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Hometown Tax Donation (Furusato Nozei)
and Reciprocal Gift Consumption in Japan
- Economic Analysis of Brand Power and Transportation Costs -

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Abstract

This study develops a theoretical model based on the optimization behaviors of households and local governments for the hometown tax donation (Furusato Nozei) system in Japan, which has garnered attention as a new means of obtaining financial resources for local governments. Further, it conducts theoretical, numerical simulation, and empirical analyses. This study is the first to apply the Krugman model, which focuses on brand power and the transportation cost of reciprocal gifts and addresses differentiated goods and spatial trade.

The empirical analysis targets municipalities in Hokkaido because of (1) the brand power of Hokkaido products and (2) the fact that transport to Honshu is almost exclusively limited to airports and ports; thus, transportation costs can be analyzed. This study is also the first to use the transportation distance of reciprocal gifts measured using a road network.

Comparative statics analysis based on the theoretical model revealed the following trends: Higher reciprocal gift prices reduce reciprocal gift consumption but have an indeterminate impact on donation amounts; stronger brand power increases both donation amounts and reciprocal gift consumption; and higher transportation costs reduce reciprocal gift consumption. Reciprocal gift ratio, brand power, and transportation costs also affect the optimal reciprocal gift price.

Finally, the empirical analysis based on municipal data for Hokkaido confirms that the price of reciprocal gifts does not significantly affect donation amounts and negatively affects reciprocal gift consumption, whereas the number of reciprocal gift types (a proxy variable for brand power) positively affect both donation amounts and reciprocal gift consumption. Transportation distance to airports and ports negatively affects both, which is consistent with the results of the theoretical model.

JEL Classification: H71, H72, and H77
Keywords: Hometown tax donation system (Furusato Nozei), Brand power of

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reciprocal gifts, Transportation costs

1. Introduction

The hometown tax donation (*Furusato Nozei*) system in Japan has attracted attention as a new means of obtaining financial resources for local governments. Under this system, households donate to local governments of their choice; in return, the local governments offer reciprocal gifts such as locally produced goods. While this system has attracted large donations for some local governments, it has also been criticized because of excessive competition for reciprocal gifts.

First, the types of local governments that attract large donations include those that can offer reciprocal gifts with strong brand power. For example, local products from Hokkaido are considered to have strong brand power, to the extent that Hokkaido fairs are frequently held in urban areas and local governments in Hokkaido collect large donations. According to the Ministry of Internal Affairs and Communications' (MIC) "Survey on Current Status of Hometown Tax Donation," the top 100 local governments with the largest amounts of donations to the hometown tax donation in FY2023 are 13 local governments in Hokkaido, followed by six local governments in Yamagata, Yamanashi, Fukuoka, and Saga Prefectures.

Second, local governments that are located near large consumption areas, such as the Tokyo metropolitan area in Honshu, have reduced transportation costs. Figure 1 shows the local governments in Hokkaido with the largest donations to the hometown tax donation system. The dark gray areas indicate the top 100 municipalities in Japan in terms of donation amounts, and the light gray areas indicate the top 101 to 200 municipalities. The black marks indicate airports (marked with an aircraft) and ports (marked with an anchor) that have good cargo transportation records.

Note that in Figure 1, the municipalities shown in gray are located near airports or ports. Thus, these municipalities can reduce transportation costs. We can hypothesize that they may attract large donations by controlling the price of reciprocal gifts, including transportation costs.

Figure 1 around here

In other words, the strong brand power of reciprocal gifts and the locations of nearby airports or ports may be important factors for local governments aiming to attract donations. This study focuses on municipalities in Hokkaido because, in addition to the strong brand power of the reciprocal gifts, roads cannot be used as a means of logistics to and from Honshu. Most hometown tax donations from Hokkaido are transported to Honshu through airports or ports. Local governments in Hokkaido are believed to be more affected by transportation costs than those in Honshu, Kyushu, and Shikoku, which are connected by roads.

This study takes advantage of the local governments' characteristics in Hokkaido to analyze the amount of donations and reciprocal gift consumption, focusing on the brand power and transportation costs of the reciprocal gifts. The theoretical model used in the analysis is constructed with reference to the new trade theory (Krugman (1979,1980)) and new economic geography (Krugman (1991a,b)).

The Krugman model is applied because, first, it is suitable for analyzing the market for branded hometown tax donations. The Krugman model can analyze differentiated goods in a monopolistic competitive market. Second, it allows for spatial analysis. The Krugman model is suitable for dealing with the flow of goods and funds between regions. Third, it can handle the interaction between households' utility-maximizing donations and reciprocal gift consumption behavior and local governments' net donation revenue-maximizing behavior.

Krugman (1979,1980) is credited with pioneering the new trade theory, which explains patterns of international trade while accounting for economies of scale and the differentiation of goods. This theory is innovative because it extends the traditional comparative advantage framework to consider firms' market entries and market structures. Krugman (1991a,b) proposed the new economic geography to explain the mechanisms that shape industrial agglomeration among regions. In this theory, differences in transportation costs and market size are considered factors that create uneven distribution of economic activities among regions. As the analysis of hometown tax donations is better suited to a model of trade between domestic regions than to a model of international trade between nations, this study applies the ideas of the new economic geography. This is the first study to apply the Krugman model to analyze hometown tax donation systems.

This study theoretically models the hometown tax donation system to clarify how the optimal behaviors of households and local governments are related and then analyzes how policy changes, such as the pricing of reciprocal gifts, MIC regulations, and transportation costs, affect the optimal behavior of households and local governments. Furthermore, we test the validity of the theoretical model through empirical analysis using the spatial location data of municipalities, airports, and ports in Hokkaido.

Existing studies on hometown tax donation systems are mainly empirical, and many have evaluated the system's economic impact using statistical methods (Akai, Ishimura and Nishimura (2017), Musha (2019), Suematsu (2020), Yamamura, et al.

