Property Tax Reform and Land Use:

Evidence from Japan♣

Tomomi Miyazaki♣ and Motohiro Sato♠

In a standard public finance textbook, property tax on land is neutral with respect to resource allocation. We find evidence to the contrary in Japan, where farmland in urban areas (i.e., cities and inner suburbs) are given preferential treatment over housing lots. The Japanese government rectified the property tax preferential treatment of urban farmland in the 1990s. We utilize this reform as a natural experiment and examine its impact on land use. The empirical results show that the reform failed to turn urban farmland into housing lots. This implies that the problem of obstructed urbanization remains to be solved.

♣ Corresponding Author. *Graduate School of Economics, Kobe University, 2-1 Rokkodai-cho Nada-ku, Kobe, Hyogo, 657-8501, Japan. E-mail address*: miyazaki@econ.kobe-u.ac.jp (T. Miyazaki).
♠ *Graduate School of Economics, Hitotsubashi University, 2-1 Naka, Kunitachi, Tokyo, 186-0002, Japan. E-mail address*: satom@econ.hit-u.ac.jp (M. Sato).

Foreign visitors to Tokyo, Japan, are surprised to see farmers tending crops of broccoli and radishes amid high-rise office and apartment buildings ... these are possibly the most expensive fruits and vegetables in the world. ... economists see the farms as an extreme example of economic inefficiency. (Bruce 2000)

1. Introduction

In a standard public finance textbook, property tax on land is neutral with respect to resource allocation. However, the reality is that property tax is distortive because preferential tax treatment is provided for certain use of land.[1] Indeed, the taxable value of farmland turns out to be lower than that of housing lots in the US and other countries.[2] Such preferential treatments are also given to farmland within cities and inner suburbs (hereafter defined as urban areas).[3] In this circumstance, landowners will be reluctant to convert their farmland for other uses. Consequently, more valuable uses (e.g., housing lots or office buildings) may be forgone as suggested by Bruce (2000), which may ultimately hinder urbanization. However, to our knowledge, the effects of preferential property tax law reforms on land use in urban areas remains underexplored.

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[1] Regarding the overview on the neutrality or non-neutrality of property tax, see Arnott (2005).
[2] Bird and Slack (2004) raise four policies as preferential treatments with regard to farmland: (1) lower assessments, (2) exemptions for part or all of the farm property, (3) lower tax rates on farms, and (4) farm tax rebates. Among the four policies, this paper focuses on the first one.
[3] Some local governments in the US give preferential treatment on urban farmland via use-value assessment as indicated by Anderson and England (2014); for example, the state of California allows municipalities to lower the assessed value of property tax base even in urban area. Please see also the link: http://articles.latimes.com/2013/oct/02/local/la-me-urban-agriculture-law-20131003.

The objective of this study is to examine the effects of the property tax reform in Japan

in the 1990s; the reform contained the abolishment of the preferential tax treatment in

the urban areas, as well as an exception to this rule. In fact, Japanese local governments

in the three metropolitan areas (Tokyo, Chubu, and Kansai) have been eager to preserve

farmland, leading to the circumstances discussed by Bruce (2000).[4] The fundamental

reform aimed to limit the preferential tax measures so as to induce landowners to

transform their farmland into residential lots.[5]

Let us touch upon the preferential treatment of farmland and the history of the reform

in Japan. Farmland in Japan has been classified as either ordinary farmland or farmland

in urban promotion areas (hereafter UPA farmland). UPA farmland in the designated

cities within the three metropolitan areas (hereafter referred to as the designated cities)

is taxed as housing lots. The terminology "designated cities" follows Ishi (1991), and

does not mean that the government chose these cities solely for tax purposes; see

Section 2 details on the selection process.[6] In practice, however, there existed

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[4] For example, a great portion of farmland is preserved even in the center and inner suburbs of Tokyo.
What is more, the City of Yokohama, one of the largest and most famous urban hubs of Japan, also boasts
a large agricultural industry. For more details, please visit
https://www.japanfs.org/en/news/archives/news_id035384.html.
[5] The data on housing lots also encompasses commercial land within the Japanese official statistics on
property taxes. Although we use the word "housing lots (or residential lots)" to put it simply, bear in mind
that this phrase means the land for both business and residential purposes.
[6] The designated cities in the three metropolitan areas include: (1) ones designated by the government
ordinance, whose population is over 500,000 (e.g., Osaka, Nagoya, and Yokohama); (2) those classified
as existing urbanized areas by the National Capital Region Development Act; and (3) those earmarked for
suburban development by the same act.

preferential property tax treatment for the UPAs in the designated cities prior to the

reform. Accordingly, many farmland owners in the major cities took advantage of this

system and escaped higher tax burdens by "disguising" their property as farmland,

which was pointed by Ishi (1991). To solve this, the preferential property tax measure

was repealed at the end of FY 1991 (March 1992), details of which are presented in

Section 2.[7] The reform, which took effect in FY 1992, aims to induce landowners to

convert their farmland into housing lots such as apartments and commercial buildings,

which is expected to encourage urbanization.

  We examine impacts of the tax reform using difference in difference (DID) estimation.

We set the designated cities as the treatment group whereas all other comparable cities

are as the control group. Municipality level data are used for our empirical

investigation.[8]

  Our empirical results are as follows. First, the share of the UPA farmland declined in

the designated cities after our treatment year. This is strongly supported by our simple

DID estimation as well as when we estimate the causal effects in an event study

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[7] Following the UK, the Japanese fiscal year is from April to the following March.
[8] Another possibility would be to use micro data on individual landlords, but there are no household level
data available. The Survey of Housing and Land offers information about land use based on
questionnaires given to individual households. However, this survey is conducted every five years, which
makes it difficult for us to examine the effects before and after the reform in terms of exact timing.
Although Japan's Geospatial Information Authority gives us detailed data on land use, we cannot identify
the difference between the UPA farmland and other types; this is crucial to our analysis.

approach with other independent variables and region-specific time trends. Second,

unexpectedly, we did not find evidence that tax reforms had any impact on the ratio of

housing lots. The graphical evidences also support these empirical results. These

contrasting results can be attributed to the exception made in the reform. One important

implication of these findings is that the problem of obstructed urbanization remains to

be unsolved.

Our results contribute to two literatures. First, this study is related to the literature on

the effects of preferential property tax treatment. A number of studies have addressed

this issue: Brueckner (2001), Brueckner and Kim (2003), Lynch (2003), Song and

Zenou (2006, 2009), Anderson et al. (2015), and Wassmer (2016). However, these

studies focus on how preferential treatment of farmland is useful in solving deficiencies

of farmland resources and the encroachment of farmland to the fringe due to urban

sprawl. This is the first research that addresses the preferential property tax treatment of

farmland in urban areas.

Furthermore, our research contributes to the literature on the effects of property tax

reforms that use natural or quasi-experimental approaches such as the reforms' effects

on fiscal competition (Lyytikäinen 2012, Skidmore et al. 2012), the real estate market

(Dachis et al. 2012), housing investments (Löffler and Siegloch 2015, Lutz 2015,

Gemmell et al. 2019), and tax collection (Stine 2003, Ross and Yan 2013). However, to

our best knowledge, nobody has explored the reforms with respect to the preferential

treatment of land use. We differentiate ourselves by utilizing a natural experiment

provided by the reform in Japan.

  The rest of this paper is organized as follows. Section 2 explains the institutional

background of Japan's property tax system and preferential treatment on farmland.

Section 3 presents our empirical framework. Section 4 explains the data and discusses

the assumptions to validate our DID estimation. Section 5 reports the empirical results.

Section 6 concludes.

2. Institutional background and our empirical hypotheses
2.1. Experience with preferential treatment on farmland around the world

  Property taxes have served as major revenue sources to subnational governments

around the globe. For example, property tax revenue is the primary source of tax receipt

at the local level in the US. Indeed, on average, it accounts for 40% of total state and

local tax revenues; some state and local governments count more heavily on property

tax revenues than others.[9] What is more, although the property tax in Norway is a

voluntary tax for the local governments, nearly 50% of them gained revenue from

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[9] For more details, see the website: http://eyeonhousing.org/2017/10/property-taxes-by-state-2016/.

property taxation. In many countries, the property tax is applied to land. This is plausible in terms of economic efficiency. Since land is in fixed supply, a tax on land falls on owners.

However, in practice, many countries give various kinds of preferential treatments with regard to farmland in tax collection. In fact, all 50 states in the U.S. adopt some form of use-value assessment for farmland. For example, as shown in Wassmer (2009), the California Land Conservation Act of 1965 (the Williamson Act) allows landowners to receive property tax assessments which are much lower than normal for a ten-year renewable term if they agree to keep their land in agricultural production or open space.

There are some rationales for conserving farmland through preferential treatment. For example, Lynch (2003) raises four points: local and national food security, employment in the agricultural industry, the efficient development of urban and rural land, and the protection of rural and environmental amenities.

2.2. Japan's property tax system and preferential treatment on farmland

There are two tiers in the Japanese local government: prefectures and municipalities. As shown in Figure 1, municipalities are classified into cities, towns, and villages. Further, the 23 special wards in Tokyo operate much like cities, and are often grouped together with actual cities as a result.[10] Municipalities have the authority to impose

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[10] For more details, please see the website:

property taxes, except for the 23 special wards in Tokyo, where the metropolitan

government is engaged in property tax administration.

Table 1 outlines Japan's property tax system. Property taxes cover land, houses,

buildings, and depreciable business assets (tangible assets except for land and

buildings). The statutory tax rate is set as 1.4%; there is little room for municipalities to

change it. The upper limit is 2.1%, and the reality is that not many local governments

set the tax rate above 1.4%. When it comes to the share of the tax revenue of

municipalities, as shown in Figure 2, property tax comprises 42% in FY 2016,

suggesting that municipalities heavily rely on property taxes.

Property tax is levied annually based on the assessment value of the aforementioned

three taxable assets. Each municipality assesses the value of taxable assets based on a

unified formula set by the Ministry of Internal Affairs and Communications (hereafter

referred to as MIAC). The assessed value of land is determined by considering the

return on each item. Tax liability is determined by ownership of the assets, based on the

value as of January. This record becomes the basis for tax collection over the next fiscal

year (from April to the following March).

Farmland in Japan is taxed much more lightly than housing lots as is done in other

countries, but the UPA farmland in the designated cities is an exception; it is treated as

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https://www.metro.tokyo.lg.jp/ENGLISH/ABOUT/STRUCTURE/structure02.htm.

housing lots when local governments make evaluations in the designated cities. The

current City Planning Law, enacted in 1968, regards the UPAs in the designated cities

as urban zones where existing farmland should, in principle, be converted to housing

use from the viewpoint of urban planning.[11] In this regard, the UPA farmland in the

designated cities can be defined as land expected to be changed into housing lots.

Meanwhile, in the designated cities, not all UPA farmland has been transformed into

residential use, which may give rise to the inefficiency of land use. The long-term

agricultural operation system was enacted from FY 1982 to FY 1991, whereby the tax

burden was mitigated if farmers operated large tracts of land over a period of ten years.

As indicated by Ishi (1991), such lenient treatment of farmland in major cities reflected

farmers' special interests. Whereas the City Planning Law aims to promote

urbanization, the long-term agricultural operation system contradicts this objective

because the system prevented landowners from converting the land for other uses.

2.3.   Details on the reform, econometric method, and our hypotheses

To solve the problems mentioned in Section 2.2, the long-term agricultural operation

system was abolished at the end of FY 1991 (March 1992). Therefore, FY 1992 is our

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[11] For more details, please see Ishi (1991) and Ito (1994).

treatment year. As can been seen from Table 2, the UPA farmland in the designated

cities were taxed as housing lots after FY 1992. The aim of this reform is to not only

decrease the proportion of "disguised" farmland, but also to spur the development of

housing lots.

