The future of agriculture in the shrinking suburbs: The impact of real estate income and housing costs

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**ABSTRACT**

This paper offers solutions to some of the challenges around maintaining productive agricultural land close to cities in countries facing a decline in urban populations. In such circumstances, some farmers have been observed to convert their land into real estate and leave farming before land prices decline, therefore decreasing the area of agricultural land close to large cities. In contrast, many suburban farmers in developed countries remain in farming even when land prices decline and suburbs shrink. We argue that such behaviour can be explained by a desire to remain in farming, even at the expense of profits. In such cases, agricultural income may be supplemented by rental income or by selling land. This paper demonstrates that, when land prices are high, a preferential taxation system may help farmers with real estate income to retain more of their land.

This study is based on data from a survey of farmers in Tokyo, Japan where, in 1992, a programme combining preferential taxation and restrictions on the conversion of farmland was implemented. Our findings suggest that farmers in more populated areas with a strong dependence on real estate income tend to continue farming, as do those in less populated areas who are less dependent on this income source. Analysis further suggests that imposing heavy taxes on residential property simply increases living costs for farmers and results in the loss of agricultural land and that policies which promote diversification and reduce housing costs are important for keeping urban fringe land in agriculture.

1. Introduction

Over recent decades competition over land between agricultural uses and urban development has become an important issue in many countries. The desire to protect land from development may be based on one of a number of motives and this has resulted in a variety of policy-based solutions ranging from regulation restricting development, to the introduction of incentive schemes. Based on traditional location theory (e.g. North (1955)), incentives to develop agricultural land exist because of the differences in the rents from urban land use compared to the income available from agricultural use. In contrast, the conservation of agricultural land can be justified on the grounds of its multi-functional values including agricultural production (Kline and Wichelns, 1990).

However, abiding by the general principle of freedom of property rights and occupational choice in the market economy, compelling landowners to preserve agricultural land against their wills is not an easy task.

Some developed countries are now, however, entering a period of population decline. Due to an overall decrease in fertility rates, population growth in Europe is predicted to be negative in the next decade. Declining populations are also likely to be observed in many countries in Asia and South America by the middle of the century (United Nations, Working Paper No. ESA/P/WP/248). According to OECD population projections, by 2050 at least six OECD countries are expected to see their populations falling to a level more than 10% below their peak (Below, 2016). Above all, Japan’s population, which peaked in 2010 at just over 128 million, is projected to experience a steep and continuous decline. This raises the issue of land use and the state of agriculture in the so-called “shrinking suburbs” (Hollander et al., 2009; Yokohari and Bolthouse, 2011) as opposed to the problems of urbanization and urban sprawl observed in the growth phase. In the suburbs, most farmers rely on off-farm income particularly from rental property (Keep, 2009). When the population decreases and demand for rental properties falls, landowners tend to adapt slowly and are often not able to achieve adequate returns from their land. This leads to instability in...
farm household incomes, which may result in the eventual sale of agricultural land and the associated loss of its multifunctional benefits. In many areas suburban agriculture is expected to provide such multifunctional benefits to local populations (Zasada, 2011), but ensuring its sustainability requires appropriate land use planning systems that are informed by an understanding of the possibility of the loss of farmland to other uses.

In 2016 the number of urban areas (defined as a continuously built up land mass of urban development), with a population in excess of ten million was 36, compared to only two in 1950. Nearly one-tenth of the world’s population resides in these cities and a quarter live in urban areas with populations greater than a million. Among these, Tokyo, the capital city of Japan, is by far the largest with 37.8 million people living in the associated urban area (Cox, 2016). To look at agriculture in the shrinking suburbs within the Japanese metropolis is, to some extent, to glimpse the future challenges that will be faced by other developed countries (Yokohari and Bolthouse, 2011). Based on a survey of farmers located in the suburban areas surrounding central Tokyo, this paper focuses on the strategies employed by farmers to remain in agriculture. This will provide some insights into how agriculture and the benefits it provides can be retained in the shrinking suburbs.

1.1. The shrinking suburbs

There is an extensive literature on urban shrinkage which is relevant to this study. When investigating ten European cites, Haase et al. (2016) identified three major factors affecting urban shrinkage, namely, economic crisis, suburbanization and demographic change. Of these, demographic change, in particular falling birth rates, is a particular threat in certain countries, such as Japan. In addition, domestic and urban-rural migration, regional economic downturn and a decrease in demand for land in particular urban areas have all been identified as important factors leading to urban shrinkage. In some cases, rather than a reduction in size of the city centre, the outlying suburbs are observed to shrink. This phenomenon has been observed in some parts of Eastern Europe (Haase et al., 2016; Oswalt, 2006; Turok and Mykhnenko, 2007) the Mediterranean (Salvati et al., 2015), South Korea (Nam et al., 2016) and Japan (Buhnik, 2010, 2017; Flüchter, 2008; Fol and Cunningham-Sabot, 2010).

Acknowledging the difficulty of delineating the urban core from the surrounding suburbs (Weaver, 1975), we define suburbs, or more precisely sprawling suburbs, as areas within the urban agglomeration where agricultural and residential land uses are intermixed. Suburbs are typically located just outside the urban core (Fig. 1). A similar geographical concept is that of peri-urban areas which is used mainly in the European context where zoning restrictions are relatively strong. The dominant land use in peri-urban areas is agriculture and population density is relatively low (Lange et al., 2013; Piorr et al., 2011). Under this definition suburbs are usually found within urban rather than peri-urban areas (Piorr et al., 2011). In urban areas, the most common forms of agriculture tend to be non-agrarian community gardens, allotments, backyard and roof top gardens (Opitz et al., 2016). In many cases, these sites are not officially protected by planning authorities because urban areas are not regarded as spaces for agriculture (Castillo et al., 2013; Opitz et al., 2016). In contrast, the border between peri-urban and urban areas in a large, sprawling metropolis, such as Tokyo, can be hard to identify (Heimlich and Brooks, 1989). Here, agricultural holdings can be found in suburbs with a population density of 10,000 inhabitants/km² (Sorensen, 2001), where many farmers rent out a part of their land and sustain their households with the resulting income.