(2021), Ishimaru (2022)). Several studies have also used theoretical models to addressed competition among local governments (Furusawa, et al. (2020), Fukazawa (2020), Kato and Yanagihara (2022), Ayukawa (2022, 2023)); however, most focus on competitive relationships among local governments. This study is unique in that it analyzes the interrelationship between the optimization behaviors of households and local governments, not from the perspective of competition among local governments, and empirically clarifies how brand power and transportation cost of reciprocal gifts affect the optimization behaviors of households and local governments based on the construction of a theoretical model.

The subsequent sections of this study are organized as follows. Section 2 presents a theoretical model formulating the economic behaviors of households and local governments. Section 3 discusses the impact of changes in parameters on the optimal behavior of each entity through comparative statics and numerical simulation analyses. Section 4 presents an empirical analysis of Hokkaido municipalities. Section 5 concludes the study and discusses future research topics.

2. Theoretical model of households and local government

In this section, we present a theoretical model that represents the optimal behaviors of households and local governments that incorporate the hometown tax donation system. Households' utility-maximizing behavior determines the optimal donation amounts and the choice between reciprocal gift consumption and other consumption types. The local government determines the optimal reciprocal gift price under the net donation revenue-maximizing behavior. In the following section, we present the model in the order of households and local governments.

First, the utility function of households is constructed based on the quasi-linear utility function introduced in the monopolistic competition model by Ottaviano, Tabuchi and Thisse (2002), who analyzed interregional trade. As the total number of local governments n, households residing in a local government $i \in (1, \cdots, n)$ choose between other consumption C and consumption of reciprocal gifts $q_{i,j}$ from the local government $j \in (1, \cdots, n)$ to which they donate under the hometown tax donation system. Assuming that households prefer a variety of reciprocal gift consumption, we formulate the utility function U as follows:

$$U_i = C_i + \sum_{j \neq i}^{n} \beta_j q_{i,j} - \sum_{j \neq i}^{n} \frac{\gamma}{2} q_{i,j}^2 - \frac{\eta}{2} \left(\sum_{k \neq j}^{n} q_{i,k} \right)^2 \qquad (1)$$

The parameter $\beta (\geq 0)$ shows the strength of households' preferences for reciprocal gifts and the parameter $\gamma(>0)$ shows the diminishing effect of local government j on marginal utility for reciprocal gift consumption.

The parameter η, which represents the diminishing effect of marginal utility on the consumption of a reciprocal gift from a different local government $k \in (1, \cdots, n)$ and not from local governments j, also indicates the degree of reciprocal gift competition. If $\eta > 0$ indicates a situation in which other local governments' reciprocal gifts compete as substitute goods, and if $\eta < 0$ indicates a situation in which other local governments' reciprocal gifts are complementary goods, we assume that $\eta > 0$ because the market for reciprocal gifts is generally competitive. In summary, one local government is assumed to supply only one reciprocal gift, and $q_{i,i} = 0$ is assumed because under the hometown tax donation system, households i cannot consume reciprocal gifts from the local government i under which they reside.

The budget constraint equation for households is as follows:

$$C_i + \sum_{j \neq i}^{n} d_{i,j} = Y_i - T_i \qquad (2)$$

$d_{i,j}$ shows the donation amount by households i to local government j, income Y, and tax burden T. The price of consumption C is standardized to 1 because of numéraire. Under the hometown tax donation system, households cannot consume reciprocal gifts from their local government under which they reside; however, they can institutionally donate to their local government. For model simplicity, we assume that households do not donate to the local government i in which they reside ($d_{i,i} = 0$).

Furthermore, the hometown tax donation system may reduce income tax through inhabitant tax donation deductions and introduce income effects through the household budget constraint equation. However, the model used in this study does not analyze income effects because it uses a quasi-linear utility function. Therefore, the deduction mechanism in the hometown tax donation system is excluded from this study's model.

In addition, the following reciprocal ratio criteria specified by the MIC are considered in the optimizing behavior of households:

$$g d_{i,j} \geq \tau_{i,j}(r_{i,j}) p_j q_{i,j} \qquad (3)$$

$g (0 \leq g \leq 1)$ shows the reciprocal ratio criterion, reciprocal gift price p, iceberg transportation costs $\tau_{i,j}$, and transportation distance $r_{i,j}$ incurred when the local government j ships returns to households i living under the local government i. Therefore, τp is the reciprocal gift price, including iceberg transportation costs.

The iceberg transportation cost τ is a concept used in the Krugman model and considers that some of the goods will melt during transportation. Here, the initial iceberg transportation cost is $\tau_{i,j} > 1$ when local government j ships the reciprocal gifts to local government i; however, it is $\tau_{i,j} = 1$ when the reciprocal gifts reach local government i. We assume that the longer the transport distance r, the more the iceberg transport cost increases ($\partial\tau/\partial r > 0$).

According to the reciprocal ratio g by the MIC, the procurement cost of individual reciprocal gifts on the right-hand side cannot exceed 30% of the donation amount d. In the current system, the reciprocal ratio parameter is $g = 0.3$. This reciprocal ratio criterion presents inequality in the system; however, for simplicity, we assume that equality holds and solves the utility maximization problem for households[1]. Consequently, the optimal amount d^* of households' i contributions to local government j is obtained as follows:

$$d_{i,j}^* = \frac{\tau_{i,j}(r_{i,j})p_j}{\gamma g^2}\{gB_j - \tau_{i,j}(r_{i,j})p_j\} \qquad (4)$$

B shows the brand power of the reciprocal gifts of local government j as follows: For positive donations, the brand power of reciprocal gifts should be positive.

$$B_j = \beta_j - \eta \sum_{k \neq j}^{n} d_{i,k} > 0 \qquad (5)$$

That is, if the strength of preference β for the reciprocal gifts of local government j does not exceed the product $\eta \sum d$ of the degree of reciprocal gift competition η and the total amount of donations to the local government itself, other than to local government j, no donations will be made to local government j. A positive reciprocal gift brand power B means that the strength of preference for the local government's reciprocal gifts is an attraction that exceeds the amount donated to other local governments. Thus, the stronger the preference for a given local government's reciprocal gifts is, the lower the degree of competition for reciprocal gifts, and the more donations are made to that local government.

