader governments j exist out of the total number J, we consider follower government i is to be influenced by the contribution price P_L of the leader governments, weighted by the distance w between the follower government and each leader government. Here, the location of the government is defined as the location of its city, town, or village office. We obtain the latitude and longitude coordinates of the government offices from the Ministry of Land, Infrastructure, Transport, and Tourism's "National Land Information Download Site." The distance between the two local governments is measured using the latitude and longitude coordinates of the follower and leader government offices.

Given Hokkaido's vast land area, we employ the haversine distance, a spherical trigonometry method for the Earth's surface, rather than the Euclidean distance [7]. The Earth's radius is R ($R = 6{,}371km$), the location of the follower government's office is $L_i(\phi_i, \lambda_i)$, and the location of the leader government's office is $L_j(\phi_j, \lambda_j)$. Here, longitude ϕ and latitude λ are expressed in radians. The haversine distance d between the leader government j and follower government i is

$$d_{i,j} = 2R \cdot arcsin\left(\sqrt{sin^2\left(\frac{\emptyset_j - \emptyset_i}{2}\right) + cos(\emptyset_i)cos(\emptyset_j)sin^2\left(\frac{\lambda_j - \lambda_i}{2}\right)}\right). \qquad (49)$$

Weight w is the reciprocal of the haversine distance, d. The weighted average contribution price P_L of the leader government to the follower government is then

$$w_{i,j} = \frac{1}{d_{i,j}} \qquad (50)$$

[7] We can obtain the Euclidean distance d^E conveniently as follows. While we use the Euclidean distance as an approximation in small areas, it introduces significant error in analyses covering large regions like Hokkaido.

$$d^E_{i,j} \approx \sqrt{\left(\emptyset_j - \emptyset_i\right)^2 + \left(\lambda_j - \lambda_i\right)^2}$$

$$P_{L,i} = \sum_{j=1}^{J} w_{i,j} P_j \Big/ \sum_{j=1}^{J} w_{i,j} \,. \qquad (51)$$

This formulation represents a typical weighted average structure commonly used in spatial econometrics. This assumes that follower governments are strongly influenced by the contribution prices of geographically closer leader governments. Changing the total number of leader governments J alters the weights, and consequently, changes the contribution prices of leader governments to follower governments.

We prepare multiple estimation based on the number of leading governments selected from the top of the donation amount ranking [8]. We consider four estimation models, ranging from a two-leader model to a five-leader model. Tables 4 and 5 report the descriptive statistics of the data and the estimation results for the follower government's donation demand function, respectively.

Table 4 around here

Table 5 around here

In Table 5, the coefficient θ_1 for the logarithm of the follower government's donation price P, which indicates the self-price elasticity of the donation demand function, is negative and statistically significant in all estimation models. That is, setting the follower government's own donation price higher reduces the donation demand. This result implies that follower governments face a downward-sloping donation demand curve, consistent with the findings of Uemura (2025, 2026).

[8] Furthermore, limiting the number of leader municipalities to just one is impossible. Without the contribution prices of at least two or more leader municipalities, one cannot obtain contribution price data P_L with sufficient variation, making it impossible to estimate the contribution demand function for follower governments.

The key focus in this section is the cross-price elasticity coefficient θ_2 for the leader government's donation price P_L relative to the follower government. According to Table 5, in the two-leader model, the coefficient θ_2 is negative and statistically significant. The negative coefficient θ_2 indicates strategic complementarity between the follower and leader governments' reciprocal gifts due to brand externalities. Hokkaido's locally produced goods, which are nationally renowned, are considered to have an established Hokkaido brand, as evidenced by frequent Hokkaido fairs in urban areas. Therefore, the reciprocal gifts offered by leader governments in Hokkaido are thought to have a strategically complementary relationship with the reciprocal gifts of follower governments through the Hokkaido brand.

However, in the estimation results for the three-, four-, and five-leader models, the coefficients θ_2 are not statistically significant. Therefore, for fiscal year 2024 in Hokkaido, Monbetsu City and Shiranuka Town are considered leader governments. Furthermore, in the two-leader model, we note that the absolute value of the coefficient θ_2, indicating cross-price elasticity, is larger than the absolute value of the coefficient θ_1, indicating self-price elasticity. This finding demonstrates that the influence of brand externalities from leader governments is significant for follower governments in Hokkaido. As described above, we show that a strategic price competition structure based on brand externalities exists within the hometown tax donation system among governments in Hokkaido.