1.2. Agriculture in the shrinking suburbs

A large body of literature exists on the persistence of agriculture in suburban or peri-urban areas. Major factors influencing the maintenance of agricultural land use in such areas includes proximity to urban markets, agricultural viability, individual preferences, and land use policy.

Many researchers agree that increasing land prices accelerate the tendency of farmers to leave agriculture, or that at least they contribute to the so-called “impermanence syndrome” attributable to speculation related to conversion (Adelaja et al., 2011; Edelman et al., 1999; Lopez et al., 1988). Speculation is generally observed when landowners wait to dispose of land during times of urban expansion and rising land prices, even though immediate conversion for rental use would be profitable because revenue from urban rents exceeds that from agricultural rents. If speculation is assumed, farmland should be sold before prices decrease. Moreover, profits can be maximized through conversion for rental use even if owners delay the timing of a sale as long as the rental income achieved still significantly exceeds the agricultural rent (Stobbe et al., 2009). Such speculative behaviour would not, however, explain the behaviour of those farmers who remain in the shrinking suburbs.

A number of empirical studies have found that while large-scale farmers close to urban areas tend to continue agriculture (Kimhi and Bollman, 1999; Towe et al., 2008), only the most intensive, innovative, and adaptive farmers on smaller holdings keep farming (Adelaja et al., 2011; Heimlich and Brooks, 1989; Hoppe and Korb, 2001; Inwood and Sharp, 2012). In areas where multifunctional land use is encouraged, including some suburban areas, agriculture-oriented diversified activities such as the direct marketing of food products may be common (Jongeneel et al., 2008; Lange et al., 2013; Pölling and Mergenthaler, 2017; Stobbe et al., 2010; Zasada, 2011).

Other researchers have suggested that individual subjective utilities from owning farmland and engaging in agriculture are important in influencing farmers’ decisions to keep farming (Lynch and Lovell, 2001; Rilla and Sokolow, 2000). For example, hobby or lifestyle farmers may

<table>
<thead>
<tr>
<th>Urban and peri-urban with strict zoning</th>
<th>Typology</th>
<th>Population density</th>
<th>Dominant type of Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>Urban Periphery</td>
<td>Urban Fringe</td>
<td>Suburb</td>
</tr>
<tr>
<td>Peri-Urban Areas</td>
<td>Agrarian enterprise</td>
<td>Non agrarian urban agriculture (UA)</td>
<td></td>
</tr>
</tbody>
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<thead>
<tr>
<th>Sprawled metropolis</th>
<th>Typology</th>
<th>Population density</th>
<th>Dominant type of Agriculture</th>
</tr>
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<tbody>
<tr>
<td>Rural</td>
<td>Suburb (sprawled)</td>
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<td></td>
</tr>
<tr>
<td>Agrarian</td>
<td>Mainly agrarian enterprise (with real estate income)</td>
<td></td>
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</tr>
</tbody>
</table>

Fig. 1. Suburban Agriculture in Sprawled Metropolis.
Source: Piorr et al. (2011) and authors’ illustration.
be willing to pay higher rents and endure lower returns than conventional farmers (Stobbe et al., 2009). In terms of farm characteristics, hobby farmers and non-farming landowners tend to be reluctant to invest in further agricultural production (Gottlieb et al., 2015). Even professional farmers close to the city may be motivated to continue in agriculture in order to maintain family tradition rather than for economic motives (Jongeneel et al., 2008; Primdahl and Kristensen, 2011).

A significant concern exists over the institutional effects of zoning and taxation on the continuity of agriculture in the suburbs. In most developed countries, agricultural land owners receive preferential tax treatment (Barrows and Bonderud, 1988; Coogan et al., 2014; Kashian, 2004; Malme, 1993; Stewart and Libby, 1998). Theories based on profit maximization suggest that such preferential treatment may delay the development of agricultural land during urban growth periods (Anderson, 1986; Capozza and Yuming, 1994). Simulation results show that farmers’ decisions to allow development are determined by price change patterns, which suggest that they speculate to maximize the total profits from agriculture and real estate subject to restrictions on conversion and the prevailing tax conditions (Schwartz et al., 1975).

The results of some studies (e.g. Hite et al. (2002)) have supported the hypothesis that preferential taxes on agricultural land delay development and increase the probability of agricultural land being retained.

1.3. Real estate income and housing costs of the farm household

The decision to remain in farming in suburban areas is closely linked to housing costs and the income that could be derived from renting out part of the agricultural holding.

In general, urban rents are higher than agricultural rents and the former increase as the location gets closer to the city centre. This potential difference in rental income is significant, particularly if the land holding is close to the city centre, and in some countries it is common for farms to rent out buildings to other users. In England, for example, one third of active farms rent out buildings for non-agricultural use (Keep, 2009). Although most farmers in Tokyo depend to some extent on real estate income from apartments or parking lots on their properties, many continue to farm either to maintain family tradition or because they see farming as their primary occupation (Yagi, 2013).

Farms close to the city face increased housing costs due to land prices being higher than those in rural areas (Castillo et al., 2013; Stobbe et al., 2009; Yagi, 2013). These increased costs may also reflect additional expenses that such urban-fringe farm households have to pay, for example higher taxes associated with the farmhouse and other facilities that are used for agriculture but are not treated preferentially. These costs tend to increase as the land gets closer to the central business district. Little previous research has explicitly focused on housing costs for suburban farms in relation to their persistence.

1.4. Japanese policy context

The Japanese government enacted the City Planning Act in 1968 to identify Urbanization Promotional Areas (UPAs), and at the same time Urbanization Control Areas were designated to control rapid urban growth and urban sprawl. As a result of negotiations between local governments and landowners, the UPA zones for potential development included substantial areas of farmland. In fact, most suburban farms in Tokyo Metropolitan Prefecture (Tokyo MP) are located in UPAs.