However, there was an exception; the UPA landowners can maintain preferential tax

treatment if they commit to preserving their farmlands as Production Green Land (PGL)

for the next 30 years. The PGL Law, whose objective is to keep green space within

urban promotion areas, was rectified and became effective in January of 1992.[12] Under

the amended PGL Law, UPA landowners whose farmland area is 500 m^2 or greater in

the designated cities faced two options: (1) Convert farmland into housing lots; or (2)

Preserve it as PGL for 30 years. When they choose the latter option, however, they

cannot convert the land for another use over 30 years.

As addressed by Terai (2001), farmland owners face a stricter rule after the forenamed

reform. In this sense, landowners are incentivized to convert their farmland into housing

lots.[13]

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[12] For more information on the PGL, please visit: https://unu.edu/publications/articles/japan-s-urban-agriculture-what-does-the-future-hold.html.
[13] The Japanese government also implemented several reforms with respect to land-related taxes in the early to mid-1990s. However, unlike the repeal of the long-term agricultural operation system, these reforms did not aim at certain groups of municipalities, but for all cities. We explain the details in Section 4.3 when we discuss the common shocks assumption.

The government chose the designated cities to promote further urbanization in the three metropolitan areas. As mentioned earlier, these cities are designated by some laws beforehand, and were not chosen for the purpose of the aforementioned reform; designation occurred independently of the reform. Since the reform was not a randomized controlled trial but a natural experiment, we use DID. The validity of DID estimation is illustrated in Section 4.

Meanwhile, the central government decides whether or not a local community becomes a city based upon the size of its population. While all other comparable cities are included in the control group in our basic case, we also perform our DID estimation by limiting the control group to cities with populations of certain sizes as discussed in Section 4.

To perform our empirical examination using DID, we assume FY 1992 is the year of treatment because the evaluation on land use changed in April 1992 (FY 1992) following the abolishment of the long-term agricultural operation system. In addition, because some owners may have acted in anticipation of this policy change, we also address the anticipatory effects using event study approach in our estimation.

The reform then yields the following empirical hypotheses.[14]

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[14] We develop the formal model to illustrate how the tax reform affects landowners' choice and establish the propositions which become a basis for our empirical hypotheses in the Appendix 1 of this paper.

(1) The property tax reform decreased UPA farmland in the designated cities.

(2) After the reform, the supply of housing lots increased.

3.   Empirical framework

This section establishes the empirical methodology. In doing so, we give three

specifications of the DID regression. The first and basic one is as follows.

(1) $L_{ipt} = \beta_0 + \beta_1 T_i + \beta_2 REFORM_t + \beta_3 D_{i,t} + \varepsilon_{ipt},$

where L_{ipt} is the ratio of UPA farmland to total land in city i within prefecture p in

period t (year), and total land is the sum of UPA farmland, ordinary farmland, and

housing lots. This is called the UPA farmland ratio. T_i is the dummy variable that takes

1 if it is a designated city within the three metropolitan areas and zero otherwise,

$REFORM_t$ is the dummy variable that takes 1 if it is FY 1992 (our treatment year) and

zero otherwise, $D_{i,t} = T_i \times REFORM_t$, and ε_{ipt} is the disturbance term. Note that

$D_{i,t} = 0$ if i is not treated in FY 1992, and $D_{i,t} = 1$ if i is treated in FY 1992.

Second, in addition to a simple DID estimation as given by Equation (1), we also examine the treatment effects in an event study framework as follows:

$$(2) \quad L_{ipt} = \gamma_i + \lambda_t + \sum_{\tau=0}^{m} \delta_{-\tau} D_{i,t-\tau} + \sum_{\tau=1}^{q} \delta_{+\tau} D_{i,t+\tau} + X'_{ipt}\eta + \varepsilon_{ipt},$$

where τ specifies the time period relative to the treatment year. We modify from $D_{i,t}$ to $D_{i,t-\tau}$ or $D_{i,t+\tau}$ to capture the post-treatment and the anticipatory effects, respectively. Both $\delta_{-\tau}$ and $\delta_{+\tau}$ are the estimated coefficients on $D_{i,t-\tau}$ or $D_{i,t+\tau}$. The right-hand side allows for m period lags of $D_{i,t-\tau}$ (we set lag length to two, δ_{-1} and δ_{-2}, and q period leads of $D_{i,t+\tau}$ (we set lead length to two, δ_{+1} and δ_{+2}). For example, if $\tau = 0$, which corresponds to the treatment year, FY 1992, δ_0 is equivalent to β_3 (the coefficient on $D_{i,t}$) of Equation (1). We include both city-specific and year fixed effect, γ_i and λ_t. The year fixed effect captures the macroeconomic movement of the entire country. We also include X_{ipt}, which specifies the vector of other control variables.

Finally, we further check the robustness by adding region-specific intercepts and region-specific time trends (i.e., interaction terms between regional dummies and time trends). This follows Besley and Burgess (2004). Regional dummy variables refer to

13

prefectural dummies. We do this in order to address business cycle fluctuations at the

prefectural level. The DID model with prefecture-specific time trends is given by

$$(3) \quad L_{ipt} = \alpha_{0p} + \alpha_{1p}t + \gamma_i + \lambda_t + \sum_{\tau=0}^{m} \delta_{-\tau}D_{i,t-\tau} + \sum_{\tau=1}^{q} \delta_{+\tau}D_{i,t+\tau} + X'_{ipt}\eta + \varepsilon_{ipt},$$

where α_{0p} is a prefecture-specific intercept and $\alpha_{1p}t$ is a prefecture-specific trend

coefficient multiplying the time trend variable, t.

As stated previously, our hypotheses are that the property tax reform (1) decreased the

amount of UPA farmland, and (2) increased the amount of housing lots. Therefore,

when it comes to the UPA farmland ratio, if the coefficients on $D_{i,t}$ are estimated to be

negative and statistically significant, then the first hypothesis is substantiated. We also

estimate Equations (1), (2), and (3) using the ratio of housing lot per total land (housing

lot ratio) and the ratio of ordinary farmland (ordinary farmland ratio) per total land as

the dependent variable. We do so to check whether reduced UPA farmland was

converted into housing lots to investigate our second hypothesis; if the coefficients on

$D_{i,t}$ are estimated to be positive and statistically significant, the second hypothesis is

substantiated. Meanwhile, landowners may keep their land as PGL rather than

converting it into housing lots. To confirm this, we use the ordinary farmland ratio as

the dependent variable because the data on ordinary farmland also encompass PGL after

the reform as stated in Section 4.1.

For other control variables, we add the effective tax rate of UPA farmland[15], local

government tax revenue per total local government revenue, agricultural income,

population density, and shipments.[16]

4. Data and graphical evidence

4.1. Data and city characteristics

The sample period is from FY 1989 to FY 1994 to focus on the duration before and

after the reform.[17] Table 3 gives the description and source of the data used in

estimation.

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[15] To calculate the effective tax rate, we use two procedures. First, the tax revenue is determined by multiplying tax base by the statutory tax rate (=0.014) as follows.

Tax revenue $=$ tax base $\times$ 0.014

After that, we calculate the effective tax rate by dividing the tax revenue by the property value.

[16] Regarding possible additional variables, the age structure and share of primary and secondary industries can be considered. Although the National Census can provide such data, the census is a quinquennial survey in Japan.

[17] It is possible to extend the sample period by including years before FY 1988. However, due to the asset price bubble, land prices skyrocketed over the mid to late 1980s. Even if such types of macroeconomic shock contemporaneously affect all areas within a country, it would be favorable not to include the data before FY 1988 in order to exclude the influence of the irregular business cycle fluctuation during the bubble periods.

All data on square (area) measure, property value, and tax base come from the Brief

Report on the Value of Properties provided by MIAC.[18] We use these data in order to

calculate the ratios of UPA farmland, ordinary farmland, and housing lots. These are

obtained by dividing each item by total land (the sum of UPA farmland, ordinary

farmland, and housing lots). Note that after the reform, a proportion of the UPA

farmland may have become preserved as the PGL and has been added into ordinary

farmland in the official statistics. Recall that the collection of property taxes between

April and the following March (the fiscal year in Japan) is based on information from

January of the previous fiscal year. In this regard, for example, our data on land use in

FY 1991 (April 1991–March 1992) come from the Brief Report on the Value of

Properties in FY 1992, reflecting the land use in January 1992 when the long-term

agricultural operation system was still in effect. Likewise, the data in FY 1992 are from

the Brief Report in FY 1993, which is based on the evaluation in January 1993.

Data on local government tax revenue and total local government revenue come from

the Statistics of the Final Accounts of Municipal Governments, and population data are

from the Basic Resident Register. MIAC provides these data. Regarding the area of

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[18] Unlike the US and some other countries, city boundaries do not change over time unless cities are
merged. Since we exclude these cases, the boundary of all the municipalities remained the same
throughout our sample period.

municipality, we use the data of the Area Statistics of Prefectures and Municipalities by the Geospatial Information Authority of Japan. The data on agricultural income come from the Production Agricultural Income Statistics, provided by the Ministry of Agriculture, Forestry, and Fisheries. The data on shipments come from the Industry Statistics provided by the Ministry of Economy, Trade, and Industry.

We focus on 501 cities throughout the period from FY 1989 to FY 1994.[19] We chose these cities as follows. First, we omit cities without ordinary or UPA farmland. Second, during our sample period, the central government did not designate certain cities as ordinance cities before FY 1991. Therefore, we do not include such cities.[20] Finally, there was an amalgamation of municipalities even in the 1980s and 1990s, which makes it difficult for us to obtain coherent data throughout that period for such cities. Thus, we omit cities that merged or disappeared from FY 1989 to FY 1994.

The process above yields a sample of 501 cities. Here, the treatment group comprises 183 designated cities, and the control group has 318. There are three cases for our treatment groups. We set this as the basic case and call it "Case 1."

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[19] Although the Brief Report on the Value of Properties includes data on Tokyo's 23 wards, such data is aggregated; information is not provided for individual wards. Therefore, our sample exclude the 23 wards.
[20] For example, Chiba became a city designated by government ordinance in FY 1992. Although Chiba may be classified as an existing urbanized area or a suburban development even before that time, we omit Chiba city following the argument above.

As our second case, we limit our sample to cities with populations over 50,000 on

average. This is why though there are some exceptions, under Japan's local public

finance system, the population should be over 50,000 for municipalities to be classified

as a city. Whereas most designated cities (treatment group, 183) meet this requirement,

this is not the case for the rest. In order to make the two groups comparable, we restrict

the sample to 206 cities with population over 50,000 on average throughout our sample

period. This is "Case 2," and total number of cities is 389.

Furthermore, for the third case, we chose 104 cities with populations over 100,000 as

our control group. This is defined as "Case 3," and the total number of cities is 287.[21]

4.2. Summary statistics and graphical evidence

Table 4 reports the descriptive statistics of all variables used in estimation, and Table 5

presents the statistics between FY 1991 and FY1992 for the ratios of UPA farmland,

housing lot, and ordinary farmland.[22] Table 6 is useful to support our simple DID

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[21] There are some cities designated by government ordinance outside of Tokyo, Chubu, and Kansai.
Since the population of these cities are as large as major cities within the three metropolitan areas, it
would be an option for us to use these cities as our control group. However, throughout our sample
periods, there were only four cities designated by government ordinance outside of the three metropolitan
areas: Sapporo, Hiroshima, Kitakyushu, and Fukuoka (we exclude Sendai because it became a city
designated by government ordinance in 1989 by merging the surrounding towns). If we choose these four
cities as our control group, the number of control group is too small in comparison to the one of the
treatment group. Thus, we do not restrict our control group to these four cities.
[22] Detailed results on other variables can be obtained from the working paper version of this paper.

estimation. Here, the UPA farmland ratio plunged between FY 1991 and FY 1992 for

the treatment group, while it did not change between the two fiscal years for the control

group. On the other hand, while the difference between the two periods with regard to

housing lots ratio is not large, ordinary farmland ratio increased after the reform for the

treatment group. These simple comparison before and after the reform for our treatment

and control groups suggest the following. First, the decrease in the UPA farmland at the

timing of the reform is consistent with our first hypothesis. Second, however,

landowners might not convert all UPA farmlands into housing lots, instead keeping

them as PGLs.