The formula for the optimal donation amount d^* also shows that donations to the local government j will not be made unless the product gB of the brand power of the local government's reciprocal gifts and the reciprocal ratio parameter exceeds the reciprocal gift price including transportation costs τp. For a household to make a positive donation, the following conditions must be met:

[1] Uemura (2025a,b) showed that many local governments that are eager to obtain hometown tax donation follow the reciprocal ratio criterion and that $g = 0.3$ is almost established. Therefore, this study assumes that the reciprocal ratio criterion is established using equal signs.

$$gB_j - \tau_{i,j}(r_{i,j})p_j > 0 \qquad (6)$$

Thus, the higher the reciprocal ratio parameter is, the lower the reciprocal gift price including transportation cost τp, and the shorter the transportation distance r, the more donations are made to the local government.

Using the relationship between a household's optimal donation amount d^* and the reciprocal ratio criterion, the following optimal reciprocal gift consumption q^* can be derived:

$$q_{i,j}^* = \frac{B_j}{\gamma} - \frac{\tau_{i,j}(r_{i,j})p_j}{\gamma g} = \frac{1}{g\gamma}\{gB_j - \tau_{i,j}(r_{i,j})p_j\} \qquad (7)$$

In other words, the stronger the brand power B of the reciprocal gifts is, the larger the reciprocal gift consumption, and the larger the reciprocal gift priceτp is, including transportation costs or the longer the transportation distance r, the smaller the reciprocal gift consumption. As the denominator $g\gamma$ is positive, the earlier condition $gB - \tau p > 0$ is necessary for a positive reciprocal gift price.

Second, the local government j maximizes its net donation revenue Π based on the aggregated total donations D.

$$\Pi_j = \sum_{i=1}^{n} d_{i,j} - (p_j + m_j)\sum_{i=1}^{n} q_{i,j} + F_j = D_j - (p_j + m_j)\sum_{i=1}^{n} q_{i,j} + F_j \qquad (8)$$

Here, the local government bears marginal costs m such as public relations costs and fixed costs F such as personnel costs. As households are on the demand side and local governments are on the supply side in the market for reciprocal gift, the equilibrium conditions for the reciprocal gift market for local government j are as follows:

$$Q_j = \sum_{i=1}^{n} q_{i,j} \qquad (9)$$

Considering this, we obtain the equilibrium reciprocal gift price p^* for the reciprocal gift market by solving the net donation revenue maximization problem for local government j.

$$p_j^* = \frac{g\{(\tilde{\tau}_j - g_j)B_j + \tilde{\tau}_j m_j\}}{2\tilde{\tau}_j(\tilde{\tau}_j - g)} \qquad (10)$$

Here is the average transportation cost $\tilde{\tau}$ faced by local government j.

$$\tilde{\tau}_j = \frac{1}{n}\sum_{i=1}^{n} \tau_{i,j}(r_{i,j}) \qquad (11)$$

Given that, by definition, the transportation cost $\tilde{\tau} \geq 1$ and the reciprocal ratio parameter $g(0 \leq g \leq 1)$ is $g = 0.3$. The current system is $(\tilde{\tau} - g)$, and the denominator and the numerator are institutionally non-negative. In addition, for a positive equilibrium reciprocal gift price, the brand power of the reciprocal gifts B must remain positive.

3. Comparative statics analysis of brand power and transportation costs of reciprocal gifts

In this section, using the theoretical model in the previous section, we conduct a comparative statics analysis of the effects of reciprocal gifts price p, brand power of reciprocal gifts B, and transportation cost τ (or transportation distance r) on the optimal donation amount d^*, optimal consumption of reciprocal gifts q^*, and equilibrium reciprocal gift price p^* of the hometown tax donation system, with a view toward empirical analysis in the next section. First, the optimal donation amount and reciprocal gift consumption are analyzed, followed by the equilibrium reciprocal gift price. Thereafter, a numerical simulation analysis is conducted.

3.1.1 Effects of optimal donation amount and optimal reciprocal gift consumption

First, the impact of the reciprocal gift price p on the optimal donation amount d^* and optimal reciprocal gift consumption q^* is as follows.

$$\frac{\partial d_{i,j}^*}{\partial p_j} = \frac{\tau_{i,j}}{\gamma g^2}\left(gB_j - 2\tau_{i,j}p_j\right) \qquad (12)$$

$$\frac{\partial q_{i,j}^*}{\partial g_j} = -\frac{\tau_{i,j}}{\gamma g} < 0 \qquad (13)$$

The impact of the reciprocal gift price on optimal reciprocal gift consumption is negative, but the impact on the optimal donation amount is not sign-conditional. $\tau p/(\gamma g^2)$ is positive; therefore, the sign condition is determined in parentheses on the right-hand side. When the condition $B > 0$ for the existence of a positive donation holds, the optimal donation amount increases if $gB > 2\tau p$ and decreases if $gB < 2\tau p$.

Second, the impact of reciprocal gift brand power B on optimal donation amount d^* and optimal reciprocal gift consumption q^* is as follows:

$$\frac{\partial d_{i,j}^*}{\partial B_j} = \frac{\tau_{i,j}p_j}{\gamma g} > 0 \qquad (14)$$

$$\frac{\partial q_{i,j}^*}{\partial B_j} = \frac{1}{\gamma} > 0 \qquad (15)$$

In other words, the stronger the brand power of reciprocal gifts is, the more the donation amount and consumption of reciprocal gifts. As the brand power of reciprocal gifts is an increasing function of the strength of preference β for reciprocal gifts, the strength of preference for reciprocal gifts should be increased to increase the amount of donations and consumption of reciprocal gifts.