Since 1992, farmland within UPAs in the three major metropolitan areas, Tokyo, Osaka and Nagoya, has been subject to the same level of property taxation as residential use, with the important exception of Productive Green Land (PGL) as designated under the Productive Green Land Act. Although land designated as PGL remains in private hands, owners cannot convert it to uses other than agriculture. Such a combination of preferential taxation and conversion restrictions is one of the most common mechanisms for protecting agricultural land in the suburbs (Kashian, 2004; Malme, 1993). PGL owners must continue to use their land for agricultural purposes in order to enjoy both preferential taxation assessments for fixed asset taxes and exemptions from inheritance taxes. A discount assessment for fixed asset taxes is applied for all PGL on which land use other than agriculture is prohibited for at least thirty years. Exemption from inheritance tax mandates landowners to continue in agriculture until the next inheritance. The inheritance condition is relaxed if the current owner-operator faces severe health problems. At the time of enforcement in 1992, all farmers were able to choose whether or not their land was designated as PGL, unless the area was less than 500 m². When inheriting land, farmers can also choose whether or not the plot remains as PGL. In Tokyo MP, the PGL area was 4073 ha in 1993 but decreased to 3275 ha by 2015. In the same period, non-PGL farmland in the UPA decreased sharply from 3085 ha to 970 ha. This difference is argued to be the result of the preferential tax regime for PGL.

Recently, the national government enacted the Basic Law for the Promotion of Urban Agriculture (2015), which states that urban farmland should be protected rather than developed, a policy motivated by concerns similar to those arising from demographic change in the shrinking suburbs (Buhnik, 2010, 2017; Flüchter, 2008; Fol and Cunningham-Sabot, 2010).

Although a number of studies have examined the behaviour of Japanese farmers who hold PGL farmland, few model this behaviour. For example, several studies have investigated the characteristics of farmers who applied for PGL status and these have found that relatively large farms with lower off-farm incomes were the most likely to seek this designation (Shimizu, 1997; Terawaki, 1996). Such choices have led to increased urban sprawl and are compounded by the absence of spatial planning restrictions (Kishi et al., 1997). Simulation results have demonstrated that the preferential taxation associated with PGL can delay the conversion of farmland by landowners during phases of increasing land prices (Asada and Yamazaki, 2009). If landowners within the UPA did not take the PGL option, continuing with agriculture is an irrational decision given the associated heavy tax burden, even when agricultural profits are taken into account (Iwata and Yagi, 2012; Shibagaki, 1994). Hence, most non-PGL farmland plots within the UPA in suburban Tokyo are likely to have been converted to urban use following the introduction of the legislation.

Finally, a subjective preference to remain in agriculture has been found to be an important motive for Japanese suburban farmers. Although such preferences are important drivers for suburban farmers to continue in agriculture (Yoshida and Yagi, 2015), most need to generate real estate income to subsidize their heavy housing costs. If the income generated is insufficient, farmers tend to sell their land lot by lot (Yoshida et al., 2015). Further research is required to fully understand the foundations of such behaviour and the consequences that it has for the distribution of farmers in suburban areas.

1.5. Objectives

Previous research has focused mainly on farmers’ profit maximizing behaviour in conditions of urban growth associated with increases in population and land prices. In particular there have been many studies investigating the economically rational timing for converting farmland to other uses at times of urban growth. Other studies have shown that not all farmers set out to maximize income or asset value but instead are keen to retain inherited farmland and continue farming. Adaptive farmers have been found to be more likely to be persistent in the face of urbanization, diversifying their activities and using innovative practices, although real estate income may make a substantial contribution to meeting their living expenses. Clearly, persistence of farmers in the face of urbanization depends on location and in particular proximity to...
the central business district.

When urban growth has ceased, or has even begun to reverse, an alternative explanation for the behaviour of farmers who continue farming is required in order to understand and manage future suburban land use. Our research therefore focuses on the fact that many farmers in suburban Tokyo kept farming through a period of significant urban growth and continued to do so even during a phase of urban shrinkage with associated decreases in population and land prices.

By considering the impacts of housing costs, this study provides novel insights into how suburban farmers maintain both their households and their farms at a time when suburban populations are decreasing. First, we examine a theoretical formulation for conserving agricultural land that incorporates housing costs, geographical variations in land prices, real estate incomes, and agricultural productivity. Second, using data from a survey conducted in suburban Tokyo, we model farmers’ behaviour associated with the decision whether or not to continue in agriculture. Finally, we discuss prospects for future farmland use in the shrinking suburbs.

2. Materials and methods

2.1. Theoretical model: farmland, real estate and housing costs

A farmer who owns PGL faces a constraint with respect to sustaining the household. In addition to agricultural income, the farm can also generate real estate income from converting a proportion of the farmland to other uses. To formulate this constraint, denote \( A \) as the area of the land owned (except for the owner’s house), \( \alpha \) as the proportion of agricultural land in land area \( A \), and \( \gamma \) as the proportion of land converted for the purpose of generating rental income. For simplicity, fluctuations in income and expenses are assumed to level out. Sources of income other than agricultural and real estate are assumed to be negligible. An annual budget for the farm household can be sustained by the following condition:

\[
sPA(1 - \alpha - \gamma) + \gamma xPA + aRA - (CP + I) \geq 0
\]

(1)

where \( s \) is the ratio of the return on real estate assets, \( P \) is the market land price, \( R \) is agricultural income per unit of farmland area, \( C \) is the housing cost per unit value of land, \( I \) is household expenses, and \( x \) is the annual average proportion of land sold.

The first term in (1) is annual real estate income where a proportion of land (i.e. the remaining area of land given any areas sold for agriculture and \( \gamma \) sold) is rented out. The ratio of return \( s \) is proportional to land price and is assumed to be positive following asset taxation based on land price. The second term is the income from selling small plots of land to help sustain the household. The land sold is averaged by the annual budget for the farm household can be sustained by the following condition:

\[
sPA(1 - \alpha - \gamma) + \gamma xPA + aRA - (CP + I) \geq 0
\]

(1)

where \( s \) is the ratio of the return on real estate assets, \( P \) is the market land price, \( R \) is agricultural income per unit of farmland area, \( C \) is the housing cost per unit value of land, \( I \) is household expenses, and \( x \) is the annual average proportion of land sold.