  Figures 3a to 3c show the average of the ratio for each item with regard to land use

(each item per total land, respectively) between the designated cities (the treatment

group or treated cities) and the remaining cities (the control group or untreated cities)

from FY 1989 to FY 1994. According to the figures, in FY 1992, the year of treatment,

the share of UPA farmland fell dramatically in the designated cities from the previous

year; on the other hand, the ratio did not change after the reform in the remaining cities.

Therefore, the reform is useful in reducing UPA farmland in the designated cities.

  On the other hand, the right charts of Figures 3a to 3c suggest that landowners did not

convert all PGL farmland into housing lots after the reform. Had most owners converted

19

their PGL farmland into housing lots, the proportion would have increased dramatically

from FY 1991 to FY 1992. However, these figures suggest this was not the case.

As noted earlier, PGL is included in ordinary farmland data of the Brief Report on the

Value of Properties after the reform. Although it is impossible for us to extract PGL

from MIAC data, Figures 3a to 3c also suggest that the farmland ratio rose from FY

1991 to FY 1992 for the designated cities, where the size of the increase is

approximately equal to the size of the decrease in UPA farmland. This observation

suggests that many landowners decided to keep farmland as PGL after the reform.

To test our hypotheses, we perform an econometric investigation using Equations (1),

(2), and (3).

4.3. Check of the assumptions for DID estimation

Here we would like to confirm two assumptions necessary for DID estimation. First,

we discuss the common shocks assumption. The Japanese government implemented

several measures for land-related taxes in the early to mid-1990s. For example, the land-

value tax was imposed after FY 1992. Moreover, the government set the assessed value

of land at 70–80% of the market value in FY 1994, which some landowners might

respond to in advance. However, these packages were carried out not for a certain

group, but for all municipalities. Therefore, the common shocks assumption is not violated within our framework.[23]

Second, we check the common trend assumption using Figures 3a to 3c. We discuss the validity of this assumption by focusing on the UPA farmland ratio, the main outcome that we would like to address in estimating the effects of the reform. The identifying assumption of our DID specification is that both the treated and untreated cities would have to follow the same time trend in the absence of the reform in FY 1992. Indeed, the average of the share of UPA farmland moved almost in parallel in the designated and remaining cities between FY 1989 and FY 1990. Therefore, these graphs provide visual evidence of treatment and control cities, with a common underlying trend for pretreatment periods.

Furthermore, as discussed in Section 5, the coefficients of $D_{i,t+\tau}$ are close to zero before the reform, which also support the validity of common trend assumption.

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[23] Meanwhile, the inheritance tax burden is lowered if landlords preserve land as PGL in the designated cities under the revised PGL Law. However, a string of inheritance tax reforms in the 1990s, which provided tax deduction to landowners across the country, made its effect on land use less substantial. For example, the Japanese government raised the threshold on the inheritance tax from JPY 40 million to JPY 48 million in FY 1992. Such reforms would lower the cost of ownership, and thus the effects of the inheritance tax could be minimal for landowners even in the designated cities.

5.　　Empirical results

　Table 6 reports the estimation results for the simple DID model given by Equation (1).

Overall, the estimation results are consistent with the descriptive statistics for FY 1991

and FY1992 shown in Table 5. For the case where the UPA farmland ratio is used as the

dependent variable, the coefficients of $D_{i,t}$ are estimated to be negative and significant

for all cases. However, once we use the housing lot ratio as the dependent variable, the

coefficients are not statistically significant under any cases. Table 6 also shows that the

coefficients of $D_{i,t}$ are estimated to be positive and significant in Cases 1 and 2 with

ordinary farmland ratio as the outcome, implying that after the treatment the PGL in the

designated cities increased. However, we cannot confirm a statistically significant result

in Case 3.

　Figures 4a to 4c plot the estimated coefficients on $D_{i,t-\tau}$ and $D_{i,t+\tau}$ of Equation (2),

which is the specification without prefecture-specific time trend.[24]　Figure 4a confirms

that while the causal effects were near zero before the reform, the coefficients of $D_{i,t}$,

$D_{i,t-1}$, and $D_{i,t-2}$ were down to about -0.04 after FY 1992, implying that UPA

farmland ratio plummeted as was suggested by our simple DID estimation. This is also

the case for Figures 4b and 4c. The size of the coefficients is not substantially different

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[24] Detailed results on each estimation equation are available in Appendix 2 of this paper.

before and after the reform when we use housing lot ratio as a dependent variable,

though 95% confidence intervals do not include zero. However, all figures show that the

estimated coefficients became larger and statistically significant after the reform with

ordinary farmland ratio as the outcome. Figure 4c also shows that the causal effects on

the ordinary farmland fade gradually.

Figures 5a to 5c report the estimated coefficients on $D_{i,t-\tau}$ and $D_{i,t+\tau}$ with

prefecture-specific time trends based on Equation (3). As can be seen from all figures,

though the coefficients of UPA farmland ratio were around zero before the reform, the

coefficients of UPA farmland ratio became negative and 95% confidence intervals do

not include zero after FY 1992 for all cases. Therefore, the results on the UPA farmland

ratio are robust. On the other hand, when we use housing lot ratio as a dependent

variable, the confidence intervals sometimes include zero after FY 1992. Regarding

ordinary farmland ratio, the estimates are close to zero before the reform, with sharply

increasing effects after the reform for all cases. However, Figure 5c shows the estimate

becomes statistically insignificant in FY 1994.

These figures strongly confirm our first hypothesis. However, the empirical results

also suggest that after the reform, many landowners preserved UPA farmland as PGLs

rather than convert them into housing lots, which impugns the second hypothesis.

Our results imply PGL served as an additional option for the owners in UPA. Although it mandates 30 years of cultivation, PGL is a commitment by the government to sustain preferential tax treatment, which removes policy uncertainty and risk of future tax increase for the farmers. Therefore, the exception to the reform impeded landowners from turning farmland into housing lots.

In the end, the reform failed to make property tax neutral for the use of lands because of a "lock-in" effect. We discuss the background. Until the 1990s, the Japanese people preferred land to financial assets in terms of portfolio choice. That is why land prices were believed to continue to rise indefinitely; this is so called the "myth of ever-rising land prices" as indicated by Okina et al. (2001). It is highly probable that many owners thought the downturn of asset prices as temporary and took for granted that the land prices would rise again. Therefore, they chose to keep farmland as PGLs when the reform took effect and planned to sell it after land price rose. Our conflicting findings on ordinary farmland ratio and housing lot ratio can be attributed to beliefs landowners had about future land prices.

6.   Conclusion

This paper examines how the property tax reform affect land use through empirical

investigation by focusing on land use tax reform that took place in the 1990's in Japan.

Our empirical findings strongly illustrate that the reform reduced the proportion of UPA

farmland in the designated cities within the three metropolitan areas. However, whereas

no evidence is found that all reduced UPA farmland was converted into housing lots, we

show that many landlords preserved farmland as PGL from our empirical investigations

as well as our graphical evidences in Section 4.

The results suggest that if the Japanese government had not amended the PGL Law at

that time, more land might have been changed into housing lots and thus further

urbanization could have been attained. As is well known, many commuters in the three

major cities still suffer a long commute time from the fringe to the city center.[25] One

reason for this is housing scarcity in the urban areas, which is also related with the fact

that many landlords in the designated cities did not convert their land into housing lots

at the time of the reform in the early 1990s. In this regard, the government should not

have rectified the PGL Law.

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[25] According to the 2013 Survey on Time Use and Leisure Activities by MIAC, it takes more than one and a half hours on average to make a round-trip commute in the Tokyo Metropolitan Areas.

Our findings also imply that policy makers should be wary of unintended consequences when they make changes to laws concerning preferential property tax treatments. However, there are caveats to generalizing our results. For example, the results apply only to countries where investors have a strong desire to own land as their primary asset like the 1990s in Japan, as we mentioned before. Nevertheless, our research demonstrates that if the exception becomes a rule, the reforms with regard to preferential treatment will lead to unintended consequences, as in the case of many tax reforms.

Meanwhile, the amended PGL Law will expire at the end of FY 2021. It would be worthwhile to examine whether or not the landlords in the designated cities really convert PGL into housing lots after FY 2022.

Appendix 1: Theoretical foundation

In this appendix, we develop a theoretical illustration of how preferential tax treatment of PGL influences land use. Land may be utilized for either residential or agricultural purposes. The model contains three periods over which land prices stochastically

evolve[26] and addresses different options of land holding, one of which is PGL. For

example, consider farmland owners in the designated cites who decide when to sell their

property. We assume that their decision is discrete for simplicity's sake, but the model

can easily be extended to continuous choice, whereby landowners choose the size of

land to sell. We also assume that they form an expectation for future land prices and tax

policies.

Before the property tax reforms, there is policy uncertainty during the second period

regarding property taxes on farmland. Given that PGL is in place for 30 years, one

period may refer to 10 years. Thus, it is plausible that landowners are not sure about

future taxes. Hence, they may opt to sell land in the first period if they expect a higher

property tax to be applied to their holding land afterward. The reform does not remove

the uncertainty, but instead clarifies the tax treatment of UPA farmland. In the present

context, PGL symbolizes government commitment to maintain preferential tax rates on

farmland, and requires landlords to not sell their land during the first two periods. This

corresponds to the institutional arrangement of the PGL, with the mandate of 30 years

of cultivation. In UPAs, landowners have to pay higher taxes according to the land

value of residential use. By doing so, however, they can exert their selling option before

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[26] Similarly, Anderson (1986) develops a dynamic model for the optimal timing of development (land improvement) with continuous time.

the last period. Thus, there is a tradeoff between favorable tax treatment and the option

value of selling land.

Note that we focus on the representative landowner's selling decision, taken as the

given price dynamics, thus abstracting the general equilibrium effect of property taxes

on land prices.[27] P_t denotes the market price of land corresponding to residential use at

period t (=1, 2, 3). P_t may be interpreted as the net price, subtracting the cost

associated with leveling the land. P_1 is known, whereas prices in subsequent periods

involve uncertainty. Let $E[P_t]$ be the expected land price. To clarify our theoretical

hypothesis, we assume that in the last period, landlords always opt to sell their land.

(Assumption) $P_3 > R$ for all P_3

where R represents the return on farmland use, including non-market gains (such as

recreation). This implies that landlords seek the timing to sell their land, rather than

intending to cultivate it. Figure A1 provides a timeline of their decisions. We consider

that the reform is undertaken during the first period and becomes effective afterward.

Accordingly, no tax is charged at t=1. As noted above, tax policy at period t=2 is

uncertain before the reform. Let x_2 represent the government policy stance taking

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[27] The model is close to the optimal timing of a job search model. In this regard, the present model deviates from previous literature such as Arnott (2005), Brueckner (2001), and Brueckner and Kim (2003). Wassmer (2016) reviews theoretical findings as to how property taxes and urban sprawl interact.

unity if agricultural land becomes subject to tax and zero otherwise. Then an effective

tax is applied to farmland at period $t=2$, which can be written as $x_2 \tau$ where x_2 is

stochastic in the pre-reform era. After the reform, $x_2 = 1$ for UPAs and $x_2 = 0$ for

PGL.

