Spatially Varying Impacts of Farmers Markets on Agricultural Land Use

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Abstract

Forming part of the locavore movement, farmers markets are attracting a considerable number of citizens worldwide in recent years. While previous studies have extensively explored consumer preferences for this form of direct marketing, few have paid a close attention to their effect on agricultural producers' behaviours. Using a dataset from Chiba Prefecture in Japan's eastern region where the locavore movement is highly active, we investigate how producers alter their cropping patterns, particularly from grain production to vegetable production, when a new farmers market is established in their neighbourhood. At the same time, we also attempt to identify the degree of spatial diversity of such an impact, under a conjecture that the magnitude of the impact varies greatly depending on the area's biophysical and socioeconomic conditions. To achieve these dual goals, we propose a novel combination of the geographically weighted regression with the difference-in-differences analysis, so that the coefficient of interest, the treatment effect, is estimated individually for each observation in the sample. The results show that at the sample median new opening of a farmers market increases the proportion of vegetable farms in its neighbourhood by 0.8 percentage points, although this effect can be as large as 5.2 percentage points in certain areas within the prefecture. The ability to geographically differentiate high-impact areas from low-impact areas can potentially contribute to efficient policy designs, and hence the reduction in public expenditures.

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Considered by many as a means to lead a healthy and environmentally sustainable lifestyle, the locavore movement is attracting citizens worldwide in recent years. Various channels of alternative food networks, defined as direct or nearly direct transactions between agricultural producers and consumers, are increasing both their market share and their standing in the society (Renting, Marsden and Banks 2003). Local food restaurants, roadside food stands, mail order services offered by farms, and community supported agriculture are all examples of such a movement.

Among all alternative marketing channels, arguably one of the most important is farmers markets, where urban and rural consumers alike can purchase fresh agricultural commodities, most commonly vegetables, fruits and dairy products, straight off farms. According to a USDA survey, an average vendor at a farmers market in the United States sells approximately $12,000 worth of their products annually (Payne 2002), while another study estimates that 25% of vendors use farmers markets as a sole outlet for their sales (USDA 2006). The benefit trickles down to wider communities as well: farmers markets in Iowa, Oklahoma and West Virginia are estimated to generate $31.5 million, $5.9 million and $2.4 million, respectively, to the state economy each year (Hanneberry, Whitacre and Agustini 2009; Hughes et al. 2008; Otto and Varner 2005).

It has also been reported that farmers markets have a positive effect on local employment opportunities and human capital development (Brown and Miller 2008), although some suggest that the existence of such unquantifiable benefits of farmers markets is debatable (Smithers and Joseph 2010).

Outside of these studies to derive economy-wide impacts, the preceding works on farmers markets are primarily confined to consumer studies. The topics of these studies include the characteristics of shoppers who prefer farmers markets to conventional outlets (Zepeda 2009), the characteristics shoppers seek in farmers markets (Elepua and Mazzocco 2010; Wolf, Spittler and Ahem 2005), determinants of per shopper spending at farmers markets (Hunt 2007), the price premium the shoppers are willing to pay at farmers markets (Onken, Bernard and Pesek 2011), the relationship between a consumer's preference for local food and that for organic food (Pugliese, Zanasi and Oussama 2013), and the effect of farmers market attendance on consumer preference for quality (Pascucci et al. 2011). Collectively, they offer invaluable information to both market vendors and market managers, which is used to design market operation manuals (Ostrom and Lyon 2012). A few other works complement these consumer studies through institutional designs, for example in terms of the location selection (Berning, Bonano and Etemaadnia 2013) and the rules of market operations (Zheng and

Kaiser 2013).