The third term in (1) is proportional to land price and is assumed to be positive following asset taxation based on land price. The second term is the income from selling small plots of land to help sustain the household. The land sold is averaged by the length in years of the farm’s planning horizon (e.g., until the next inheritance). For farmers who intend to remain in agriculture, this term (i.e. \( \gamma \)) should be minimized. The third term is agricultural income and the last term is housing cost proportional to land price \( CP \) and general household expenses \( I \). The housing cost is composed of annual fixed asset taxes and the annually averaged inheritance tax on an owner’s farmhouse and workspace, both of which are exempted from preferential treatment. Although the inheritance tax rate is progressive, the annualized total tax from the fixed asset tax and the inheritance tax can be linearly approximated by land price. The area required for a farmhouse and workplace is assumed to be the same in different locations. For example, most farmers tend to live in farmhouses that need relatively large sites, even following urbanization (Pfeffer, 1989). The average area on a farm used for neither agricultural nor business use was 941 m² in the three major metropolitan areas (National Chamber of Agriculture, 2009).

Consider first the case without real estate income. The condition under which a farmer can sustain his household with no property sold (\( \gamma = 0 \)) is:

\[
aRA - (CP + I) \geq 0
\]

(2)

Under this condition, the farm has to cover all outgoings using agricultural income. If land price \( P \) increases, then agricultural income \( RA \) also needs to increase, which may be difficult for many suburban farmers.

Now, we examine the case with real estate income. By solving (1) for \( \gamma \), we obtain:

\[
\alpha \leq (sPA - \gamma xPA + \gamma xPA - CP - I)/(sPA - RA) = \gamma
\]

(3)

Denote \( \alpha^* \) as the maximum of \( \alpha \), which indicates the largest proportion of agricultural land that the household can sustain. By partially differentiating \( \alpha^* \) with respect to land price \( P \) with \( \gamma = 0 \) (no property sold), we obtain:

\[
\partial \alpha^*/\partial P = (CR + s(I - AR))/(R - sP)^2 \gamma
\]

(4)

The denominator of (4) is clearly positive. The sign of the numerator is still ambiguous and depends on productivity and land size, \( R \) and \( A \). Because \( CR \) is a positive value and the potential agricultural income \( AR \) is usually relatively low compared to household expenses \( I \), the numerator tends to be positive in suburban farms. In such a general case of positive gradient \( \alpha^* \) on \( p \), farmers can own a higher proportion of farmland in urban areas in which land prices are high and land can be used to generate real estate income.

In a similar vein, the partial derivative of \( \alpha^* \) with respect to agricultural productivity \( R \), with \( \gamma = 0 \), is expressed as:

\[
\partial \alpha^*/\partial R = (sPA - CP - I)/(sPA - RA)^2 \gamma
\]

(5)

Again, the denominator of (5) is positive but the numerator is ambiguous. When the numerator is positive, household income can only be sustained by supplementing it with real estate income \( sPA \). In this case, higher agricultural productivity \( R \) contributes to an increase in \( \alpha^* \) and more farmland can be retained. In contrast, the case of a negative numerator arises when \( P \) and \( A \) are small. In this situation, unless agricultural income is high enough to sustain the household without real estate income, the farmer has to sell land. Therefore, a positive gradient of \( R \) to \( \alpha^* \) (and vice versa) is conditional on generating sufficient real estate income.

Finally, the partial derivative of \( \alpha^* \) with respect to land area \( A \) with \( \gamma = 0 \) is:

\[
\partial \alpha^*/\partial A = (CP + I)/(sPA - RA) \gamma
\]

(6)

The numerator is clearly positive and the denominator is usually positive because \( sP \) is generally greater than \( R \). The gradient of \( \alpha^* \) on \( A \) is thought to be positive; that is, owning more land means that farms can retain a larger proportion of their land.

Using this examination of farmers’ behavioural conditions, we are able to assume that farmers can own more land in urbanized areas in which land prices and potential real estate incomes are high. In areas of lower land prices, farmers must increase agricultural productivity or sell land in order to maintain their households. In the following section, we report on an empirical study that investigates the observed behaviour of a group of suburban farmers.

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2 When profits before taxes, profits after taxes, and the tax rate on the total land value are \( R_p, R_s \) and \( t \), respectively, the tax per area is \( tP \) and the profit after tax is written as \( R_s = sP - (R_s - CP) \). Solving each side for \( P \), we obtain \( P = R_s/(s + t) = R_s/s \). Therefore, \( s \) is defined as a proportional return ratio, after taxes, to the land price considering the impact of the asset taxation ratio \( t \).

3 For example, \( x = 30 \) when land is sold every thirty years, such as at the time of an inheritance. This coefficient can be ignored because we examine the condition \( \gamma = 0 \).

4 Note that the components of the numerators in Eqs. (3) and (5) are identical. The former is negative if the latter is negative and \( \gamma = 0 \). The denominator of Eq. (3), \( A(sP - R_s) \), is positive unless \( R > sP \), which is uncommon in the suburbs. Therefore, the probable condition for \( \alpha > 0 \) is \( \gamma > 0 \).
people/km² (2010). The county in California in the United States is San Francisco County, with a density of 6,633.

increased to 55%, which is larger than the national average (4% in

is roughly similar to other large cities such as Shanghai, Beijing,
Presents the maximum area of farmland owned: however, some farmers

MP, located approximately 10

Higher residential land prices. Despite a high population density,6

Table 1

<table>
<thead>
<tr>
<th>City</th>
<th>Distance from central Tokyo (km)</th>
<th>Population density (population/km²)</th>
<th>Mean residential land price (JPY/m²)</th>
<th>City area (km²)</th>
<th>Area of farmland (ha) (% of city area)</th>
<th>Area of PGL (ha)</th>
<th>Number of farm household (household)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Musashino</td>
<td>12.2</td>
<td>12,929.5</td>
<td>499,500</td>
<td>10.73</td>
<td>31.7 (3.0)</td>
<td>27.8</td>
<td>61</td>
</tr>
<tr>
<td>Mitaka</td>
<td>13.8</td>
<td>11,277.8</td>
<td>373,500</td>
<td>16.50</td>
<td>158.9 (9.6)</td>
<td>143.5</td>
<td>204</td>
</tr>
<tr>
<td>Koganei</td>
<td>18.8</td>
<td>10,490.0</td>
<td>309,300</td>
<td>11.33</td>
<td>73.9 (6.5)</td>
<td>66.0</td>
<td>93</td>
</tr>
<tr>
<td>Kokaubuji</td>
<td>21.1</td>
<td>10,590.6</td>
<td>273,000</td>
<td>11.48</td>
<td>151.3 (13.2)</td>
<td>129.7</td>
<td>158</td>
</tr>
<tr>
<td>Kodaira</td>
<td>22.6</td>
<td>9,141.5</td>
<td>220,000</td>
<td>20.46</td>
<td>197.8 (9.7)</td>
<td>174.4</td>
<td>215</td>
</tr>
<tr>
<td>Hino</td>
<td>30.5</td>
<td>6,540.2</td>
<td>183,400</td>
<td>27.53</td>
<td>167.1 (6.1)</td>
<td>118.7</td>
<td>150</td>
</tr>
</tbody>
</table>