Designate $j=H$, A and G to housing, agriculture, and PGL, respectively. This

corresponds to the three options farmland owners have: (1) Sell and convert the land to

housing lots at period 1; (2) hold their property as farmland in UPA; or (3) maintain

their land as PGL by committing not to sell the land at period $t=2$. There may be another

option of lending land for housing use to gain rent revenue. We include this in $j=H$,

interpreting P_t as the present value of rent. In the case of j=H, the payoff to the

landlord equals $V_H = P_1$ which is not affected by the property tax reform. If the owner

opts for the PGL after the reform, the owner commits to cultivating the land during the

first two periods. At $t=3$, the preferential tax treatment expires, and the owner chooses

to sell land at price P_3. Then, his payoff is given by

$$V_G^1 = (1 + \beta)R + \beta^2 E_1[P_3]$$

where $\beta < 1$ is the discount factor and the superscript 1 refers to the post-reform period. The second term is the expected price at $t=3$ from the first period perspective.

For simplicity's sake, we assume zero property tax on the land for agricultural use. Let V_G^0 symbolize the pre-reform pay-off from the commitment to farming at $t=2$, as required by the PGL, and is defined by

$$V_G^0 = (1 + \beta)R - \beta E_1[\tau x_2 P_2] + \beta^2 E_1[P_3]$$

The difference from V_G^1 is that the tax may be charged at $t=2$ before the reform. Alternatively, the owner can delay selling, although this may trigger a high property tax afterward. Before the tax reform, given that x_2 is stochastic, i.e., either 0 or 1, the payoff from $j=A$ becomes:

$$V_A^0 = R + \beta E_1[Max(P_2, \quad R - \tau x_2 P_2 + \beta E_2[P_3])]$$

where the superscript 0 denotes pre-reform and τ is the tax rate. The tax reform determines the tax rate at $t=2$ with certainty. The above pay-off after the reform is written as:

$$V_A^1 = R + \beta E_1[Max(P_2, \ R - \tau P_2 + \beta E_2[P_3])]$$

With $j=A$, the owner can keep the option of selling land at $t=2$. Such an option is not

allowed under $j=G$, whereas the last term represents the property tax burden, given that

the tax base is assessed based on residential use after the reform. Thus, there is a

tradeoff between the option to sell and the tax burden at $t=2$. Such a tradeoff does not

occur before the reform. Indeed, we have $V_A^0 > V_G^0$. To sum up, the following lemma

establishes a relationship among the pay-offs.

[Lemma 1]

(i) $V_A^0 > V_A^1$

(ii) $V_A^0 > V_G^0$

(iii) $V_G^0 < V_G^1$

We now turn to decision making by landowner over different options among $j=H$, A

and G. In characterizing it, we adopt the setting of the random utility model that has

been widely used in empirical literature on decision makings over options. To be

specific, let landowner's utility from each option be given by $U_j = V_j + \varepsilon_j$ where ε_j is

a random variable. It may represent transaction costs associated with land sale and non-

pecuniary costs such as attachment to own land. Then for instance landowner would

like to hold land in the form of PGL if and only if

$$U_G = V_G + \varepsilon_G \geq U_j = V_j + \varepsilon_j \Leftrightarrow V_G - V_j \geq \varepsilon_j - \varepsilon_G \text{ for j=}A \text{ and } H.$$

 The joint distribution of the three random variables, ε_j $(j=A, G, H)$ yields the

probability that option j is chosen against the other alternatives:

$$Q_j = F_j(V_A, V_G, V_H) = Pr\big(\varepsilon_j - \varepsilon_i \geq V_j - V_i, \quad \text{i} \neq \text{j}\big)$$

The probability is increasing in V_j and declining with V_i $(i \neq j)$. In empirical studies

on discrete choice over different alternatives, Q_j may be often specified as the multiple

logit function.[28]

$$\Delta Q_A = F_A(V_A^1, V_G^1, V_H) - F_A(V_A^0, V_G^0, V_H)$$

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[28] The multiple logit function is given as $Q_j = \frac{exp[V_j]}{exp[V_A] + exp[V_G] + exp[V_H]}$. Since our data is at the municipality level, we cannot directly apply Eq. (6) to our estimation. Eq. (6) should be therefore interpreted a conceptual foundation of our empirical strategy.

$$\Delta Q_H = F_H(V_A^1, V_G^1, V_H) - F_H(V_A^0, V_G^0, V_H)$$

ΔQ_A becomes negative given that $V_A^0 > V_A^1$ and $V_G^0 < V_G^1$. This may be obvious since

the tax reform raises the tax burden on holding farmland. Thus, option $j=A$ becomes less

likely to be exercised. On the other hand, ΔQ_H cannot be signed. Given $V_A^0 > V_A^1$, the

choice of selling land at $t=1$ becomes more advantageous relative to holding it as

farmland, whereas the gain from the commitment to PLG is enhanced due to

preferential tax treatment leading to $V_G^0 < V_G^1$. Therefore, we can establish the

following Proposition, which should be empirically confirmed:

<Proposition 1:>

(1) Property tax reform decreases farmland in UPA at the time that the reform is

conducted.

(2) The property tax reform effect on the supply of housing lots at the time of the

reform is ambiguous.

Appendix 2: Details on the estimation results of Equations (2) and (3)

When it comes to additional control variables, the coefficient on the effective tax rate is expected to be negative. We also use this as an independent variable when the housing lot ratio is used as a dependent variable, where the coefficient would be negative. However, we also assume that the coefficient is estimated to be positive with housing lots or ordinary farmland being used as a dependent variable. By doing this, we hope to capture the path through which the reduction in UPA farmland leads to an increase in housing lots.

Local tax revenue share in total local government revenue and population density are added as indicators of urbanization. Hence, the coefficients are expected to be positive when we use UPA farmland ratio or housing lots ratio as the dependent variable; on the other hand, we expect these coefficients to be negative when using farmland ratio as the outcome. Shipment addresses the size of manufacturing industries, and agricultural income is a proxy for rural areas. The coefficient of shipment is estimated to be positive when we use UPA farmland or housing lot ratio as the left-hand side variable, and negative if farmland ratio is employed as the dependent variable. The coefficient on agricultural income is expected to be negative when UPA farmland or housing lots ratio is used as the outcome, and positive in the case that farmland ratio is used as the left-

hand side variable. We take the logarithm of agricultural income, population density, and shipment in the estimation.

Tables A1 to A3 present the details on the estimation results of Equations (2) and (3). Table A1 confirms that after the reforms, the UPA farmland ratio decreased as was suggested by our simple DID estimation for all cases. Therefore, we also establish that the results regarding the UPA farmland ratio are robust. Meanwhile, Table A2 reports that the estimation results on the coefficients of $D_{i,t}$ are not robust. Moreover, as we discussed based on Figures 3a to 3c, the size of the coefficients is not so substantially different before and after the reforms. Table A3 shows that the coefficients are estimated to be positive and significant with farmland ratio as the outcome, and we confirm that the coefficients of $D_{i,t}$ and $D_{i,t-1}$ are larger, which implies that many farmers preferred to keep the land as PGL rather than to convert into housing lots, though the coefficient of $D_{i,t-2}$ is not statistically significant.

Among the control variables, the estimation results on the effective tax rate are not robust. For all cases, the coefficients of the logarithm of population density are estimated to be positive and significant in Tables A1 and A2, and negative in Table A3 as we expected. The coefficients of shipment is estimated to be positive for all cases in Tables A1 and A2, but it is estimate to be negative and significant in Table A3. The

coefficient of the logarithm of agricultural income is estimated to be insignificant for all

cases.

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Fig. 1. Structure of the central and local government in Japan.

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              ┌──────────────┐
              │ Central Gov. │
              └──────┬───────┘
                     │
              ┌──────┴───────┐
              │Prefecture (47)│
              └──────┬───────┘
          ┌──────────┼──────────┐
   ┌──────┴────┐ ┌───┴────┐ ┌───┴────────┐
   │City* (815)│ │Town(743)│ │Village(189)│
   └───────────┘ └────────┘ └────────────┘
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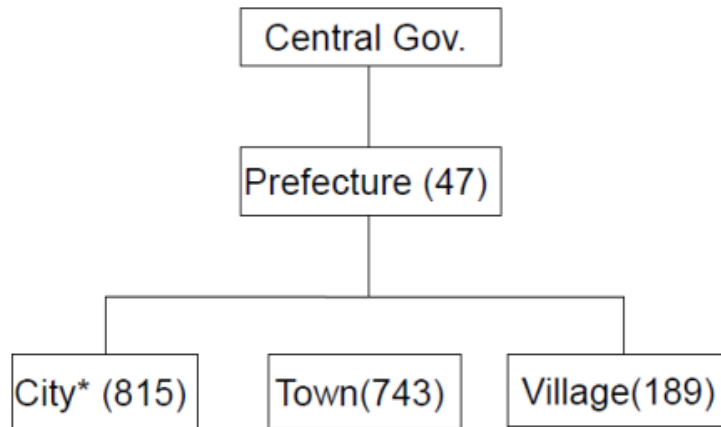
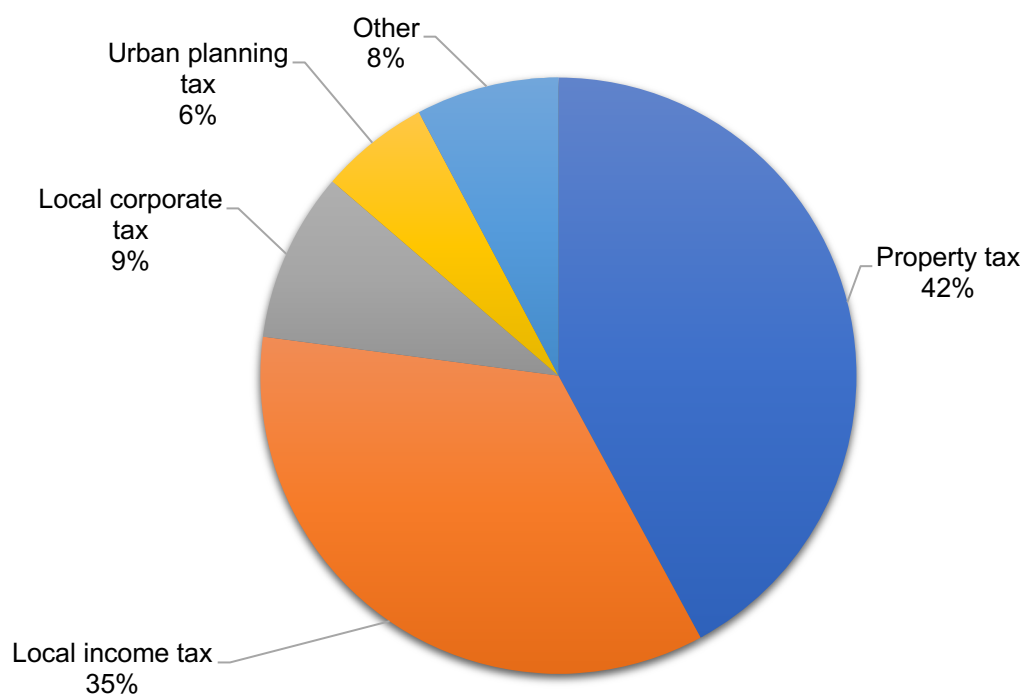Notes: The number of municipalities is the information in July 2020, which can be available from the website of the Ministry of Internal Affairs and Communications.
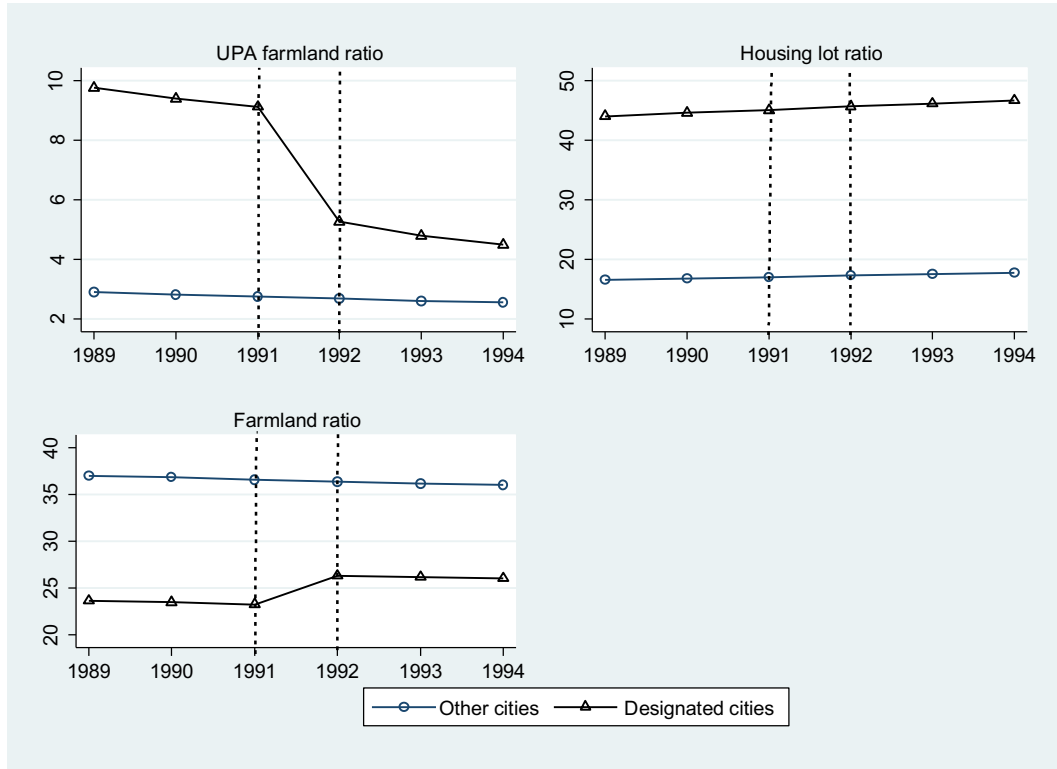
* "City" includes Tokyo 23 special wards.