On the other hand, microeconomic research on farmers markets from the producers' perspective are few and far between. To the best of the authors' knowledge, they are mostly limited to econometric studies investigating the determinants of vendors' sales values on the market day, in which the population around the market, their per capita income and proactive marketing activities are all shown to possess a positive impact on producers' revenue (Brown et al. 2007; Varner and Otto 2008). Importantly, very few studies examine the impact of farmers markets on farming decisions, that is, agronomic consequences induced by their existence, such as how producers alter their cropping patterns when a new farmers market is established in their community. Thus, Brown (2002), the most comprehensive review to date of farmers market research, concludes unreservedly that "studies linking farmers' markets to changes in land-use patterns have not been found" anywhere in the literature.

The objective of the present study is to evaluate the impact of newly opened farmers markets on the land use decisions made by agricultural producers in their vicinity. Using a dataset from eastern Japan where the locavore movement is highly active, statistical tests are conducted to investigate whether there has been a shift in land use from grain production to vegetable production following the recent establishment of new and often lucrative farmers markets. In so doing, we follow the standard procedure of program evaluation (Khandker, Koolwal and Samad 2010) and try to estimate the effect of the treatment on the treated (TT).

At the same time, we also attempt to identify the degree of spatial variability of such an impact. This is because most program effects in the real world are confounded and vary among observations, whether or not the sources of this variability are detectable by researchers (Todd 2007). While the estimation of these heterogeneous effects requires additional estimation techniques (Xie, Brand and Jann 2012), we consider this as a necessary procedure to fulfil our purpose because, in agriculture, producers' decisions related to land use are heavily influenced by the area's biophysical and socioeconomic conditions and because, in turn, these conditions are widely diverse within the geographical scope of our investigation. Indeed, it has been suggested, albeit descriptively, that the performance of farmers markets depends considerably on their geographical locations (Lawson et al. 2008; Ricketts, Illbery and Kneafsey 2005).

In order to achieve these dual goals, we propose a novel combination of the geographically weighted regression (Fotheringham, Brunsdon and Charlton 2002) with the difference-in-differences analysis (Wooldridge 2008), so that the coefficient of interest, the magnitude of the impact of an exogenous shock, is estimated for each observation within the sample. In the present case, this coefficient corresponds to the increase in the proportion of vegetable producers in the local community that is attributable to the opening of a new farmers market.

The reminder of the article is structured as follows. The next section details the dataset and the statistical methods used in the present study, together with theoretical justifications to employ them. It is then followed by the summary of the estimation results and an in-depth discussion on their interpretation. The final section concludes the article with policy implications of the study.

Material and Methods

This section outlines the dataset and the statistical methods employed in the analysis.

Data

The dataset in the present study covers the entire jurisdiction of Chiba Prefecture in Japan’s eastern region. Chiba is one of the most geographically, agronomically and socioeconomically diverse prefectures in the country, where urban-fringe agriculture near the prefectural border with the adjacent national capital, Tokyo Metropolitan District, and large-scale crop and livestock production systems on the Boso Peninsula in the prefecture's far south coexist. We purposely selected this prefecture because it was one of the earliest adopters of the locavore movement in the country and therefore has a well-established culture of farmers markets (Kimura and Nishiyama 2008), and because its diversity makes it an ideal site to study spatially varying impacts on farming practices induced by an exogenous change in the production environment (Sato et al. 2013). Under temperate climate conditions with the average temperature of 16.0 °C and annual precipitation of 1,726 mm, Chiba has a population of 6.1 millions spread across its 5,156 km^2 territory. The prefecture's agricultural GDP of JPY 8.7 trillion ($85 billion) is ranked third among Japan's 47 prefectures, mainly owing to its vegetable and milk production.

The analysis was conducted using the community-level panel data on agricultural production primarily compiled from Japan's National Agricultural Census. Conducted every five years and forming part of the FAO World Programme for the Census of Agriculture, the National Agricultural Census collects production-related information from all agricultural producers who at minimum cultivate 0.3 ha of farmland or sell agricultural products worth JPY 500,000 ($ 4,902). The comprehensive nature of this survey minimises the possibility of the selection bias, and offers stark contrast to the US Census of Agriculture which has been criticised for its "notoriously inaccurate" list of producers (Brown 2002). Although farm-level data are concealed for privacy reasons, community-level aggregates are publicly available, and these are utilised in the present study. Typically, a community in Chiba Prefecture covers a population of around 1,600 people.