5. Conclusion

This study constructs a strategic price competition model in which donation prices are the strategic variables and decision-making occurs sequentially in the presence of brand externalities of reciprocal gifts. We use this model to analyze the donation price competition between leader governments offering reciprocal gifts with strong brand power and follower governments offering reciprocal gifts with weak brand power among multiple local governments providing similar local products as reciprocal gifts under Japan's hometown tax donation system. The results also verify the existence of strategic relationships between local governments.

We formulate an economic model featuring a strategic price competition structure between leader governments acting as first movers and follower governments acting as second movers. This model is based on donation demand functions derived from household utility-maximizing behavior and behavior aimed at maximizing the net donation revenue. We analytically derived the optimal price reaction equations for donation gifts and the surplus. Using a comparative static analysis, we examine the impact of policy parameters on donation prices and surpluses in the hometown tax donation system. This study is the first to apply an economic model with strategic price competition to the hometown tax donation system in the presence of brand externalities from reciprocal gifts. A comparative static analysis using a theoretical model reveals that strengthening the brand power of reciprocal gifts is crucial for achieving a surplus for both follower and leader governments. Furthermore, it clarifies that enhancing the interdependence of reciprocal gifts positively impacts the government surplus for both follower and leader governments.

To verify the existence of the strategic price competition structure among the local governments examined in the theoretical model, we estimate the donation demand functions for follower governments using data from governments within Hokkaido, where nationally renowned local products serve as reciprocal gifts. We measure the haversine distance between follower and leader governments to estimate the leader government's donation price and applied a spatial econometric analysis. Both the empirical analysis of strategic price competition structures within the hometown tax donation system and the analysis using the haversine distance represent novel contributions of this study. To address endogeneity, we conduct the empirical analysis using a two-stage least squares method with an instrumental variable.

The empirical results confirm the assumptions of the theoretical model:

multiple leader governments exist, their donation prices influence follower governments' donation demands, and a strategic competition structure based on the brand power of reciprocal gifts exists. In Hokkaido, the relationship between reciprocal gifts of leaders and follower governments is negative, indicating complementarity. This result suggests that, even among Hokkaido's local products, complementarity exists based on the strength of brand power, implying the presence of brand externalities.

Future research challenges include estimating the donation demand functions of leader governments. Refining the indicators of the brand power of reciprocal gifts and logistics conditions, such as transportation costs, as well as verification through comparisons before and after system reforms and interregional comparisons, are also important tasks. Research combining theoretical and empirical approaches will further deepen our understanding of hometown tax donation systems.

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Table 1: Strategic Competition Models in Industrial Organization Theory

Competition Model	Strategic Variables	Decision-Making
Cournot	Output	Simultaneous
Stackelberg	Output	Sequential (Leader → Follower)
Bertrand	Price	Simultaneous
Strategic Price (This study)	Price	Sequential (Leader → Follower)

Table 2: Signs of the Partial Derivatives in the Comparative Static Analysis of the Donation Price Reaction Functions

Parameter	Donation price of follower government P_F^*	Donation price of leader government P_L^*
Intercept of follower government's donation demand function α_F	+	(−)
Intercept of leader government's donation demand function α_L	0	(+)
Slope of follower government's donation demand function β_F	−	Undetermined
Slope of the leader government's donation demand function β_L	0	Undetermined
Marginal cost of follower government m_F	+	0
Marginal cost of leader government m_L	0	Undetermined
Interrelationships among reciprocal gifts γ	−	Undetermined

Note: "Undetermined" indicates cases where the sign's polarity is undefined. A "0" indicates that partial differentiation is impossible because the equation does not include the parameter, or where the effects cancel each other out. "(+)" and "(−)" denote signs based on the assumption of a complementary relationship among reciprocal gifts ($\gamma > 0$).

Table 3: Signs of the Partial Derivatives of the Comparative Static Analysis of Surpluses

Parameter	Donor surplus for follower government CS_F	Follower government surplus Π_F	Total surplus for follower government TS_F	Donor surplus for leader government CS_L	Leader government surplus Π_L	Total surplus for leader government TS_L
Intercept of follower government's donation demand function α_F	+	+	+	(−)	(−)	(−)
Intercept of leader government's donation demand function α_L	0	0	0	+	+	+
Slope of follower government's donation demand function β_F	−	−	−	(+)	(+)	(+)
Slope of leading government's donation demand function β_L	0	0	0	−	−	−
Marginal cost of follower government m_F	−	−	−	(−)	(−)	(−)
Marginal cost of leader government m_L	0	0	0	−	−	−
Interrelationships among reciprocal gifts γ	+	+	+	+	+	+

Note: "Undetermined" indicates cases where the sign's polarity is undefined. A "0" indicates that partial differentiation is impossible because the equation does not include the parameter, or where the effects cancel each other out. "(+)" and "(-)" denote signs based on the assumption of a complementary relationship among reciprocal gifts ($\gamma > 0$).