Fig. 2. Share of tax revenue of municipalities in Japan (FY 2016, unit=%).

Source: The White Paper on Local Public Finance (issued by the Ministry of Internal Affairs and

Communications)

Fig. 3a. Trends in the ratio of each land use (Case 1, unit=%)

Notes: Case 1 covers a sample of 501 cities; the treatment group comprises 183 designated cities, and the control group has 318 other cities. UPA farmland stands for the farmland in the urban promotion areas, and "farmland" within the figure represents ordinary farmland. Meanwhile, housing lots also encompass commercial land following the classification of the Brief Report on the Value of Properties. Each series plots the average of the share of each item per total land (=UPA farmland + housing lots + ordinary farmland) from FY 1989 to FY 1994. "Designated cities" refer to the designated cities within the three metropolitan areas (Tokyo, Chubu, and Kansai), which follows the wording by Ishi (1991). Two dotted vertical lines indicates the years before (FY 1991) and after (FY 1992) the reform, which were presented in Table 2.

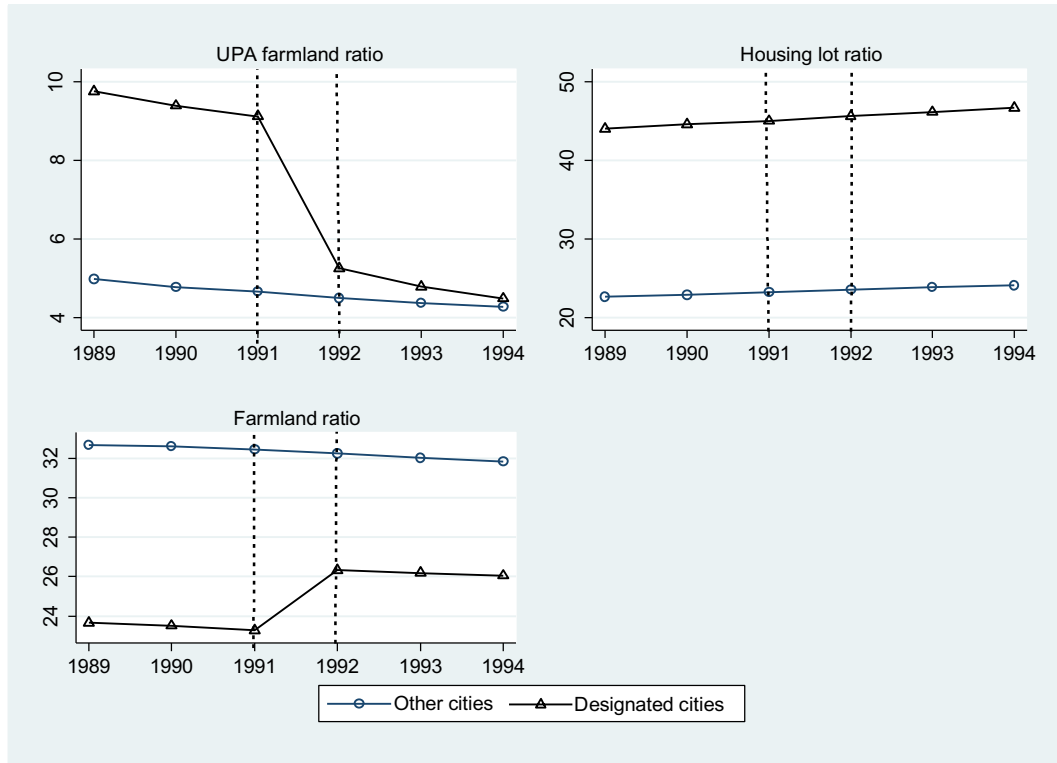**Fig. 3b.** Trends in the ratio of each land use (Case 2, unit=%).
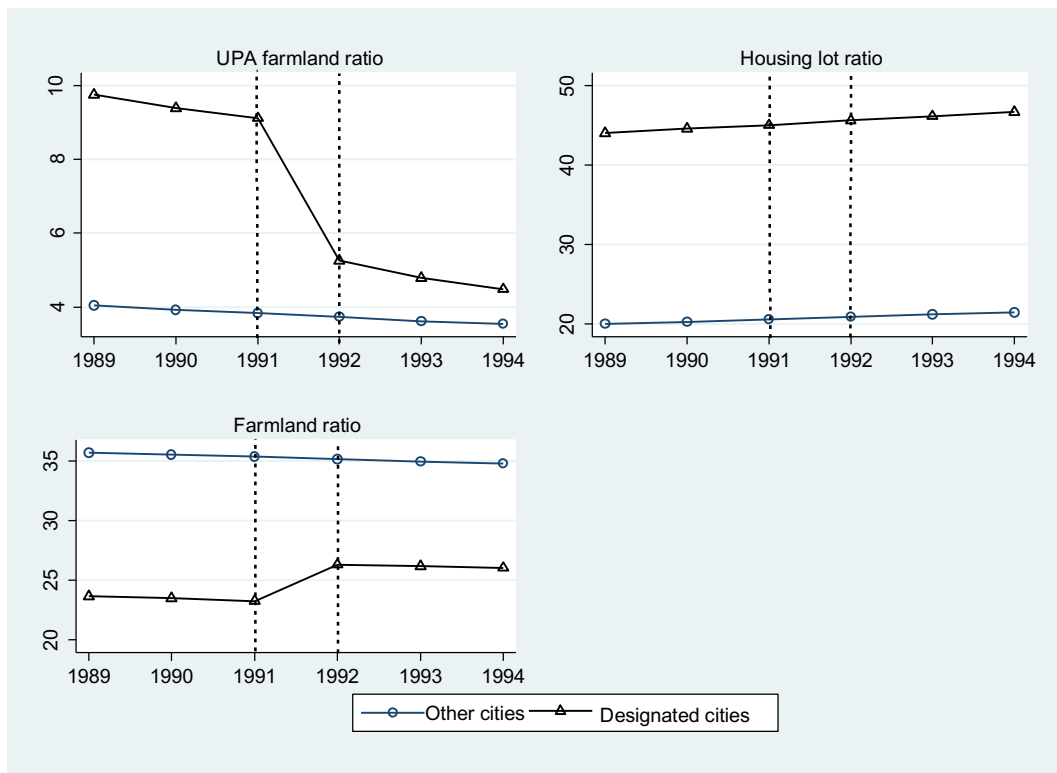
Notes: Case 2 covers a sample of 389 cities; the treatment group comprises 183 designated cities, and the control group has 206 cities with populations of over 50,000 on average throughout our sample period. UPA farmland stands for the farmland in the urban promotion areas, and "farmland" within the figure represents ordinary farmland. Meanwhile, housing lots also encompass commercial land following the classification of the Brief Report on the Value of Properties. Each series plots the average of the share of each item per total land (=UPA farmland + housing lots + ordinary farmland) from FY 1989 to FY 1994. "Designated cities" refer to the designated cities within the three metropolitan areas (Tokyo, Chubu, and Kansai), which follows the wording by Ishi (1991). Two dotted vertical lines indicates the years before (FY 1991) and after (FY 1992) the reform, which were presented in Table 2.

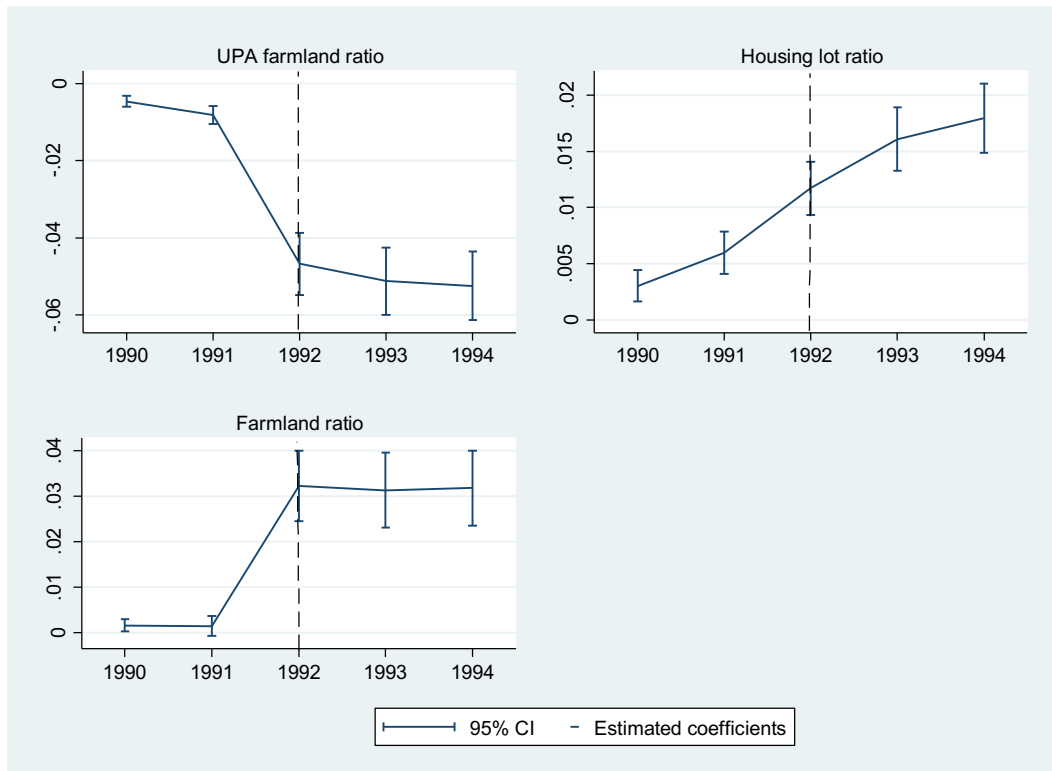**Fig. 3c.** Trends in the ratio of each land use (Case 3, unit=%).