Third, the impact of transportation cost τ (or transportation distance r) on optimal donation amount d^* and optimal reciprocal gift consumption q^* is as follows:

$$\frac{\partial d_{i,j}^*}{\partial \tau_{i,j}} = \frac{p_j}{\gamma g^2}\left(gB_j - 2\tau_{i,j}p_j\right) \qquad (16)$$

$$\frac{\partial q_{i,j}^*}{\partial \tau_{i,j}} = -\frac{p_j}{\gamma g} < 0 \qquad (17)$$

The impact of transportation costs (or transportation distance) on reciprocal gift consumption is negative, but the impact on donation amounts is not sign-deterministic. As $p/(\gamma g^2)$ is positive, the sign condition is determined in parentheses on the right-hand side. When the condition $B > 0$ for the existence of positive donation holds, the optimal donation amount increases if $gB > 2\tau p$; conversely, the optimal donation amount decreases if $gB < 2\tau p$.

Fourth, the impact of reciprocal ratio g on optimal donation amount d^* and optimal reciprocal gift consumption q^* is as follows:

$$\frac{\partial d_{i,j}^*}{\partial g} = -\frac{\tau_{i,j}p_j}{\gamma g}\left(gB_j - 2\tau_{i,j}p_j\right) \qquad (18)$$

$$\frac{\partial q_{i,j}^*}{\partial g} = \frac{\tau_{i,j}p_j}{\gamma g} > 0 \qquad (19)$$

The impact of the reciprocal ratio on reciprocal gift consumption is positive; however, the impact on donation amounts is not sign-conditional. As $\tau p/(\gamma g^2)$ is positive, the sign condition is determined in parentheses on the right-hand side. As before, when the condition $B > 0$ for the existence of positive donation holds, the optimal donation amount decreases if $gB > 2\tau p$; conversely, the optimal donation amount increases if $gB < 2\tau p$.

3.2. Impact on equilibrium reciprocal gift prices

First, the impact of the reciprocal gift brand power B on the equilibrium reciprocal gift price p^* is as follows:

$$\frac{\partial p_j^*}{\partial B_j} = \frac{g}{2\tilde{\tau}} > 0 \qquad (20)$$

Therefore, if the brand power of reciprocal gifts is stronger, their prices will increase. If the brand power of reciprocal gifts is strong, the local government can collect donations, even if the price of reciprocal gifts is high.

Second, the impact of transport costs τ (or transport distance r) on equilibrium reciprocal gift prices p^* is as follows:

$$\frac{\partial p_j^*}{\partial \tilde{\tau}_j} = -\frac{m_j g}{2(\tilde{\tau}_j - g)^2} - \frac{gB_j}{2\tilde{\tau}_j^2} < 0 \qquad (21)$$

Thus, an increase in transportation costs decreases the equilibrium donation price. Even if transportation costs increase, the reciprocal gift price must decrease to collect the donation amount while still meeting the reciprocal criteria. Based on the numerator, the greater the marginal cost m and the stronger the brand power B of the reciprocal gifts, the lower is the reciprocal gift price owing to higher transportation costs.

Third, the impact of the reciprocal ratio parameter g on the equilibrium reciprocal gift price p^* is as follows:

$$\frac{\partial p_j^*}{\partial g} = \frac{B_j}{2\tilde{\tau}_j} + \frac{\tilde{\tau}_j m_j}{2(\tilde{\tau}_j - g)^2} + \frac{m_j}{2(\tilde{\tau}_j - g)} > 0 \qquad (22)$$

An increase in the reciprocal ratio parameter increases the reciprocal gift price. According to the numerator, the stronger the brand power B of the reciprocal gifts and the higher the marginal cost m, the higher the reciprocal gift price, which increases with an increase in the reciprocal ratio parameter.

3.3.3. Simulation analysis

In this section, a numerical simulation analysis is performed using a theoretical model.

First, Figure 2 shows the results of numerical calculations of the effects of B brand power of reciprocal gifts, τ transportation cost, and g reciprocal ratio parameters on the optimal donation amount d^*. Here, we set parameters $\gamma = 0.5$ to the diminishing effect of marginal utility, the transportation cost parameter $1.0 \leq \tau \leq 1.5$, the reciprocal ratio parameter $g \in (0.3, 0.4, 0.5)$, and the brand power of the reciprocal gift parameter $B \in (3.5, 4.0, 4.5)$. Under these conditions, the equilibrium reciprocal gift price p^* is calculated, and the optimal donation amount d^* is obtained.

Figure 2 around here

According to the results in Figure 2, the optimal donation amount d^* increases as the brand power of the reciprocal gifts B increases, the optimal donation amount increases as the transportation cost τ increases, and the optimal donation amount increases as the reciprocal ratio g increases. According to the comparative statics analysis of the optimal donation amounts in the previous section, these sign conditions have not been determined and need to be confirmed by the empirical analysis in the next section.

Second, Figure 3 shows the numerical calculation results of the effects of reciprocal gift brand power B, transportation cost τ, and reciprocal ratio g on the equilibrium reciprocal gift price. Here, we set the parameters $\gamma = 0.5$ as the parameter to the diminishing effect of marginal utility, $m = 2$ as the marginal cost parameter, $1.0 \leq \tau \leq 1.5$ as the transportation cost parameter, $g \in (0.3, 0.4, 0.5)$ as the reciprocal ratio parameter, and $B \in (3.5, 4.0, 4.5)$ as the brand power of the reciprocal gift parameter. Under these conditions, the equilibrium reciprocal gift price p^* is calculated, and the optimal reciprocal gift consumption q^* is obtained.

Figure 3 around here

According to the results in Figure 3, optimal reciprocal gift consumption q^* increases as the brand power of the reciprocal gifts B strengthens, optimal reciprocal gift consumption decreases as the transportation cost τ increases, and optimal reciprocal gift consumption increases as the reciprocal ratio g increases. We confirm the same results as the sign condition in the comparative statics analysis of optimal reciprocal gift consumption in the previous section.