Note: The distance from central Tokyo is calculated as the distance by rail from Shinjuku terminal to the main station of each city. The source of population density statistics is the National Population Census (2010), and the Area of farmland and Area of PGL are provided by the Tokyo Chamber of Agriculture (2015), the number of farm households is from the Census of Agriculture and Forestry (2015), and land prices are from the Public Notice of Land Price (2016). Average currency rates were 105.9 JPY/USD and 121.0 JPY/USD in 2014 and 2015, respectively.

2.2. Empirical approach

2.2.1. Study site

Tokyo is a city in the phase of no- or low-growth and, like a number of other large OECD cities, its rate of population increase has begun to slow down (Sorensen and Okata, 2011). Another demographic feature of Tokyo is the extent to which its population is distributed across the surrounding suburban areas. As a consequence of rapid urban expansion in the previous century, urban sprawl has proceeded rapidly and a substantial area of farmland can be found close to residential land. The population density of the Tokyo urban area (which includes large areas such as the Tokyo, Kanagawa, Chiba and Saitama prefectures and parts of Gunma, Tochigi and Ibaraki prefectures) is 4400 people/km², which is roughly similar to other large cities such as Shanghai, Beijing, Bangkok, Ho-Chi-Minh and London (Cox, 2016).

Within Tokyo’s suburbs farmers undertake a wide range of diversified agricultural activities. Around 39% of farmers in the Tokyo MP had adopted direct marketing channels by 2000 and this has now increased to 55%, which is larger than the national average (4% in 2000 and 17% in 2015).2

Our study site comprises six cities in the western region of Tokyo MP, located approximately 10–30 km from Tokyo city centre (Shinjuku terminal). These cities have developed as commuter areas since the 1950s. Table 1 summarizes the general statistics of the study area. Being closer to central Tokyo implies higher population densities and higher residential land prices. Despite a high population density,6 substantial areas of farmland remain and these account for approximately one tenth of the total city area. Most of these farmland plots are designated within the UPA and a heavy asset tax is incurred on the land, with the exception of any that is PGL. Several hundred commercial farm households’ exist in each city. As a response to increasing urbanization many of these farms have turned away from the wholesale market and now sell fresh produce directly at the farm gate.

2.2.2. Empirical model

The focus of this study is to examine the behaviour of farmers who continue to engage in agriculture in suburban areas. Some problems arise in the empirical application of the formulation of the maximum farmland ratio αT, as discussed in the previous section. This ratio represents the maximum area of farmland owned: however, some farmers may prefer cash in hand to retaining a larger area of agricultural land, even if they do not aim for profit maximization. Another point is that, given this static formulation, we cannot judge the timing or frequency of development on an individual farm. The need for money should differ according to family lifecycle and, hence, by farm. In terms of empirical applications, acquiring reliable information about family expenses is very difficult. However, we can assume that some farmers will have a preference for continuing to farm, while others will wish to sell their land. Therefore, our empirical model can be operationalized by a stochastic formulation: variables based on the corresponding theoretical assumption are summarized in Table 2.

We assume that the probability that farmers will continue to engage in agriculture, Prob(Y = 1), can be formulated as the following logistic expression:

\[ \text{Prob}(Y = 1) = \frac{1}{1 + \exp(- (\beta_0 + \beta_1 \text{RealEstateHH} + \beta_2 \text{Density} + \beta_3 \text{SalesPerArea} + \beta_4 \text{AREA} + \beta_5 \text{Diversity} + \beta_6 \text{Greenhouse} + \beta_7 \text{Fruit} + \beta_8 \text{City} + \beta_9 \text{CXAreaREHH} + \beta_{10} \text{CXSalesPerAreaREHH} + \beta_{11} \text{CXDensREHH}))} \]  

(7)

where \( \beta_i \) are parameters to be estimated.

RealEstateHH is a dummy variable that indicates whether or not farm households primarily rely on real estate income from rental properties, i.e. where real estate income accounts for at least half of household income. Opportunities for speculation in land sales may hasten a commercial farmer’s departure from agriculture (Adelaja et al., 2011; Edelman et al., 1999; Lopez et al., 1988). In contrast, hobby farmers are assumed to prefer to maintain levels of agricultural land (Stobbe et al., 2009). Another recent empirical result suggested that landowner characteristics have no relation to the conservation of agricultural land (Erickson et al., 2011). As in the previous section, we assume that farmers’ behaviour in continuing to engage in agriculture differs depending on their dependence on real estate. To operationalize this assumption, we include interaction-term variables (those with names starting with CX) of RealEstateHH with the following three variables: Density, SalesPerArea, and Area.

Density is the natural log of the population density of a farm’s location. We use small area data from the Population Census, which records the population of each city block. Population density is an
indicator of urbanization and is adopted as a proxy for the market land price of the surrounding area. If farmers aim to maintain income levels, as discussed in the previous section, they can retain more agricultural land where land prices are high and which offer good real estate incomes. Hence, we assume a negative sign for Density and a positive sign for the interaction-term \( CXDensity_{REHH} \).

SalesPerArea is annual agricultural sales per farm area and is considered to be a proxy for agricultural productivity, although the impacts of productivity in previous studies remain ambiguous. Several empirical studies concluded that the presence of productive farmland supports the maintenance of agricultural land (Adelaja et al., 2011; Lynch and Lovell, 2001), whereas other studies found no such relationship (Hite et al., 2002; Towe et al., 2008). Our assumption is that farmers with real estate income can continue to farm provided that they have sufficient agricultural income and, hence, a positive sign is expected for the interaction-term \( CXSales_{AREAHH} \).