Notes: Case 3 covers a sample of 287 cities; the treatment group comprises 183 designated cities, and the control group has 104 cities with population of over 100,000 on average throughout our sample period. UPA farmland stands for the farmland in the urban promotion areas, and "farmland" within the figure represents ordinary farmland. Meanwhile, housing lots also encompass commercial land following the classification of the Brief Report on the Value of Properties. Each series plots the average of the share of each item per total land (=UPA farmland + housing lots + ordinary farmland) from FY 1989 to FY 1994. "Designated cities" refer to the designated cities within the three metropolitan areas (Tokyo, Chubu, and Kansai), which follows the wording by Ishi (1991). Two dotted vertical lines indicates the years before (FY 1991) and after (FY 1992) the reform, which were presented in Table 2.

Fig. 4a. The effect of the property tax reform on the land ratio (Case1, without prefecture-specific time trend).

Notes: Case 1 covers a sample of 501 cities; the treatment group comprises 183 designated cities, and the control group has other 318. This figure plots the estimated coefficients of $D_{i,t-\tau}$ and $D_{i,t+\tau}$ over year 1992 $\pm\tau$ in Equation (2). The dotted vertical line indicates FY 1992, when the reform came into effect. UPA farmland stands for the farmland in the urban promotion areas, and "farmland" within the figure represents ordinary farmland. Meanwhile, housing lots also encompass commercial land following the classification of the Brief Report on the Value of Properties. "Designated cities" refer to the designated cities within the three metropolitan areas (Tokyo, Chubu, and Kansai), which follows the wording by Ishi (1991).

Fig. 4b. The effect of the property tax reform on the land share ratio (Case2, without prefecture-specific time trend).
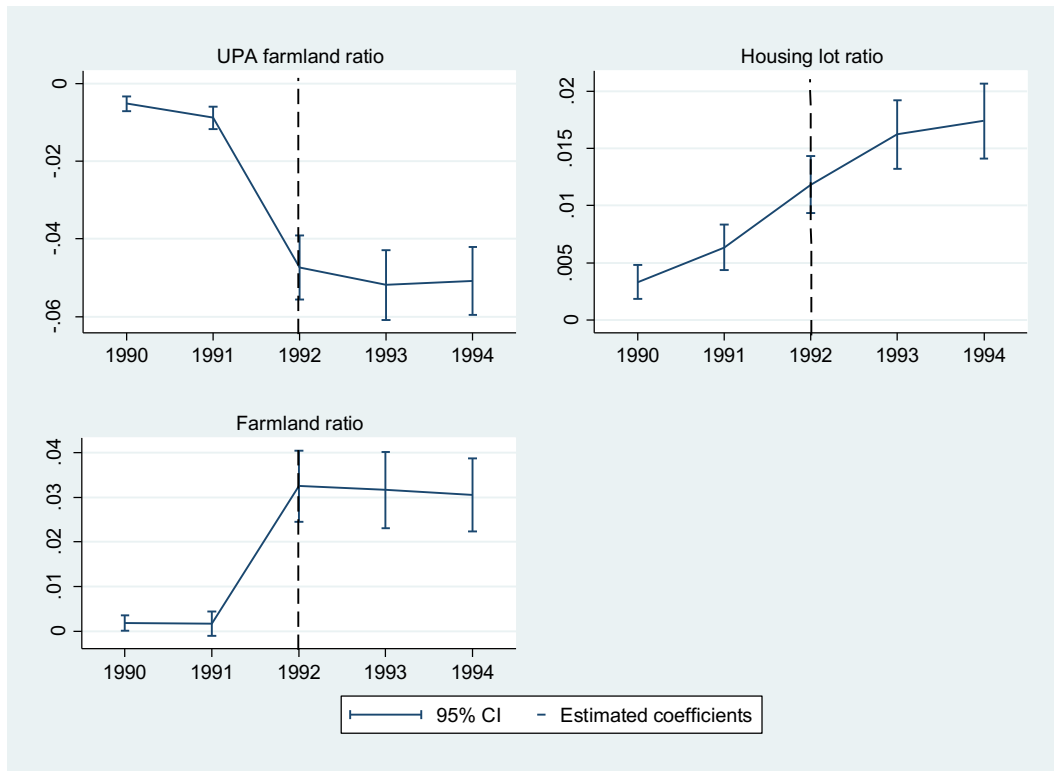

Notes: Case 2 covers a sample of 389 cities; the treatment group comprises 183 designated cities, and the control group has 206 cities with population of over 50,000 on average throughout our sample period. This figure plots the estimated coefficients of $D_{i,t-\tau}$ and $D_{i,t+\tau}$ over year 1992 $\pm\tau$ in Equation (2). The dotted vertical line indicates FY 1992, when the reform came into effect. UPA farmland stands for the farmland in the urban promotion areas, and "farmland" within the figure represents ordinary farmland. Meanwhile, housing lots also encompass commercial land following the classification of the Brief Report on the Value of Properties. "Designated cities" refer to the designated cities within the three metropolitan areas (Tokyo, Chubu, and Kansai), which follows the wording by Ishi (1991).

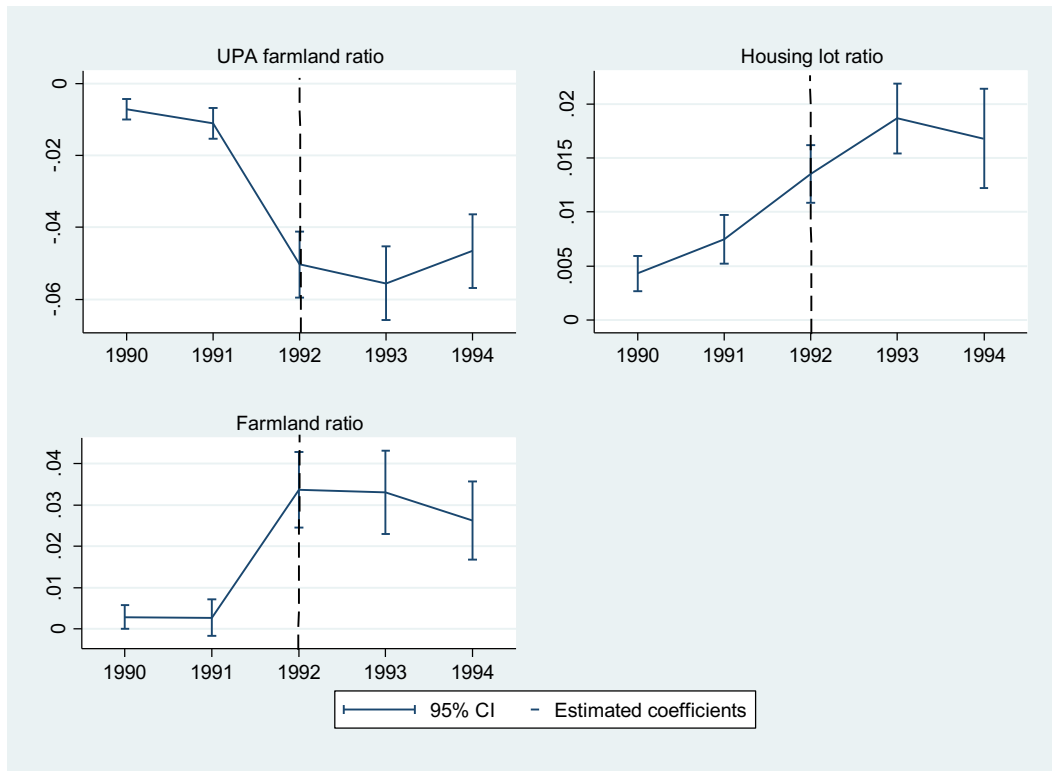**Fig. 4c.** The effect of the property tax reform on the land ratio (Case3, without prefecture-specific time trend).

Notes: Case 3 covers a sample of 287 cities; the treatment group comprises 183 designated cities, and the control group has 104 cities with population of over 100,000 on average throughout our sample period. This figure plots the estimated coefficients of $D_{i,t-\tau}$ and $D_{i,t+\tau}$ over year 1992 $\pm\tau$ in Equation (2). The dotted vertical line indicates FY 1992, when the reform came into effect. UPA farmland stands for the farmland in the urban promotion areas, and "farmland" within the figure represents ordinary farmland. Meanwhile, housing lots also encompass commercial land following the classification of the Brief Report on the Value of Properties. "Designated cities" refer to the designated cities within the three metropolitan areas (Tokyo, Chubu, and Kansai), which follows the wording by Ishi (1991).

Fig. 5a. The effect of the property tax reform on the land ratio (Case 1, with prefecture-specific time trend).

Notes: Case 1 covers a sample of 501 cities; the treatment group comprises 183 designated cities, and the control group has other 318. This figure plots the estimated coefficients of $D_{i,t-\tau}$ and $D_{i,t+\tau}$ over year 1992 $\pm\tau$ in Equation (3). The dotted vertical line indicates FY 1992, when the reform came into effect. UPA farmland stands for the farmland in the urban promotion areas, and "farmland" within the figure represents ordinary farmland. Meanwhile, housing lots also encompass commercial land following the classification of the Brief Report on the Value of Properties. "Designated cities" refer to the designated cities within the three metropolitan areas (Tokyo, Chubu, and Kansai), which follows the wording by Ishi (1991).

Fig. 5b. The effect of the property tax reform on the land ratio (Case 2, with prefecture-specific time trend).
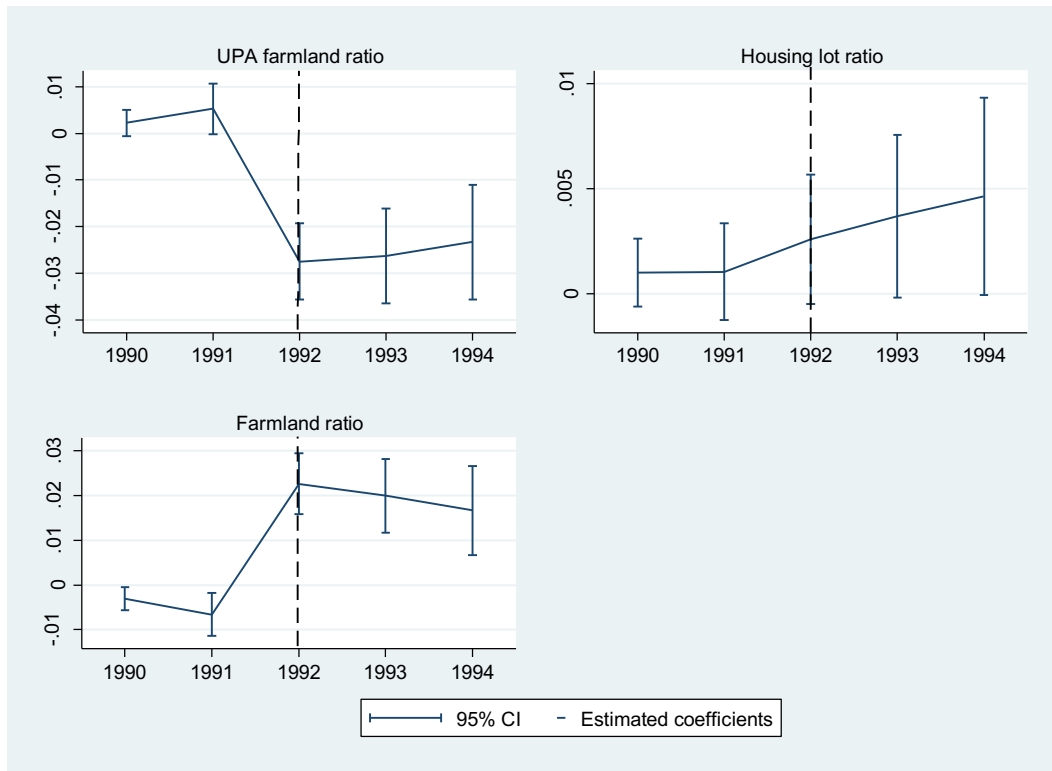