4. Empirical analysis of the amount of the donation and consumption of reciprocal gifts

With reference to the theoretical model and comparative statics analysis in the previous sections, the donation amount function D (Model 1) and the reciprocal gift consumption function Q (Model 2) are specified in the following log-linear estimation equations:

$$log(D_j) = \alpha_0 + \alpha_1 log(p_j) + \alpha_2 log(v_j) + \alpha_3 log(r_j) + \varepsilon_j \qquad (23)$$

$$log(Q_j) = \alpha_0 + \alpha_1 log(p_j) + \alpha_2 log(v_j) + \alpha_3 log(r_j) + \varepsilon_j \qquad (24)$$

These equations show the reciprocal gift prices p, the number of reciprocal gift types v, the shortest distance between a local government j and an airport or port r, and the constant terms α_0 and coefficients α_1, α_2, and α_3 to be estimated. For reciprocal gifts with strong brand power B, processed and other products are often added to the lineup of reciprocal gifts, and it is expected that the strength of the reciprocal gifts' brand power will increase the number of reciprocal gift types. Therefore, we use the number of reciprocal gift types as a proxy variable for the brand power of reciprocal gifts. In addition, the shortest distance between a certain local government and an airport or port r is a proxy variable for transportation cost τ.

With the donation amount function D and the reciprocal gift consumption function Q as log-linear type estimating equations, the estimated coefficients α_1, α_2, and α_3 show elasticity. Based on the comparative statics analysis described in the previous section, we predict the sign conditions of the coefficients. First, the sign condition for the coefficient α_1 of the reciprocal gift price p in the donation amount function (Model 1) is not determined; however, the sign condition for the coefficient α_1 of the reciprocal gift price p in the reciprocal gift consumption function (Model 2) is negative. Second, the sign condition for the coefficient α_2 of the number of reciprocal gift types v is positive for both coefficients. Third, the sign condition for the coefficient α_3 of the shortest distance r between the local government and the airport/port in the donation amount function (Model 1) is not determined; however, the sign condition for the coefficient α_3 of the shortest distance r in the reciprocal gift consumption function (Model 2) is negative.

The targets of this study are the municipalities in Hokkaido. The explained variable, donation amount D, is the "donation amount" data of municipalities in Hokkaido in FY2023 from the" Survey on the Current Status of Hometown Tax Donation" by the MIC, and the reciprocal gift consumption Q is the " number of donations " data. The explanatory variable, price of reciprocal gifts p, is obtained by dividing the "procurement cost" data by the "number of donations" data. The procurement cost does not include the shipping cost of reciprocal gifts. The number of types of reciprocal gifts v is obtained from data on the number of types of reciprocal gifts registered by municipalities in Hokkaido on "FURUSATO Choice," a hometown tax donation portal site, as of April 25, 2025.[2]

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[2] Despite several hometown tax donation portal sites, the number of sites that can explicitly obtain the number of types of reciprocal gifts from local governments is limited. Initially, we obtained data on the number of types of reciprocal gifts from the hometown tax donation portal site "SATOFURU," but the data for 25 municipalities had missing values. To ensure the completeness of the data, we recollected the same items from "FURUSATO Choice," a hometown tax donation portal site, and obtained data for all municipalities in Hokkaido. Thereafter, regression analysis is conducted on both datasets, and the results are compared. No significant differences are found in the signs or statistical significance of the coefficients of the main explanatory variables, confirming that the estimation results in this study are robust to the differences in data sources.

We describe how to obtain data for the last explanatory variable, namely, the shortest distance between a municipality and an airport or port r. We assume that the location of each municipality in Hokkaido is the address of its municipal office. The locations of municipal offices in Hokkaido as well as airports and ports with cargo transportation records are obtained from MLITT's "National Land Data Download Site" using latitude and longitude coordinate point data from the Geographical Survey Institute's "National Database of Prefectural and Municipal Offices and Villages in Japan." The data for airports is obtained from the MLITT's "Airport Management Situation Report," and New Chitose Airport, Hakodate Airport, Asahikawa Airport, Kushiro Airport, Obihiro Airport, Nakashibetsu Airport, Monbetsu Airport, Wakkanai Airport, and Nemuro Airport are selected. The data for ports is obtained from the MLITT's "National Import/Export Container Cargo Flow Survey," and Hakodate Port, Muroran Port, Tomakomai Port, Otaru Port, and Ishikari Bay New Port are selected as ports.

The distance from the longitude/latitude coordinate point of each municipal office to the longitude/latitude coordinate point of each airport and port is measured as the transportation distance when using roads and not as a straight-line distance. Library OSMnx package is used to obtain the nearest road intersection or road end from that point in OpenStreetMap based on the latitude and longitude coordinate point data for each municipal office, and the distance of the road from that point to the latitude and longitude coordinate point data for the airport or port is measured[3]. The shortest distance between a municipal office and an airport or port is selected as the shortest distance r.

The basic statistics for the above explained and dependent variables are presented in Table 1.[4] Prior to the regression analysis, the variance inflation factor (VIF) is calculated for each explanatory variable to test the possibility of multicollinearity among the explanatory variables. The three explanatory variables included are the price of reciprocal gifts per item, $log(p_j)$; number of reciprocal gift types, $log(v_j)$; and the shortest distance to the airport/port, $log(r_j)$. The VIF values for all variables are less than 1.12, well below the criterion (VIF>10), which is generally considered a concern for multicollinearity. This indicates that the effect of multicollinearity is extremely small, and the stability of the estimation results and validity of the interpretation can be ensured. Using these data, Table 2 shows the results of estimating the donation amount function

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[3] Map data is obtained from OpenStreetMap, which is provided under the Creative Commons Attribution-ShareAlike 2.0 Open Database License (ODbL).

[4] The number of municipalities in Hokkaido in FY2023 is 179, while the number of observations is 178. The number of reciprocal gifts types registered in "FURUSATO Choice" in Nae Town is zero; therefore, it is excluded for the purpose of taking logarithms.