The panel dataset was constructed from the 1995 and 2005 editions of the National Agricultural Census. Of 3,738 communities that comprised the prefecture in 1995, 653 were non-farming communities in either 1995 or 2005 (or both), and did not contain any production-related information for the relevant year. Additionally, four communities were split into multiple entities sometime between 1995 and 2005, and therefore lost data continuity. With these communities excluded, the final dataset consisted of 3,081 communities in the balanced panel format. All communities were geocoded.

This dataset on agricultural production was then combined with the spatial data describing the location of farmers markets. Based on a 2007 survey conducted by Chiba Prefecture, the original collection listed the name, the address and the year of foundation for all points of sales that were considered to be part of the alternative food network. In the light of the purpose of the present study, however, privately-owned markets at which general producers cannot freely sell their products, and markets claiming to be specialised in forestry and fisheries products were excluded from our list.

All farmers markets were geocoded using the address. The resultant list reveals that, as of 2005, there were 20 operating farmers markets established in or before 1995, and additional 54 established since (Figure 1). Through personal communications with the prefectural government, we have verified that no farmers market closed down between 1995 and 2005.

Finally, for each of the 3,081 communities contained in the production dataset, the distance between its centroid and the nearest farmers market was computed on the geographical information system (GIS) platform for both 1995 and 2005. Since there was no market closure during the 10-year period, the distance derived for 2005 is either shorter than or equal to that derived for 1995. Table1 provides the summary statistics for this variable in both years. The average distance from a community to the nearest farmers market was about 10 km in 1995. This was shortened by half between 1995 and 2005 because of the opening of the 54 new markets. As a result, the proportion of the communities that do not have a farmers market within, say, 4.5 km decreased dramatically from 72.9% to 25.5 %, making markets more accessible for many producers in the prefecture.

Statistical methods

A 2009 survey conducted by Japanese Ministry of Agriculture, Forestry and Fisheries revealed that about 70% of sales in small to medium-scale farmers markets (defined by the annual revenue of less than JPY 10 million) come from vegetables and fruits (MAFF 2011). According to our interviews of more than 10 market managers located across the region, producers wishing to sell their products in farmers markets usually check in their products in the morning, leave them with the market managers for the day together with a product descriptions sheet (often including information on fertiliser and chemical use), and come back in the evening to recollect items that remain unsold. Unlike their counterparts in the US, of which only 15% have full-time paid managers (Payne 2002), Japanese farmers markets on average hire 7.1 staff members, eliminating the need for producers to stay in the market for the whole day if they do not wish to. Notwithstanding, producers themselves are vendors responsible for their products and entitled to all proceeds sans the sales commission charged by the market operator (Iizaka and Suda 2010). The commission rate is usually between 10% and 20% of the product sales.

Similar to the situations in the rest of the country, the largest alternative to farmers markets to which Chiba producers can sell their agricultural products is Japan

Agricultural Cooperatives (JA), the nationwide producer-owned cooperative. Long playing the role of the wholesale market, JA has an extensive network of local receival centres throughout the prefecture, where producers can sell both grains (mostly rice and wheat) and vegetables at their convenient time. Although producers cannot negotiate their sales price, they face no risk of their products deteriorating unsold, and thus JA receival centres provide a less risky option to them. According to our interviews, the locations of these centres remain largely unchanged since 1995.