Notes: Case 2 covers a sample of 389 cities; the treatment group comprises 183 designated cities, and the control group has 206 cities with population of over 50,000 on average throughout our sample period. This figure plots the estimated coefficients of $D_{i,t-\tau}$ and $D_{i,t+\tau}$ over year 1992 $\pm\tau$ in Equation (3). The dotted vertical line indicates FY 1992, when the reform came into effect. UPA farmland stands for the farmland in the urban promotion areas, and "farmland" within the figure represents ordinary farmland. Meanwhile, housing lots also encompass commercial land following the classification of the Brief Report on the Value of Properties. "Designated cities" refer to the designated cities within the three metropolitan areas (Tokyo, Chubu, and Kansai), which follows the wording by Ishi (1991).
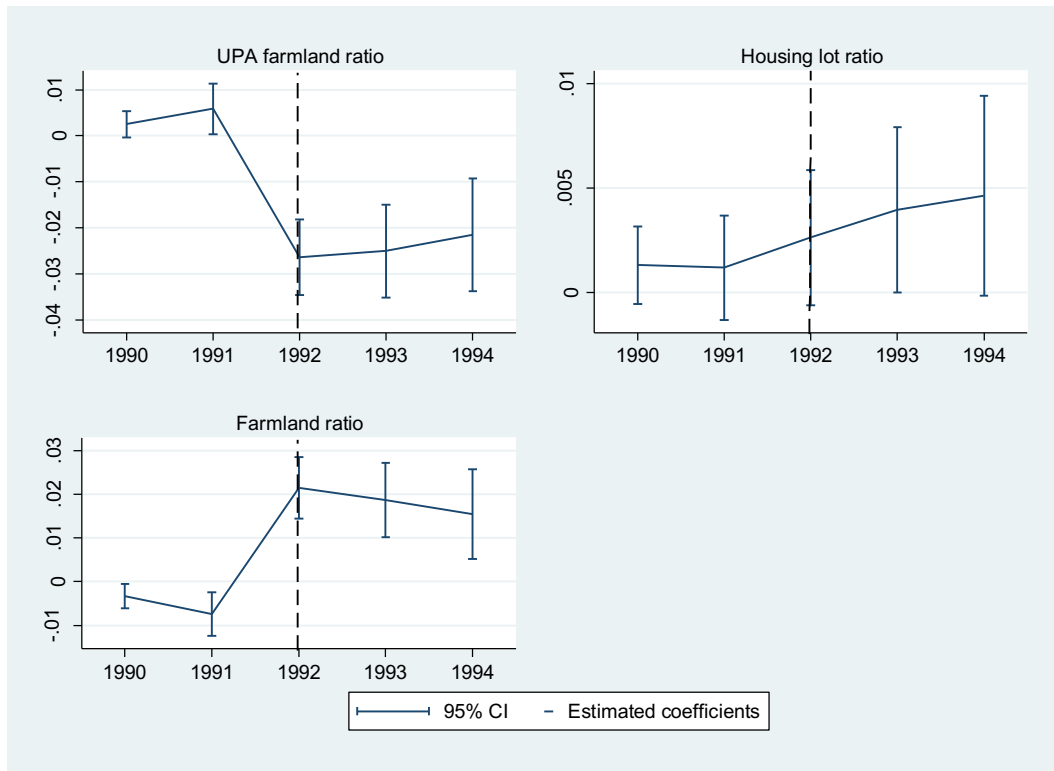
Fig. 5c. The effect of the property tax reform on the land ratio (Case 2, with prefecture-specific time trend).

Notes: Case 3 covers a sample of 287 cities; the treatment group comprises 183 designated cities, and the control group has 104 cities with population of over 100,000 on average throughout our sample period. This figure plots the estimated coefficients of $D_{i,t-\tau}$ and $D_{i,t+\tau}$ over year 1992 $\pm\tau$ in Equation (3). The dotted vertical line indicates FY 1992, when the reform came into effect. UPA farmland stands for the farmland in the urban promotion areas, and "farmland" within the figure represents ordinary farmland. Meanwhile, housing lots also encompass commercial land following the classification of the Brief Report on the Value of Properties. "Designated cities" refer to the designated cities within the three metropolitan areas (Tokyo, Chubu, and Kansai), which follows the wording by Ishi (1991).
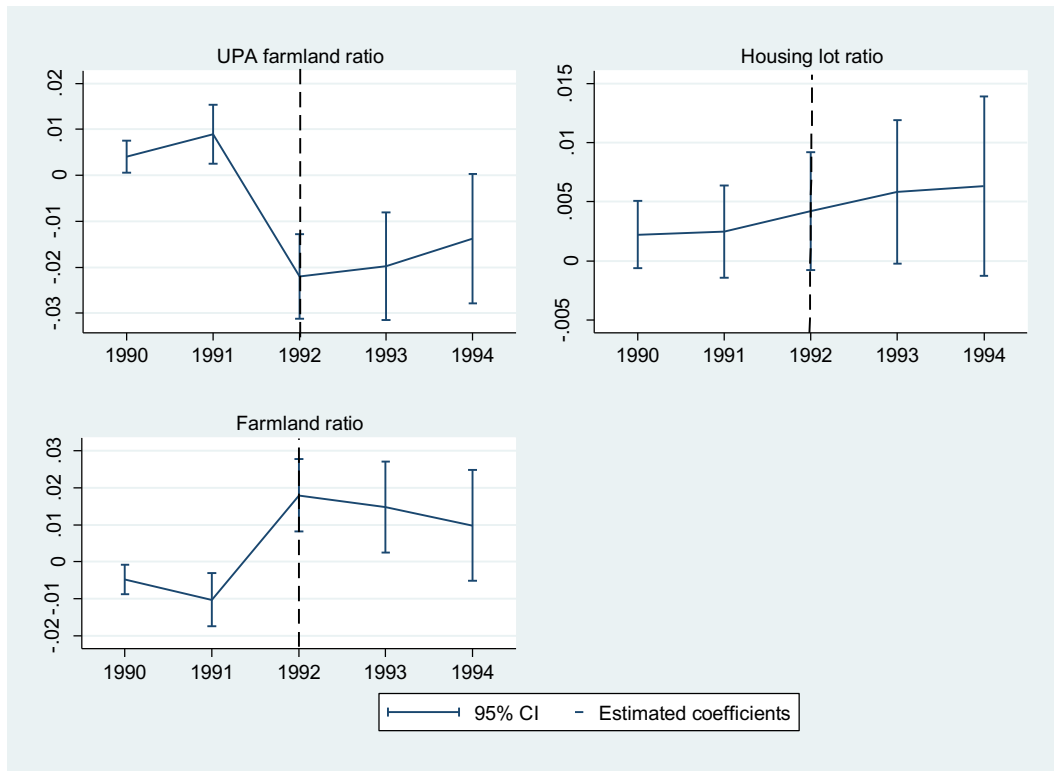
Fig. A1. The timeline of the decision
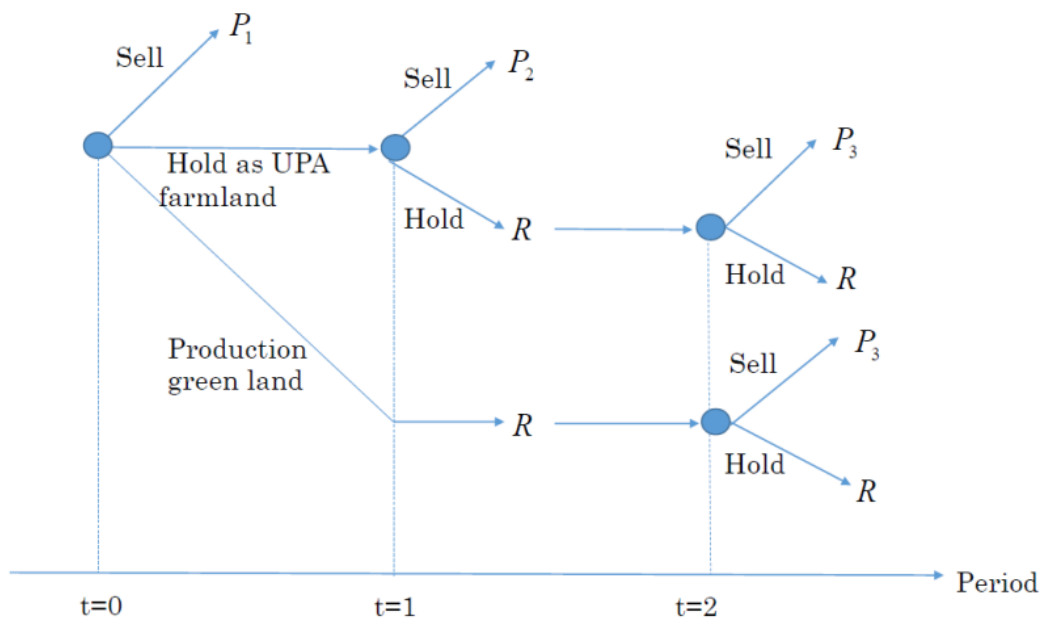
Notes: UPA farmland refers to the farmland in the urban promotion areas.

Table 1

An outline of Japan's property tax system.

Tax authority	Municipalities (cities, towns, and villages) assess, levy, and collect taxes*
Taxable assets	1. Land 2. Houses and buildings 3. Depreciable business assets
Taxpayer	Owners of each taxable asset
The evaluation of the tax base	Value (fair market value) as of January 1
Tax rate	Statutory tax rate: 1.4 %**

* For Tokyo's special wards, the Tokyo metropolitan government is in charge of tax administration.

** The upper limit is 2.1%

Table 2

The classification of the UPA farmland in the designated cities within the three metropolitan areas (Tokyo, Chubu, and Kansai) before and after the reform.

	Type of farmland	Preferential treatment
Before the reform (FY 1982-FY1991)	UPA farmland	Yes
After the reform (FY 1992 - FY 2021 (expected))	Production green land (PGL)	Yes (for 30 years)
	UPA farmland (except PGL)	No (taxed as residential lots)

Notes: "The reform" means the abolishment of the long-term agricultural operation system. UPA farmland refers to the farmland in the urban promotion areas. UPA farmland is classified as either production green land (PGL) or non-PGL UPA farmland following the reform. Note that the Japanese fiscal year runs from April to the following March.

Table 3

The description and source of the data.