Area is the farmed area of each holding, including PGL. Our earlier discussion defined the total area of land owned to include any real estate property that is rented out, however, the latter can be assumed to be relatively small compared to the area of agricultural land and data on its extent is hard to obtain. Rental farmland is also uncommon in high land price areas given the exemption of rental PGL farmland from the preferential treatment of inheritance taxes. In previous studies, farm size was found to be a positive factor in encouraging farmers to remain in agriculture (Kimhi and Bollman, 1999). We assume, therefore, that the expected impact of farmland area is positive.

Diversity is an index of the diversification of distribution channels. The diversification index is defined as \( 1 - (\frac{\sum q^2}{\frac{n(\sum q)^2}})^{0.5} \), where \( q \) is the proportion of each distribution channel (Calas and Mahendrarajah, 2005). The number of distribution channel options is twelve, namely, attended farm gate stand, non-attended farm stand, communal farmers’ market, wholesale market, consumer cooperatives, school lunch, retailers, parcel delivery, catering industry, farm experience service, farm admission, and miscellaneous. To persist in the face of urbanization, farmers need to adapt and diversify (Heimlich and Anderson, 2001; Heimlich and Brooks, 1989; Hoppe and Korb, 2001), sell directly to consumers (Eagle et al., 2015; Inwood and Sharp, 2012) and be innovative (Adelaja et al., 2011). Most traditional farmers have not diversified, while farmers who have diversified had adapted their enterprises in response to urbanization. Hence, such practices are thought to be a positive factor for continuing in agriculture.

An additional three dummy variables for farm and regional characteristics were also included in the models. Greenhouse is a dummy for farms whose major agricultural sales are from greenhouse vegetables, and Fruit is a dummy variable for those farms who specialize in fruit. Previous studies have shown that land used for horticulture within developed areas has increased in value (Marin, 2007), while fruit farmers have been found to have a greater tendency to continue in agriculture (Kimhi and Bollman, 1999). Finally, the dummy variable CityHino indicates holdings in Hino City, which is more distant from the centre of Tokyo than the other five cities.

Three different dependent variables are defined for the logit models. \( Y_{ContinueAg} \) indicates future continuity of agriculture for the household. Farmers were asked whether or not they think that their land will continue to be farmed in the future, either by their children or other successors. \( Y_{DecreasePGL} \) is the decrease in PGL area on the farm and is derived by asking about historical sales of land (over the last ten years) and the future (over the next ten years) likelihood of a decrease in the area of PGL. For this model, an ordered logit estimation is applied by expressing three levels of decrease in PGL (\( Y = 0 \) if no decrease, \( Y = 1 \) for a decrease in area either in the past or in the future, and \( Y = 2 \) if there is both a past and a likely future decrease in area). The expected sign for this model should be reversed because it obviously shows discontinuity. Finally, \( Y_{increasedSales} \) indicates whether or not farmers have stated that agricultural sales are increasing (\( Y = 1 \) if increasing). These three models are used to indicate the difference in the time horizon for the continuity of farming and to improve understanding of farmer behaviour and intentions.

### 2.2.3. Data

The empirical data were collected using a questionnaire survey conducted in 2014 through the help of regional agricultural cooperatives (JA Tokyo Musashi and JA Tokyo Minami). We asked these cooperatives to distribute questionnaires to all members of the youth and middle-age sections of each cooperative. These organizations include relatively active farmers who were thought to be suitable for investigating the continuity of farming in the suburbs. A total of 498 questionnaires were distributed, of which 170 (34.1%) were returned. After the data cleaning process, data from 138 questionnaires were available for estimation.

Table 3 compares the distribution of respondents with the Census data for the same cities. This shows that the distribution of farm size in the sample is similar to that found in the study area. Most farms are small, with an area of less than 1 ha and this is characteristic of agricultural land in the suburbs. In terms of sales, slightly more farms in the sample were found to have adopted strategies such as direct marketing or charging visitors for admission.

The frequency of dependent variables is shown in Table 4. Respondents who stated that their farms are likely to continue in agriculture accounted for only 28% of the sample (\( Y_{ContinueAg} = 1 \)). Other respondents believed that their farms would not continue or were uncertain about their future. Regarding a decrease in PGL farmland, 54% of respondents answered that their area of PGL land had already decreased or was expected to in the future (\( Y_{DecreasePGL} = 1 \)). Furthermore, 18% of respondents answered that their PGL area had decreased and was likely to decrease further in the next ten years (\( Y_{DecreasePGL} = 2 \)). These results indicate that the remaining agricultural land still faces the threat of conversion to other uses. Finally, two-thirds of respondents have experienced increases in agricultural sales (\( Y_{increasedSales} = 1 \)). The independent variables are summarized in Table 5.

The high mean value (0.79) of RealEstateHH indicates that many farmers in the sample have a greater reliance on real estate income than on earnings from agriculture. The area farmed (Area) is 64.5 a on average with a maximum holding size of 3.45 ha. Regarding agricultural productivity (SalesPerArea), a range of data exists from farms with no sales to one farm with sales of 1.47 million JPY/a. Most
farmers, cannot obtain rents from agricultural land equivalent to the potential rent available from residential use. For example, assuming a 50% margin on sales and a conservative discount ratio of 2%, capitalized land prices for the sample average were calculated at 19,505 JPY/m², which is much lower than that of residential land prices (Table 1). Some diversified farms engage in related activities, such as direct marketing at the farm gate, communal farmers’ markets, mail order, supplying schools, or providing farm-based tourism. In our sample, greenhouse farmers accounted for 19% and fruit farms for 16% of the sample, respectively.

3. Empirical results and discussion

3.1. Estimated results and discussion

Table 6 summarizes the results of the logit regression for the three dependent variables. The goodness of fit of the models is acceptable and approximately three-quarters (73.9% and 78.1%) of the dependent variables were correctly predicted in the two binominal logit models. In terms of the ordered logit model, a lower prediction ratio (50.7%) can be justified because predicting the exact rank is more difficult than a simple logit estimation, and the chi-square statistic was significant at the 10% level. At least three variables were significant in each model (at the 10% level or lower). These significant variables are considered important in the context of our assumptions. A detailed discussion of the results is provided below.