Based on these backgrounds, we postulate, under the standard set of assumptions to support the discrete choice model (Train 2009), that the opening of a new farmers market in a producer's neighbourhood has an upward impact on the likelihood that they choose to grow vegetables. The mechanism through which grain growers switch to vegetables is twofold: for those to whom the low price of vegetables was previously the deterrent, the price premium offered at the new farmers market (Onken, Bernard and Pesek 2011) may be attractive enough to change their decisions. For those to whom the high cost of transportation to the then-nearest farmers market was previously the deterrent, the new location may be close enough to make the two daily trips required to trade vegetables there (Durham, Sexton and Song 1996). We also postulate that a portion of agricultural producers original growing vegetables will shift their sales channel from conventional outlets to farmers markets following the opening of the new market, although this alteration does not involve a land use change.

Given our hypothesis, and given the availability of the community-level panel data, an empirically testable reduced-form equation can be expressed as follows:

$$y_{it} = \beta_0 + \beta_1 FM_{it} + \sum \beta_k x_{it}^k , \qquad (1)$$

where y_{it} is the proportion of agricultural producers in community i at time t that grow vegetables as their primary products, FM_{it} is a binary variable representing whether a farmers market exists in the neighbourhood of community i at time t, x_{it}^k $(k = 2,3,\cdots)$ are other external factors that affect producers' choice on crops, and β_0, β_1 and β_k are parameters to be estimated. All estimations were carried out using the difference-in-differences (DID) technique so that the effects of unobservable time-invariant variables are differenced out. Thus, the parameter of interest, β_1, represents the increase in the proportion of vegetable farmers following a market opening in the community's neighbourhood.

The analysis was conducted under a two-stage approach. In the first stage of the analysis, the standard (global) DID models were estimated repeatedly using different criteria to define a community's neighbourhood, hereby represented by the distance from the community's centroid. The purpose of this exercise was to investigate the geographical range of influence that farmers markets possess on producers' behaviour; markets beyond this range are not considered to be part of producers' discrete choice set of sales channels, and thus assumed to be uninfluential. The model fit was used as the benchmark to obtain the appropriate distance.

In the second stage of the analysis, the same DID equation (1), now with the fixed range to define neighbourhood, was estimated *for each community* using the geographically weighted regression (GWR). Briefly, GWR is an expansion of the ordinary least squares regression whereby the regression coefficients are allowed to vary across space. More formally, for the general form equation $\mathbf{y} = \mathbf{x}\boldsymbol{\beta} + \varepsilon$, the coefficient vector for location *i* is given by

$$\boldsymbol{\beta}_i = (\mathbf{y}^T \mathbf{W}_i \mathbf{y})^{-1} \mathbf{y}^T \mathbf{W}_i \mathbf{x}, \tag{2}$$

where $\mathbf{W}_i$ is the weight matrix to express the importance of location $j \neq i$ from location *i*'s perspective. In the present study, $\mathbf{W}_i$ was assigned by the fixed bandwidth with the Gaussian function, with the bandwidth optimised by cross-validation (Fotheringham, Brunsdon and Charlton 2002). These weights act to ensure that, for the estimation of parameters for location *i*, data points near *i* have a larger influence than those farther away. While GWR has been applied to studies from various fields including agricultural production (Cho et al. 2007), consumer studies (Farrow et al. 2007), economic development (Kam et al. 2005), industrial organisation (Cheng and Li 2011), city planning (Partridge et al. 2008) and urban land use (Wang, Kockelman and Wang 2011), its application in program evaluation is novel and, to the best of the authors' knowledge, GWR has not been used elsewhere under the DID framework. We refer to the proposed estimation method as the geographically weighted difference-in-differences (GW-DID) estimation.

For both the first-stage (global) estimations and the second-stage (local) estimations, the dependent variable, the proportion of vegetable farms in the community, was regressed against the same set of independent variables. In addition to the treatment variable, *FM*, three time-variant control variables known to positively affect producers' decision to grow vegetables (Martini and Kimura, 2009) were included: (i) the proportion of farms with farmers 65 years of age or under (suitable for labour-intensive vegetable production vis-à-vis capital-intensive grain production); (ii) the average farm size in hectares (large farms can enjoy the economy of scale more evident in vegetable production rather than grain production); and (iii) the proportion of upland farmland (more suitable for vegetable production compared to lowland area prone to waterlogging) within the total farming area. All variables were expressed in terms of ten-year differentials between 1995 and 2005.