Description	Source
The square measure of UPA farmland, housing lots, and ordinary farmland (unit: ㎡)	The Brief Report on the Value of Properties (FY 1990 to FY1995) *
Tax base and property value of UPA farmland (unit: million JPY)	The Brief Report on the Value of Properties (FY 1990 to FY 1995) *
Population	The Basic Resident Register (FY 1989 to FY 1994)
The area of municipality (unit: ㎡)	The Area Statistics of Prefectures and Municipalities (FY 1989 to FY 1994)
Agricultural production income (unit: million JPY)	The Production Agricultural Income Statistics (FY 1989 to FY 1994)
Shipment value of manufactured goods (unit: million JPY)	The Industry Statistics (FY 1989 to FY 1994)
Local government tax revenue and total local government revenue (unit: million JPY)	The Statistics of the Final Accounts of Municipal Governments (FY 1989 to FY 1994)

* The collection of property taxes between April and the following March (the fiscal year in Japan) is based on information from January of the previous fiscal year. In this regard, for example, our data with regard to land use in FY 1991 (April 1991–March 1992) come from the Brief Report on the Value of Properties in FY 1992, reflecting the land use in January 1992 (still within FY 1991). Likewise, the data in FY 1992 are from the Brief Report in FY 1993, which indicates the evaluation in January 1993 (within FY 1992). Therefore, we use the data from the Brief Report on the Value of Properties in FY 1990-1995 instead of FY 1989-1994.

Table 4

Descriptive statistics for all sample periods (FY1989-1994) and all 501 cities.

Variable	Description	NOB	Mean	Std. Dev.	Min	Max
UPA farmland ratio	The ratio of UPA farmland per total land	3006	0.043	0.046	0	0.443
Housing lot ratio	The ratio of housing lots per total land	3006	0.322	0.181	0	0.871
Farmland ratio	The ratio of farmland per total land	3006	0.275	0.206	0.018	0.959
Effective tax rate	Effective tax rate of UPA farmland	3006	0.006	0.005	0	0.014
Population density	Population per the area of municipality	3006	7.412	1.226	2.303	10.347
Agricultural income	Agricultural production income	3006	12.239	1.276	7.586	15.979
Shipment	Shipment value of manufactured goods	3006	6.944	1.204	3.779	9.556
Local tax revenue ratio	Local government tax revenue per total local government revenue	3006	0.424	0.135	0.095	0.737

Notes: See Table 3 for the definitions and data sources of all the variables. "Farmland" within the table represents ordinary farmland. "Total land" within the table indicates the sum of UPA farmland, ordinary farmland, and housing lots.

Table 5

Descriptive statistics between FY 1991 and FY 1992.

Group	Treatment						
Variable	FY1991			FY1992			(1) Growth rate (FY1992-1991, %)
	N	mean	Std. Dev.	N	mean	Std. Dev.	
UPA farmland ratio	183	0.091	0.061	183	0.053	0.028	-42.323
Housing lot ratio	183	0.450	0.212	183	0.456	0.214	1.388
Farmland ratio	183	0.233	0.185	183	0.263	0.171	13.117

Group	Control						
Variable	FY1991			FY1992			(2) Growth rate (FY1992-1991, %)
	N	mean	Std. Dev.	N	mean	Std. Dev.	
UPA farmland ratio	318	0.028	0.033	318	0.027	0.032	-2.829
Housing lot ratio	318	0.170	0.109	318	0.173	0.111	1.557
Farmland ratio	318	0.366	0.168	318	0.364	0.167	-0.576

Dif (1)-(2),%
-39.494
-0.168
13.693

Notes: See Table 3 for the definitions and data sources of all the variables. "Farmland" within the table represents ordinary farmland.

Table 6

Simple DID estimates (without control variables, sample periods=FY1991-FY1992).

Dependent variable =UPA farmland ratio	Case1	Case2	Case3
$D_{i,t}$	-0.038 ***	-0.037 ***	-0.037 ***
	(0.005)	(0.006)	(0.007)
Adjusted R^2	0.29	0.22	0.18
NOB	1002	778	574
N. of treated municipalities	183	183	183
N. of control municipalities	318	206	104

Dependent variable =housing lot ratio	Case1	Case2	Case3
$D_{i,t}$	0.004	0.003	0.003
	(0.02)	(0.024)	(0.031)
Adjusted R^2	0.43	0.35	0.26
NOB	1002	778	574
N. of treated municipalities	183	183	183
N. of control municipalities	318	206	104

Dependent variable = farmland ratio	Case1	Case2	Case3
$D_{i,t}$	0.033 *	0.032 *	0.033
	(0.022)	(0.025)	(0.03)
Adjusted R^2	0.1	0.09	0.05
NOB	1002	778	574
N. of treated municipalities	183	183	183
N. of control municipalities	318	206	104

Notes: Heteroskedasticity-robust standard errors are in parentheses. Asterisks indicate significance levels:

* = 10% and *** = 1%. "Farmland" within the table represents ordinary farmland.

Table A1.

DID estimates with other control variables. Dependent variable= the share of urbanization promotion area farmland per total land. Sample periods=FY1989-FY1994

	Equation (2)			Equation (3)		
	Case1	Case2	Case3	Case1	Case2	Case3
$D_{i,t+2}$	-0.003 ***	-0.003 ***	-0.003 ***	0.002	0.003 *	0.004 **
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
$D_{i,t+1}$	-0.006 ***	-0.005 ***	-0.004 ***	0.005 *	0.006 **	0.009 ***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)
$D_{i,t}$	-0.043 ***	-0.042 ***	-0.041 ***	-0.028 ***	-0.026 ***	-0.022 ***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
$D_{i,t-1}$	-0.048 ***	-0.046 ***	-0.047 ***	-0.026 ***	-0.025 ***	-0.02 ***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.006)
$D_{i,t-2}$	-0.050 ***	-0.046 ***	-0.04 ***	-0.023 ***	-0.022 ***	-0.014 ***
	(0.004)	(0.004)	(0.005)	(0.006)	(0.006)	(0.007)
Effective tax rate	0.156 *	0.667 ***	2.625 **	-0.003	0.145	0.422
	(0.094)	(0.221)	(1.097)	(0.064)	(0.137)	(0.531)
Local tax revenue	0.017	0.013	0.015	0.018	0.016	0.021
ratio	(0.018)	(0.021)	(0.025)	(0.015)	(0.018)	(0.022)
Agricultural income	0.001	0.002	0.002	-0.001	-0.001	0.001
	(0.003)	(0.004)	(0.005)	(0.002)	(0.003)	(0.004)
Population density	0.077 **	0.098 ***	0.148 **	0.047 *	0.062 **	0.094 **
	(0.03)	(0.036)	(0.053)	(0.03)	(0.035)	(0.049)
Shipment	0.017 **	0.024 **	0.038 **	0.008 **	0.01 *	0.014 *
	(0.007)	(0.011)	(0.015)	(0.004)	(0.006)	(0.009)
const	-0.699 ***	-0.967 ***	-1.565 ***	-0.368 *	-0.517 *	-0.837 **
	(0.234)	(0.285)	(0.447)	(0.218)	(0.264)	(0.387)
Adjusted R-squared	0.893	0.869	0.836	0.931	0.915	0.891
NOB	3006	2334	1722	3006	2334	1722

Notes: We take the logarithm for agricultural income, population density, and shipment in our estimation. Standard errors, estimated with clustering by municipality, are presented in the parenthesis. Year effects (year dummy variables) are not shown for the sake of brevity. Asterisks indicate significance levels: * = 10%, **=5%, and *** = 1%.

Table A2.

DID estimates with other control variables. Dependent variable= the share of housing lots per total land. Sample periods=FY1989-FY1994

	Equation (2)			Equation (3)		
	Case1	Case2	Case3	Case1	Case2	Case3
$D_{i,t+2}$	0.002 ***	0.003 ***	0.003 **	0.001	0.001	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$D_{i,t+1}$	0.004 ***	0.004 ***	0.004 **	0.001	0.001	0.002
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
$D_{i,t}$	0.007 ***	0.006 ***	0.006 ***	0.003 *	0.003	0.004 *
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)
$D_{i,t-1}$	0.009 ***	0.009 ***	0.009 ***	0.004 *	0.004 *	0.006 *
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)
$D_{i,t-2}$	0.012 ***	0.011 ***	0.008 ***	0.005 *	0.005 *	0.006
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)
Effective tax rate	-0.005	-0.115	-0.795 **	0.009	-0.114	-0.205
	(0.061)	(0.117)	(0.347)	(0.061)	(0.09)	(0.286)
Local tax revenue	-0.004	-0.002	-0.0001	-0.002	-0.002	0.001
ratio	(0.006)	(0.006)	(0.008)	(0.005)	(0.006)	(0.007)
Agricultural income	-0.002 *	-0.003 *	-0.004 *	-0.002	-0.002 *	-0.003 *
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
Population density	0.064 ***	0.048 ***	0.031 **	0.055 ***	0.047 ***	0.04 **
	(0.018)	(0.018)	(0.018)	(0.017)	(0.017)	(0.021)
Shipment	-0.002	-0.002	-0.003	-0.0001	0.001	0.001
	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)	(0.004)
const	-0.138	0.007	0.19	-0.101	-0.019	0.067
	(0.127)	(0.129)	(0.136)	(0.116)	(0.124)	(0.161)
Adjusted R-squared	0.999	0.999	0.999	0.999	0.999	0.999
NOB	3006	2334	1722	3006	2334	1722

Notes: We take the logarithm regarding agricultural income, population density, and shipment in our estimation. Standard errors, estimated with clustering by municipality, are presented in the parenthesis. Year effects (year dummy variables) are not shown for the sake of brevity. Asterisks indicate significance levels: * = 10%, **=5%, and *** = 1%.

Table A3.

DID estimates with other control variables. Dependent variable= the share of ordinary farmland per total land. Sample periods=FY1989-FY1994

	Equation (2)			Equation (3)		
	Case1	Case2	Case3	Case1	Case2	Case3
$D_{i,t+2}$	0.001	0.001	0.001	-0.003 **	-0.003 **	-0.005 **
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
$D_{i,t+1}$	0.001	0.0001	-0.001	-0.007 **	-0.007 ***	-0.01 ***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.004)
$D_{i,t}$	0.034 ***	0.033 ***	0.032 ***	0.023 ***	0.021 ***	0.018 ***
	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.005)
$D_{i,t-1}$	0.035 ***	0.034 ***	0.035 ***	0.02 ***	0.019 ***	0.015 **
	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)	(0.006)
$D_{i,t-2}$	0.036 ***	0.033 ***	0.029 ***	0.017 ***	0.015 ***	0.01
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.008)
Effective tax rate	-0.121	-0.467 **	-1.93 **	0.058	0.07	-0.07
	(0.119)	(0.222)	(0.954)	(0.093)	(0.156)	(0.488)
Local tax revenue	-0.01	-0.01	-0.014	-0.015	-0.016	-0.022
ratio	(0.017)	(0.02)	(0.024)	(0.014)	(0.016)	(0.019)
Agricultural income	0.0003	-0.0003	-0.002	-0.0005	-0.0001	-0.002
	(0.002)	(0.003)	(0.005)	(0.002)	(0.003)	(0.004)
Population density	-0.111 ***	-0.115 ***	-0.143 **	-0.076 ***	-0.078 **	-0.096 **
	(0.031)	(0.039)	(0.063)	(0.028)	(0.032)	(0.049)
Shipment	-0.013 **	-0.02 **	-0.032 **	-0.007 **	-0.01 **	-0.013 *
	(0.007)	(0.01)	(0.015)	(0.004)	(0.006)	(0.008)
const	1.257 ***	1.398 ***	1.793 ***	0.942 ***	0.999 ***	1.189 ***
	(0.236)	(0.307)	(0.534)	(0.197)	(0.241)	(0.389)
Adjusted R-squared	0.993	0.992	0.988	0.996	0.995	0.993
NOB	3006	2334	1722	3006	2334	1722

Notes: We take the logarithm regarding agricultural income, population density, and shipment in our estimation. Standard errors, estimated with clustering by municipality, are presented in the parenthesis. Year effects (year dummy variables) are not shown for the sake of brevity. Asterisks indicate significance levels: * = 10%, **=5%, and *** = 1%.