3.1.1. Dependence on real estate income

Being reliant on real estate income (RealEstateHH) had a negative impact on the continuity of agriculture. This result is consistent with previous studies that found that speculation in real estate tended to cause farmers to leave farming (Adelaja et al., 2011; Edelman et al., 1999; Lopez et al., 1988) and that non-operator landowners or hobby farmers were reluctant to improve their farmland (Gottlieb et al., 2015). In contrast, other research has found that hobby farms were more likely to maintain areas of farmed land (Stobbe et al., 2009). In

Note: Significance ***1%, **5%, *10%. First row’s constant term of Ordered Logit is for dependent Y = 1, second row is for dependent Y = 2.
the following subsections, we examine how real estate income combines with other factors in influencing the continuity of farming in the suburbs.

3.1.2. Population density

The population density of surrounding areas (Density) was negative and its interaction term with real estate income (CXDensREHH) was positive for the continuing agriculture model. Therefore, the combined magnitude is positive \((-6.327 + 7.964)\) for farms with a high dependence on real estate (RealEstateHH = 1) and negative for other farmers. The finding that the relationship between continuity of agriculture and population density depends on whether or not farms rely on real estate is noteworthy. The point where the probability of continuing agriculture is the same, regardless of dependency on real estate income, can be calculated using estimated parameters and mean values of independent variables. In terms of population density such a point is reached at densities of 9845 people per km\(^2\) which can be observed around the municipality border of Kokubunji and Kodaira. This location is some 22 km from Tokyo city centre and the land price\(^8\) is around 250,000 JPY/m\(^2\). In more densely populated locations, farmers are likely to receive enough real estate income to cover their housing costs and can therefore continue agriculture. In suburbs further from the centre, a high dependence on real estate income does not lead to agricultural sustainability. In summary, higher levels of urban development provide opportunities for farmers who depend on real estate income to retain more farmland. This result is an important confirmation of our assumption. In the other models, there is no relationship between population density and either a decrease in PGL farmland or an increase in sales. Population density, as a proxy for land price is considered to have a long-term effect, and may result in intergenerational continuity.

This result challenges findings from previous studies which have argued that conversion is more likely to occur in farms close to the city (Adelaja et al., 2011; Edelman et al., 1999; Lopez et al., 1988; Towe et al., 2008). However, other research has found the opposite result (Hitte et al., 2002). Indeed hobby farmers have been found to prefer farmland near to the city (Stobbe et al., 2009). These results suggest that farmers close to the city centre are likely to remain in farming as long as they continue to generate a sizable real estate income under the preferential tax conditions currently offered for PGL (Fernandez-Cornejo et al., 2005; Mishra et al., 2002).

3.1.3. Agricultural output

In model 3 agricultural productivity (SalesPerArea) was found to have a negative influence on increasing sales. However, the combined magnitude with the interaction term (CXSalesPAREHH) was positive \((-0.279 + 0.336)\) for farms that were dependent on real estate income and negative for other farms. This result indicates that productive farms can use real estate income to support an increase in their agricultural sales, a similar result to that observed by Fernandez-Cornejo et al. (2005).

Previous studies (Adelaja et al., 2011) found that innovation and adaptation to urbanization (Heimlich and Brooks, 1989; Hoppe and Korb, 2001) were important if agriculture was to persist. Other empirical studies have shown that farmland productivity and soil quality had no relationship with persistence (Hitte et al., 2002; Towe et al., 2008). Our result implies that reliance on agricultural intensification is not itself sufficient to increase agricultural revenues to a level that supports the conservation of farmland in the suburbs. Diversification is required to achieve such goals as discussed below.

\(^{8}\) Assuming 2\% (5,000 JPY/m\(^2\)) of real estate income after tax, 1,000 m\(^2\) of rental property will earn an annual income of 5 mil JPY. Housing costs on such land for an average farmhouse with associated facilities area is calculated to be around 1.5 mil JPY. In this case, a minimum annual income level of 3 mil JPY would be required to cover living expenses.

3.1.4. Farmed area

In model 2, the area farmed (Area) was found to be positively related to a decrease in PGL farmland. In combination with the interaction term (CXAreaREHH), a negative impact (0.019–0.024) was indicated for farms dependent on real estate income. This result is consistent with our assumption that farmers with good real estate income can retain farmland. Given lower real estate income, farmers with a large area of land were assumed to be likely to sell off their properties. A previous empirical study suggested that farm size positively influenced the continuation of family farms (Kimhi and Bollman, 1999). Their survey in Canada and Israel included rural samples. In contrast, surveys focusing on suburban farms in the US (e.g. Adelaja et al. (2011)) did not indicate a clear relationship between farm size and continuity. Another study that indicated a link between development and plot size rather than farm size (Towe et al., 2008) is consistent with our ideas that farmers with a large area of land but less real estate income were likely to convert their land to maintain household incomes.

3.1.5. Farm type

Finally, the level of diversification in a distribution channel (Diversity) was significant among dummy variables related to farm type. Other farm-type variables were not significant. Diversification was positively related to a decrease in PGL farmland, and to an increase in agricultural sales. This result implies that while diversification contributes to an increase in sales, it cannot stop a decline in the area of agricultural land over time. Regarding the agricultural continuity model, diversification was not significant (P = 0.11) but had a positive sign. Previous studies suggested that small intensive (Heimlich and Anderson, 2001; Heimlich and Brooks, 1989), innovative (Adelaja et al., 2011), and adaptive farms (Hoppe and Korb, 2001) that distributed their products directly to consumers (Inwood and Sharp, 2012) could persist in the face of urbanization. According to a survey to farmers in Scotland and Sweden, diversification within agriculture was not necessarily significant for long term viability but having multiple income sources, including rental property, significantly contributed to farm viability (Barnes et al., 2015). Our results support the concept that small farms can increase their sales in suburbs through diversification even following a reduction in farm area and that such adaptations contribute to persistence.