Descriptive statistics for both the dependent and the independent variables are summarised in Table 2. Over the ten-year period, the average proportion of vegetable farms in the prefecture increased from 14.7% in 1995 to 15.2% in 2005. Our hypothetical tests will examine whether or not this increase is attributable to the 53 new farmers markets that opened after 1995.

Results and Discussion

The results of the first-stage analysis are presented in Table 3. When the neighbourhood was defined as the area within a 1.5 km radius from the centre of the community (Model 1), the treatment effect was estimated to be 0.010, suggesting that additional 1.0 % of farmers will turn to vegetable production if a new farmers market is opened in their neighbourhood. The definition of the neighbourhood was then extended to 3.0 km (Model 2), 4.5 km (Model 3) and so on by adding more treatment variables, until the treatment effect for the most recently added "doughnut" showed no statistical significance. This happened with Model 4, where the area between the 4.5 km-radius ring and the 6.0 km-radius ring demonstrated no neighbourhood effect of farmers markets. It is noteworthy that the model fit measured by AIC was also optimised with Model 3, suggesting again that the range of the neighbourhood effect is around 4.5 km from the community centroid.

The results of Model 5, while statistically less efficient that Model 3, also provide interesting information about the decaying mechanism of the neighbourhood effect when the defined neighbourhood area becomes larger. In this model, the treatment effect is shown to slow down gradually as the neighbourhood expands: 1.4 percentage points at 0–1.5 km, 0.8–0.9 percentage points at 1.5–4.5 km, 0.2 percentage points at 4.5–6.0 km (statistically insignificant), and –0.5 percentage points at 6.0–7.0 km (statistically insignificant). This finding is consistent with our postulate outlined in the previous section that the production shift occurs partly because the new market location provides producers with a less costly option to transport fresh vegetables frequently.

Overall, the global DID results indicate that farmers markets have a statistically significant impact to increase the proportion of vegetable producers in a community. Apart from the producers' age, the control variables also showed statistically significant effects with the expected signs.

The results of the second-stage estimations are summarised in Table 4. Compared to the global model, the model fit of the GW-DID equation was considerably better, with AICc improving from –6166 to –6264. The results of the stationarity tests also suggested that the coefficients were location-specific except for that for upland farming area. Overall, the use of the geographical weights seems to be statistically warranted.

Across Chiba Prefecture, the local impact of the opening of a new farmers market ranged widely from –1.7 percentage points to 5.2 percentage points. The distribution of this parameter is somewhat skewed to the left side of the sample, with the peak around zero (Figure 2); Only 45.3% of the communities show local impacts that exceed the global impact (0.98 percentage points). On the other hand, for 21.3% of the communities, the local impact is larger than 2.0 percentage points, more than twice the global effect.

Figure 3 shows the spatial variability of the treatment effect on the prefectural map. Strong effects (larger than 2 percentage points) are observed around the Katori District in the inland north-east (well-known for vegetable production), the northern half of the Western District (closest to Tokyo’s large population), and the Minamiboso District at the southern end of the Boso Peninsula (famous coastal resort). They are followed by the northern half of the prefecture that shows a moderate effect (1.0–2.0 percentage points). In the rest of the prefecture, the coefficient was less than 0.1 and mostly statistically insignificant, demonstrating only a slight impact of new farmers markets.

Overlaying Figure 3 with other biophysical and socioeconomic data gives us useful insights about potential determinants of the local impact at each community. Distribution of four variables previously considered to be related with the success of farmers markets are mapped in Figure 4: population density, distance to the nearest supermarket, soil type and road density. They were extracted from the agricultural database compiled by Sato et al. (2013) although, because of the one-off nature of the database, it is not possible to incorporate these variables into a DID analysis.