Table 4 Descriptive Statistics

	Number of donations Q of follower governments in FY 2024	Donation price P of follower governments in FY 2023	Donation price P of follower governments in FY 2024	Donation price P_L of leader government in FY 2023	Donation price P_L of leader governments in FY 2024
	Two-leader model (Monbetsu City, Shiranuka Town)				
Average	42,542.163	20,866.152	23,599.412	15,533.939	16,549.463
Standard error	7,826.730	1,145.440	1,403.675	1.686	13.644
Median	12,810.000	17,415.552	19,307.536	15,535.223	16,539.076
Standard deviation	104,127.880	15,239.092	18,674.682	22.443	181.534
Minimum	95.000	7,636.223	8,590.253	15,471.954	16,043.603
Maximum	1,035,913.000	138,788.648	188,725.680	15,596.479	17,050.839
Number of observations	177	177	177	177	177
	Three-leader model (Monbetsu City, Shiranuka Town, Betsukai Town)				
Average	36,898.011	20,899.132	23,628.335	15,407.249	16,609.932
Standard error	5,453.189	1,151.489	1,411.130	2.917	10.212
Median	12,542.000	17,425.559	19,456.893	15,412.535	16,602.691
Standard deviation	72,344.729	15,276.235	18,720.760	38.707	135.478
Minimum	95.000	7,636.223	8,590.253	15,190.569	16,204.534
Maximum	672,865.000	138,788.648	188,725.680	15,490.617	17,023.519
Number of observations	176	176	176	176	176
	Four-leader model (Monbetsu City, Shiranuka Town, Betsukai Town, Nemuro City)				
Average	33,263.914	20,883.746	23,648.649	16,782.935	17,052.080
Standard error	4,089.085	1,157.984	1,419.179	18.012	12.822
Median	12,274.000	17,415.552	19,307.536	16,787.024	17,523.732
Standard deviation	54,093.512	15,318.701	18,773.977	238.280	169.629
Minimum	95.000	7,636.223	8,590.253	16,001.536	16,958.877
Maximum	387,226.000	138,788.648	188,725.680	17,865.918	18,260.383
Number of observations	175	175	175	175	175

	Five-leader model (Monbetsu City, Shiranuka Town, Betsukai Town, Nemuro City, Teshikaga Town)				
Average	31,566.500	20,892.275	23,676.463	17,313.681	17,769.665
Standard error	3,741.576	1,164.627	1,427.084	19.207	10.852
Median	12,201.500	17,374.101	19,456.893	17,319.530	17,777.680
Standard deviation	49,354.785	15,362.494	18,824.543	253.368	143.149
Minimum	95.000	7,636.223	8,590.253	16,356.149	17,318.983
Maximum	387,226.000	138,788.648	188,725.680	181,77.086	18,371.671
Number of observations	174	174	174	174	174

Note: Data obtained from the Ministry of Internal Affairs and Communications' "Summary of Findings from the Survey on the Current Status of Hometown Tax Donations" and the Ministry of Land, Infrastructure, Transport and Tourism's "National Land Information Download Site."

Table 5 Estimated Donation Demand Function Results for Follower Governments

Estimation Model	Two-leader model (Monbetsu City, Shiranuka Town)	Three-leader model (Monbetsu City, Shiranuka Town, Betsukai Town)	Four-leader model (Monbetsu City, Shiranuka Town, Betsukai Town, Nemuro City)	Five-leader model (Monbetsu City, Shiranuka Town, Betsukai Town, Nemuro City, Teshikaga Town)
Constant term θ_0	336.299* (0.001)	−952.69 (0.228)	−208.678 (0.137)	−196.764 (0.274)
Coefficient of the logarithm of the donation price $\widehat{ln(P)}$ for follower government θ_1	−1.208* (0.000)	−1.232* (0.000)	−1.286* (0.000)	−1.269* (0.000)
Coefficient of the logarithm of the donation price $\widehat{ln(P_L)}$ for leader government θ_2	−32.415* (0.002)	100.262 (0.218)	23.625 (0.101)	22.355 (0.225)

Note: Values in parentheses are p-values. * indicates statistical significance at the 1% level.