3.2. Discussion and policy implications

Our theoretical framework and empirical application rely on several assumptions. Based on our objectives, we focus on those farms that do not expect an increase in land prices and hence prefer to retain land rather than speculating in real estate to gain short-term profits. This is different from the more speculative behaviours that can be observed in some cities, particularly in developing countries, experiencing rapid population growth and associated increases in land prices. Some instances of urban sprawl may be related to the illegal occupation of land (Sorensen and Okata, 2011). Such activities have not been considered in this research. Our empirical results, however, give some guidance for land use policy in the developing phase where many farmers may continue to farm even though conversion to other land uses may be more profitable. In order to better manage the expansion of urban areas, other policy tools, such as zoning, to promote diversified land use, and the conservation of suburban farmland, should be used, alongside more conventional economic incentives.

Another important assumption of our study is that of relatively high real estate incomes and housing costs for farm households compared to agricultural incomes under conditions of preferential tax treatment for farmland. The fixed asset tax ratio (including a city planning tax of 0.3%) is 1.7% of the real estate assessment value. The inheritance tax ratio is progressive by the inherited value, up to a maximum ratio of 55%. For example, a 1 ha farmland plot valued at 200,000 JPY/m\(^2\) is
subject to either approximately $8 million JPY of an annual fixed asset tax for non-PGL (farmland ratio is still less than the normal ratio) or $40,000 JPY for PGL. For the same land plot, the inheritance tax amount is calculated as approximately 0.8 billion JPY for non-PGL (2.5 million JPY for PGL). For comparison, the lifetime wage for a Japanese male university graduate is approximately 0.25 billion JPY. Generally, inheritors need to dispose of land to pay their taxes if they hold non-PGL land and have not saved any real estate income. If zoning policy had successfully prevented urban sprawl and land price was lower, such situations would not be common. We also assume that farmers prefer to stay in the same location rather than move. In a highly mobile culture, where farmers can choose to move to rural areas to acquire more land, they could avoid paying higher housing costs and still continue to farm. More detailed qualitative investigations are required to provide further evidence on farmer behaviour and preferences around land and income.

Our investigation enables some policy implications to be presented. As in other developed countries, Japanese urban farmland conservation policy (i.e. PGL) and preferential taxation are strongly linked. These policies must be reconsidered in the face of shrinking suburbs. Based on our results, the relationship between the likelihood of continuing in agriculture, location and reliance on real estate income reliance is depicted in Fig. 2.

In the inner suburbs close to the urban core, farmers can still rely on real estate income and continue to farm. In many cases the contribution made by agricultural activities to household income is low and the decision to remain in agriculture is linked to the utility of retaining farmland rather than on agricultural income. Although these farmers are continuing to farm, future generations may have different preferences. Therefore, clear restrictions over the development of agricultural land may be required to ensure that this land and the non-productive values that it generates are retained. Because the maintenance of agricultural land in populated areas is based around a reliance on real estate income, imposing a heavy tax on residential property simply increases the cost of living and results in a reduction in farmland as land is sold or converted to other uses to generate income. As an alternative, tax reductions on farmhouse sites, perhaps in return for public access or the protection of traditional farming practices, are worth considering.

Between inner and outer suburbs as shown in Fig. 2, there is a transitional ‘hotspot’ where a more focused land use strategy is required. The further a farm is from the city centre, the less income can be generated from real estate. There are areas where farmers cannot rely on those income sources to sustain their households. Further declines in suburban populations are expected to lead to a more severe impact on agriculture. Those who once relied on real estate income may no longer be able to rely on it. Land owners cannot usually decrease levels of residential supply and a considerable amount of time may be required to achieve optimal land use. In the worst case scenario, land use becomes fragmented which leads to a decline in the social values that these green spaces offer to residents (Haase et al., 2012). As a solution to some of these problems Schilling and Logan (2008) recommends a local strategy that promotes the regeneration of vacant buildings and the creation of green space.

4. Conclusion

By converting their land into real estate and leaving farming before land prices decline, farm owners exhibit profit maximizing behaviour. However, many farmers continue to farm and do not sell their land even when faced with declining land prices. This tendency supports the argument that there is a subjective value to owning farmland (Lynch and Lovell, 2001; Rilla and Sokolow, 2000). Our theoretical formulation indicates that such a behavioural difference is probably caused by individual preferences rather than individual characteristics linked to profit maximization. We demonstrated that if farmers wish to maintain the farm household, then those with real estate income tend to retain more land in areas with higher land prices. Most farm households have lived in the area prior to urbanization and are argued to react conservatively to land price fluctuations and convert primarily for motives of household sustainability. The assumption that any farmers remaining in an area after urbanization have a similar tendency to continue farming is reasonable.

This assumption becomes convincing following our empirical study of the behaviour of active farmers in the western part of Tokyo MP, and the following findings were derived from our empirical results. First, the relationship between continuing agriculture and population density is dependent on the presence of real estate income. Farmers who are strongly dependent on real estate income tended to continue farming in more populated areas, whereas those who were less dependent on this income source showed a high probability of continuing to farm in less populated areas. Second, sales increases were achieved by intensive farmers with real estate income, whereas farmers without real estate income were unable to increase sales through intensification. This result suggests a positive effect of off-farm income on agricultural productivity and sales. Third, relatively large farms could maintain both agricultural and real estate income, whereas large farms faced a reduction in agricultural area if real estate income was inadequate. Although diversification contributed to an increase in sales, it also had a significant relationship with reductions in agricultural land. This suggests that small farmers who sold farmland could increase sales through diversification and continue farming.

Although our sample farms did not include new entrants to farming from non-farming backgrounds, such individuals should be encouraged and can be found in the outer suburbs of the Tokyo MP. Generally, the preference of these individuals is to continue agriculture, rather than engage in land speculation or real estate management (Inwood and Sharp, 2012). Less populated areas in the suburbs could be marketed as being particularly suitable for new entrants into farming due to their lower housing costs.

References


One way to promote suburban agriculture is to encourage diversification even in small farms (Ilbery, 1991; Jongeneel et al., 2008; Stobbe et al., 2010; Zasadzinski, 2011). Increases in farm size may lead to an increase in farm income through permitting additional land to be rented. However, at present such strategies do not seem to be sufficient to ensure the long-term persistence of agriculture in the suburbs.

Another option is to reduce housing costs where real estate and agricultural income cannot cover them. One way of achieving this is to reduce the area of land used for owners’ houses, gardens and workshops because such land is excluded from preferential tax treatment.