Of the four variables, the first two are demand-related. While a large population creates a large demand for fresh vegetables, the existence of alternative shopping options works against farmers markets, as it is unlikely that shoppers travel a long distance purely to purchase groceries (Otto and Varner 2008). The other two variables are supply-related. Here, soil type is expressed in terms of the share of andosols (local volcanic blackish soil) in the community's arable land, an agronomic indicator for the comparative advantage of vegetable production because of the tendency of Japanese rice cultivars to suffer from phosphorus deficiency on this type of soil (Wissuwa and Ae 2001). Road density, on the other hand, is a measure of transportation cost, another critical concern at the crop change given the increased frequency of travel accompanying the production of perishable commodities (Brown 2002).

Table 5 summarises the values of the four variables for the aforementioned three regions with the largest local impacts. The table suggests that each region demonstrates a large treatment effect for different sets of reasons. The Katori District's high impact is likely attributable to low competition from supermarkets and suitable soil for vegetable production. The Western District has a high neighbourhood demand for vegetables, and this effect seemingly offsets the negative impact brought about by underdevelopment of the regional road network. Finally, while farmers markets in the Minamiboso District face a relatively low competition, the area's local demand is low and soil is not particularly suitable for vegetable production, suggesting that the production shift in this region is mostly supported by tourists who visit the peninsula for coastal holidays.

Across the prefecture, the correlation coefficient between the local impact estimate and the above four variables was –0.04, –0.18, 0.29 and –0.04, respectively. Judging from the large absolute values for the second and the third variables, the distance to the nearest supermarket and the penetration rate of andosols, establishing new farmers markets in andosol-covered areas with few supermarkets seem to be the most plausible way to lead the prefecture to more vegetable production through creation of farmers markets. This is an example of localised policy implications that could be drawn from the results of GW-DID estimations. It is worthwhile pointing out, however, that whether vegetable production *should* be encouraged is an entirely separate issue that requires another policy debate.

Conclusions

The present study estimated the geographically varying impacts of new farmers markets on agricultural production. In order to evaluate the spatial diversity of the impact, a variation of the geographically weighted regression to be used under the framework of the difference-in-differences estimation was devised. Globally, a statistically significant effect of farmers markets to increase vegetable production was detected for producers within 4.5 km of the respective market. Once spatial variation was taken into account, however, the magnitude of such an effect was shown to be considerably diverse among communities; the local parameter ranged from being statistically insignificant (no impact) to more than five times the global coefficient.

If vegetables sold with price premium at farmers markets are as good a source of income for agricultural producers as preceding studies claim, the results of the present study suggest that farmers markets have a generally positive impact on rural communities by initially providing producers with an option to grow alternative crops, and subsequently presenting an outlet to market them. Nonetheless, the degree at which these induced changes occur profoundly depends on local conditions. The ability to geographically differentiate high-impact areas from low-impact areas can potentially contribute to efficient policy designs, and hence the reduction in public expenditures.

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Table 1. Distance to the nearest farmers market

	1995	2005
Distance (km)		
Average	9.7 (5.9)	4.6 (3.7)
Minimum	0.1	0.1
Maximum	31.7	31.2
Distribution (%)		
< 1.5 km	11.4	23.8
1.5 km – 3.0 km	6.8	25.3
3.0 km – 4.5 km	8.9	25.4
4.5 km – 6.0 km	10.5	14.2
6.0 km – 7.5 km	11.8	9.3
7.5 km <	50.6	2.0
Sample size	3081	3081

Note: Numbers in parentheses are standard deviations.