D and reciprocal gift consumption function Q described above.

Table 1 and Table 2 around here

First, we confirm that the coefficient of α_1 on the reciprocal gift price p is statistically insignificant in the donation amount function D (Model 1) but statistically negative and significant in the reciprocal gift consumption function Q (Model 2). These results are consistent with the results of the comparative statics analysis in the previous section. That is, in the donation amount function, the sign condition is not determined for the reciprocal gift price; however, in the reciprocal gift consumption function, an increase in the reciprocal gift price decreases reciprocal gift consumption.

The empirical analysis results indicate that the reciprocal gift price has no clear effect on the amount of donations but has a suppressive effect on the number of donations (reciprocal gift consumption). Households adjust their consumption of reciprocal gifts (number of donations) in response to the price of the reciprocal gifts, indicating that the impact of reciprocal gift prices on the overall amount of donations is complex, as indicated by the comparative statics analysis in the previous section.

Second, the coefficient of α_2 on the number of reciprocal gift types v is statistically positive and significant for the donation amount function D (Model 1) as well as for the reciprocal gift consumption function Q (Model 2). This result is consistent with the comparative static results presented in the previous section. It is important to note that the estimated coefficient of the number of reciprocal gift types exceeds one. The estimated coefficients are elastic in the log-linear regression equation. That is, a 1% increase in the number of reciprocal gift types indicates that the amount and number of each increase by more than 1.1%.

The result that the elasticity of donation amounts and consumption of reciprocal gifts exceeds 1 for the number of reciprocal gifts v highlights a structure in which the expansion of the number of reciprocal gifts attracts donation amounts and the consumption of the reciprocal gifts in a cumulative and accelerated manner. Therefore, by taking advantage of the brand power of reciprocal gifts, having multiple types of reciprocal gifts has a positive impact on the promotion, visibility, and marketing by local governments. Therefore, for local governments seeking to secure financial resources through hometown tax donations, strategically expanding the number of types of reciprocal gifts, in addition to improving the quality of reciprocal gifts, can be an effective means of attracting more donations. The diversity of reciprocal gifts has important policy implications for the strategies of local governments in the hometown tax donation system.

Third, the coefficient α_3 of the shortest distance r between the municipality and the airport/port is statistically negative and significant for both the donation amount function D (Model 1) and the reciprocal gift consumption function Q (Model 2). In the comparative statics analysis described in the previous section, the sign condition for the donation amount function is not determined, but that of the reciprocal gift consumption function is negative. The empirical analysis in this section shows that the distance from airports and ports negatively affects the amount of donations and the consumption of reciprocal gifts.

This result indicates that an increase in transportation costs due to the deterioration of logistics access for local governments leads to a decrease in the amount of the donations and consumption of reciprocal gifts (number of donations). However, the estimated coefficients α_3 are all between -0.26 and -0.23 and thus below 1 in absolute value, confirming that the elasticity of distance to the amount of the donations and consumption of reciprocal gifts is relatively small. Conversely, as the elasticity of the number of reciprocal gifts v is above one, households as donors may value the brand power of reciprocal gifts more than the impact of transportation costs.

Therefore, to compensate for distance in logistics access, such as airports and ports, which is a constraint for local governments, they can increase household donation amounts by strengthening their reciprocal gift brand building and reciprocal gift strategies.

5. Conclusion

This study presents a theoretical model of the hometown tax donation system in Japan, which is garnering attention as a new means of obtaining financial resources for local governments. The model consists of the optimal amounts of the donation and consumption of reciprocal gifts based on the utility maximization behavior of households and the optimal reciprocal gift price based on the net donation revenue maximization behavior of local governments. In addition, an empirical analysis is conducted based on the simulation results using comparative statistics and numerical analyses.

The Krugman model, based on monopolistic competition, is particularly well-suited for analyzing differentiated goods with brand power and spatial trade between regions, especially under the framework of iceberg transportation costs. This study’s first contribution is that it builds a theoretical model by applying the Krugman model, which pioneered the new trade theory and new economic geography, to the analysis of hometown tax donation systems.

Our empirical analysis focuses on municipalities in Hokkaido for several reasons. First, we believe that reciprocal gifts of Hokkaido products also have brand power.

Second, many reciprocal gifts in Hokkaido go through airports or ports, making Hokkaido municipalities an appropriate target for analyzing the impact of transportation distance on the amount of donations and consumption of reciprocal gifts. This study is also the first empirical analysis of transportation distances based on road network data, focusing on the transportation costs of reciprocal gifts.

The analysis results in this study are outlined below.

First, according to a comparative statics analysis of the theoretical model, an increase in the price of reciprocal gifts decreases reciprocal gift consumption, but its impact on the amount of donations is not generally determined. If the brand power of reciprocal gifts is strengthened, both the donation amounts and consumption of reciprocal gifts will increase. If transportation costs increase, the consumption of reciprocal gifts decreases; however, there is no clear direction for the amount of donations. When the reciprocal ratio standard increases, reciprocal gift consumption increases; however, no clear relationship exists for the amount of donations.

Second, as the brand power of reciprocal gifts increases, the optimal reciprocal gift price increases. If the transportation costs increase, the optimal reciprocal gift price decreases to satisfy the reciprocal ratio criterion. As the reciprocal ratio increases, the optimal reciprocal gift price also increases. A numerical simulation is conducted to confirm the above comparative static analysis using the theoretical model.

Third, we conduct an empirical analysis using the shortest transportation distance obtained from data on hometown tax donations by municipalities in Hokkaido and the locations of municipal offices, airports and ports, and road networks. The donation price is not statistically significant for the amount of donations and has a negative coefficient for the consumption of reciprocal gifts. The number of reciprocal gift types, a proxy variable for the brand power of reciprocal gifts, had a statistically positive coefficient for both donation amount and reciprocal gift consumption. The shortest distance between the municipal office and the airport or port has a statistically negative coefficient for both the amount of donations and consumption of reciprocal gifts. The results of these empirical analyses are consistent with the sign conditions of the theoretical model.

This study analyzes the hometown tax donation system from both theoretical and empirical perspectives; however, many future issues remain to be addressed. First, it is necessary to construct a household behavior model that explicitly introduces institutional constraints, such as a tax deduction system and maximum donation amount. Second, a framework that considers strategic actions and competition among multiple municipalities must be introduced. Third, an extension that incorporates the behavior of firms responsible for supplying returns and the ripple effects in the local economy is also promising. These points will be addressed in future research.

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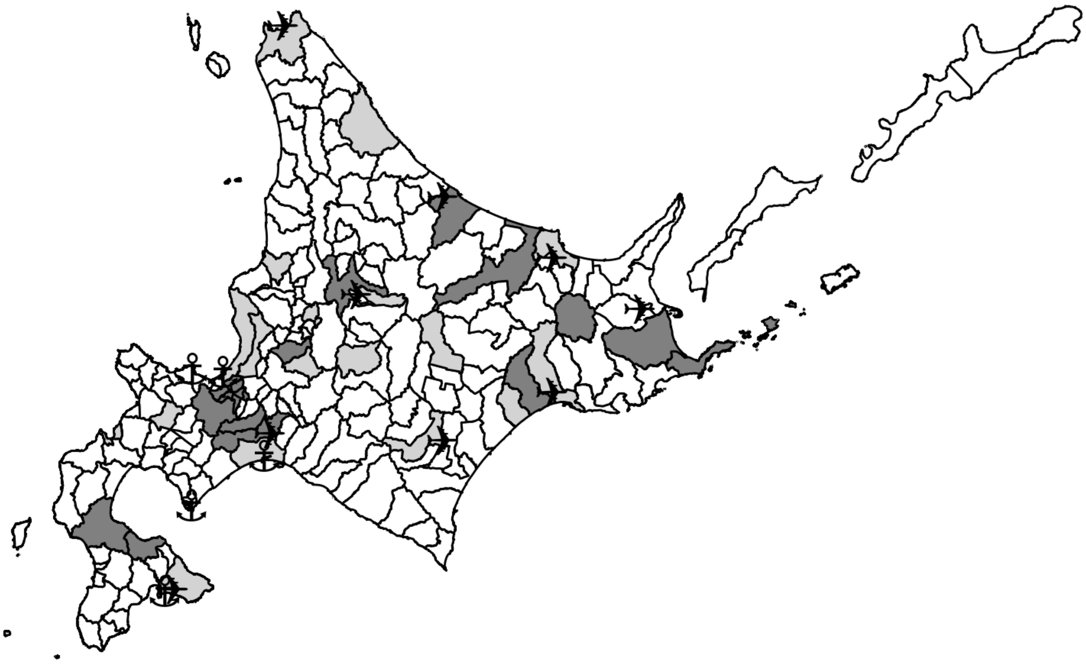
Figure 1: Top local governments in Hokkaido with the largest hometown tax donation amounts and location of major airports and ports



Note: Map data are based on the "Administrative Area Data" N03-21_01_210101 shape file from the Ministry of Land, Infrastructure, Transport and Tourism's (MLITT) "National Land Data Download Site," and the map was created using the map creation tools Geopandas, Matplotlib, and Cartopy from the Python library. Airport cargo traffic data are obtained from the "Airport Management Situation Report" by the MLITT, and port cargo traffic data are from the "Nationwide Import/Export Container Cargo Flow Survey," also by the MLITT. Airport and port locations are reflected by obtaining latitude and longitude point coordinate data from the "National Land Data Download Site" by the MLITT[5].

[5] The top 100 local governments in Hokkaido, Japan, with the largest amounts of donations in FY2023 are as follows: Monbetsu City (2nd), Shiranuka Town (4th), Betsukai Town (5th), Nemuro City (6th), Teshikaga Town (18th), Chitose City (23rd), Yakumo Town (54th), Sapporo City (59th), Asahikawa City (69th), Kitami City (75th), Mori Town (76th), Bibai City (87th), and Eniwa City (88th). The top 101 to 200 local governments in Hokkaido are Kushiro City (101st), Rumoi City (108th), Tobetsu Town (114th), Jutto Town (117th), Wakkanai City (120th), Tomakomai City (128th), Higashikawa Town (139th), Furano City (140th), Mikasa City (150th), Kutchan Town (152nd), Abashiri City (153rd), Ishikari City (166th), Hakodate City (167th), Kamishihoro Town (173rd), Akahira City (179th), Esashi Town (191st), and Obihiro City (193rd).

Figure 2: Relationship between transportation costs and optimal donation amount

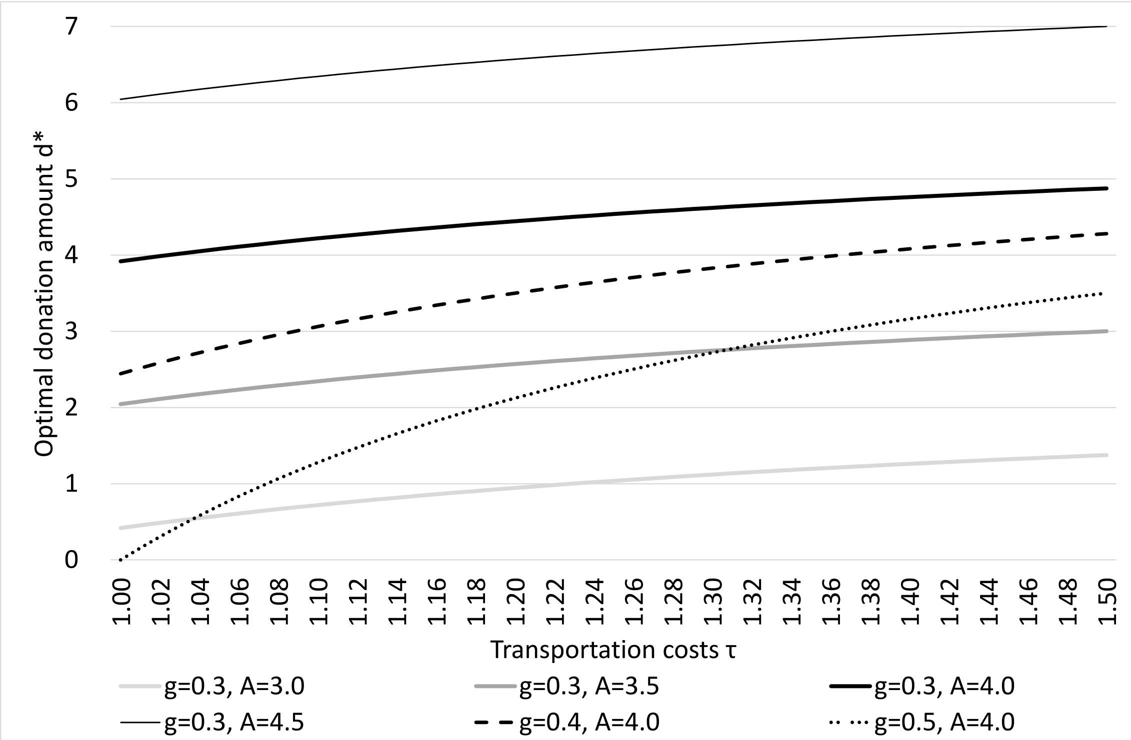


Figure 3: Relationship between transportation costs and optimal reciprocal gift consumption

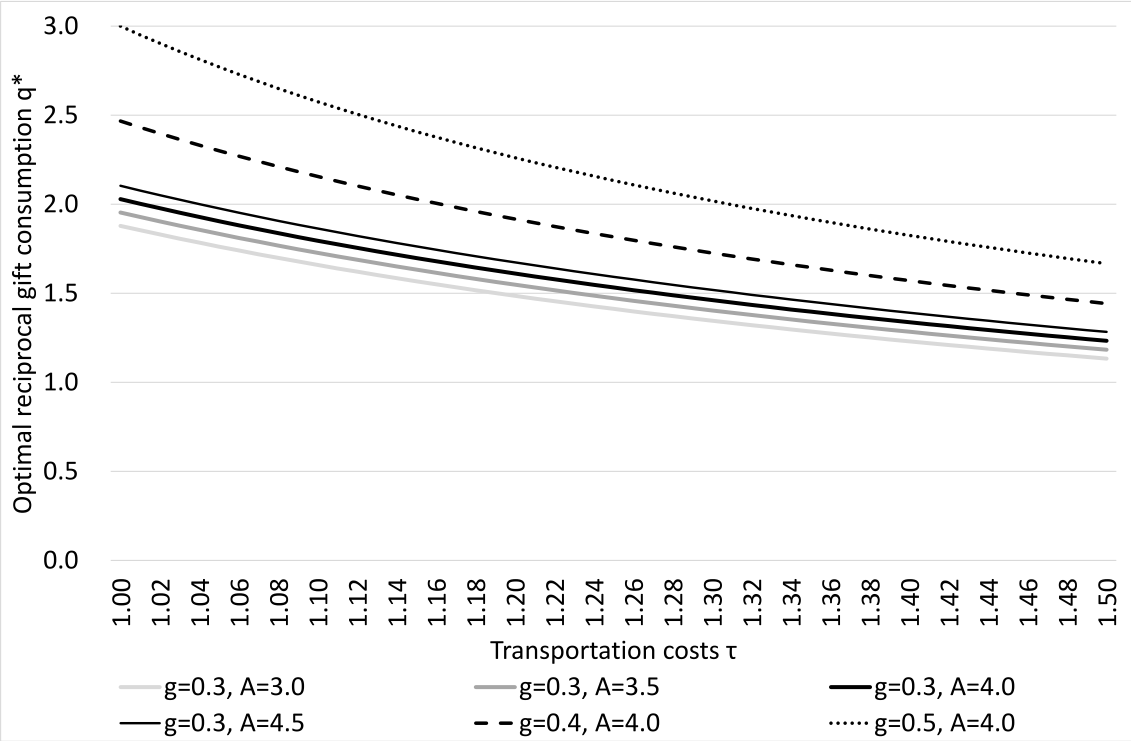


Table 1 Basic statistics

	Amount of donation D_i (Yen)	Number of donations Q_i (case)	Reciprocal gift price p_j (Yen)	Reciprocal gift number of types v_i	Shortest distance to airports and ports r_i (km)
Number of observations	178	178	178	178	178
Average	1,037,472,242	61,306	5,256	329	52.2422
Standard deviation	2,615,951,819	160,746	4,350	425	30.9951
Minimum value	2,470,000	89	1,653	11	0.2197
First quartile	91,623,000	4,488	3,751	109	28.7756
Median	256,797,000	14,397	4,460	192	47.7339
Third quartile	906,419,490	50,699	5,387	390	70.2823
Maximum value	19,213,000,755	1,243,201	4,1201	3,684	136.8919

Table 2 Estimation results of the donation amount function and reciprocal gift consumption function

	Constant α_0	Reciprocal gifts price $log(p_j)$ coefficient α_1	Number of reciprocal gifts $log(v_j)$ coefficient α_2	Shortest distance to airports and ports $log(r_j)$ coefficient α_3	Adjusted R^2
Model 1 Donation amount D_i	12.9763** (0.000)	0.1497 (0.4943)	1.1139** (0.000)	-0.2423* (0.0219)	0.5034
Model 2 Reciprocal gift consumption Q_i	10.6861** (0.000)	-0.7395** (0.0012)	1.1263** (0.000)	-0.2352* (0.0151)	0.5196

Note: Parentheses ( ) are p-values. * and ** indicate statistically significant at the 5% and 1% levels, respectively.