Table 2. Descriptive statistics

	1995			2005		
	Average	Minimum	Maximum	Average	Minimum	Maximum
Dependent variable						
Proportion of vegetable farms	0.147 (0.248)	0.000	1.000	0.152 (0.243)	0.000	1.000
Independent variables						
Proportion of farms with young farmer(s)	0.113 (0.132)	0.000	0.833	0.122 (0.134)	0.000	0.857
Average operational size (ha)	1.182 (0.478)	0.126	5.281	1.344 (0.658)	0.115	9.903
Proportion of upland farmlands	0.304 (0.256)	0.000	1.000	0.292 (0.274)	0.000	1.000
Sample size		3081			3081	

Note: Numbers in parentheses are standard deviations.

Table 3. Results of global estimations by DID

Dependent variable: Proportion of vegetable farms	Model 1		Model 2		Model 3		Model 4		Model 5	
Constant	0.004	(0.002) **	0.003	(0.002)	< 0.001	(0.002)	< 0.001	(0.002)	0.001	(0.002)
Location of the nearest farmers market										
< 1.5 km	0.010	(0.006) *	0.011	(0.006) *	0.015	(0.006) **	0.016	(0.006) **	0.014	(0.007) **
1.5 km – 3.0 km			0.005	(0.004)	0.009	(0.004) **	0.010	(0.005) **	0.008	(0.005) *
3.0 km – 4.5 km					0.009	(0.004) **	0.010	(0.004) **	0.009	(0.004) **
4.5 km – 6.0 km							0.003	(0.004)	0.002	(0.004)
6.0 km – 7.5 km									– 0.005	(0.005)
Proportion of farms with young farmer(s)	– 0.006	(0.017)	– 0.005	(0.017)	– 0.004	(0.017)	– 0.003	(0.017)	– 0.003	(0.017)
Average operational size (ha)	< 0.001	(0.000) **	< 0.001	(0.000) **	< 0.001	(0.000) **	< 0.001	(0.000) ***	< 0.001	(0.000) ***
Proportion of upland farmlands	0.088	(0.088) ***	0.088	(0.022) ***	0.088	(0.022) ***	0.089	(0.022) **	0.088	(0.022) ***
Sample size	3081		3081		3081		3081		3081	
Adjusted R^2	0.006		0.007		0.008		0.008		0.008	
F-value	5.975 ***		5.122 ***		5.172 ***		4.517 ***		4.098 ***	
AIC	– 6159.387		– 6159.092		– 6162.483		– 6161.077		– 6160.241	

*** Significant at 1%. ** Significant at 5%. * Significant at 10%.

Note: Numbers in parentheses are standard errors.

Table 4. Results of local estimations by GW-DID

Dependent variable: Proportion of vegetable farms	DID		GW-DID			
			Minimum	Median	Maximum	F-statistic for stationarity test
Constant	0.001	(0.002)	– 0.049	0.003	0.038	4.731 ***
Location of the nearest farmers market						
< 4.5 km	0.010	(0.003) ***	– 0.017	0.008	0.052	1.524 ***
Proportion of farms with young farmer(s)	– 0.004	(0.017)	– 0.184	0.022	0.201	1.331 ***
Average operational size (ha)	< 0.001	(0.000) **	– 0.001	0.000	0.001	1.871 ***
Proportion of upland farmlands	0.088	(0.022) **	– 0.061	0.081	0.419	1.016
Sample size	3081		3081			
Adjusted R^2	0.008		0.088 (Quasi-global R^2)			
F-value	7.540 ***		N.A.			
AICc	– 6165.572		– 6263.847			
Bandwidth	N.A.		8.26 km			

*** Significant at 1%. ** Significant at 5%. * Significant at 10%.

Note: Numbers in parentheses are standard errors.

Table 5. Characteristics of regions with large local impacts

Region	Katori District	Western District	Minamiboso District
Population density	Moderate	High	Low
Distance to the nearest supermarket	Long	Short	Long
Share of andosols	High	High	Low
Road density	Moderate	Low	Moderate

Figure 1. Locations of farmers markets

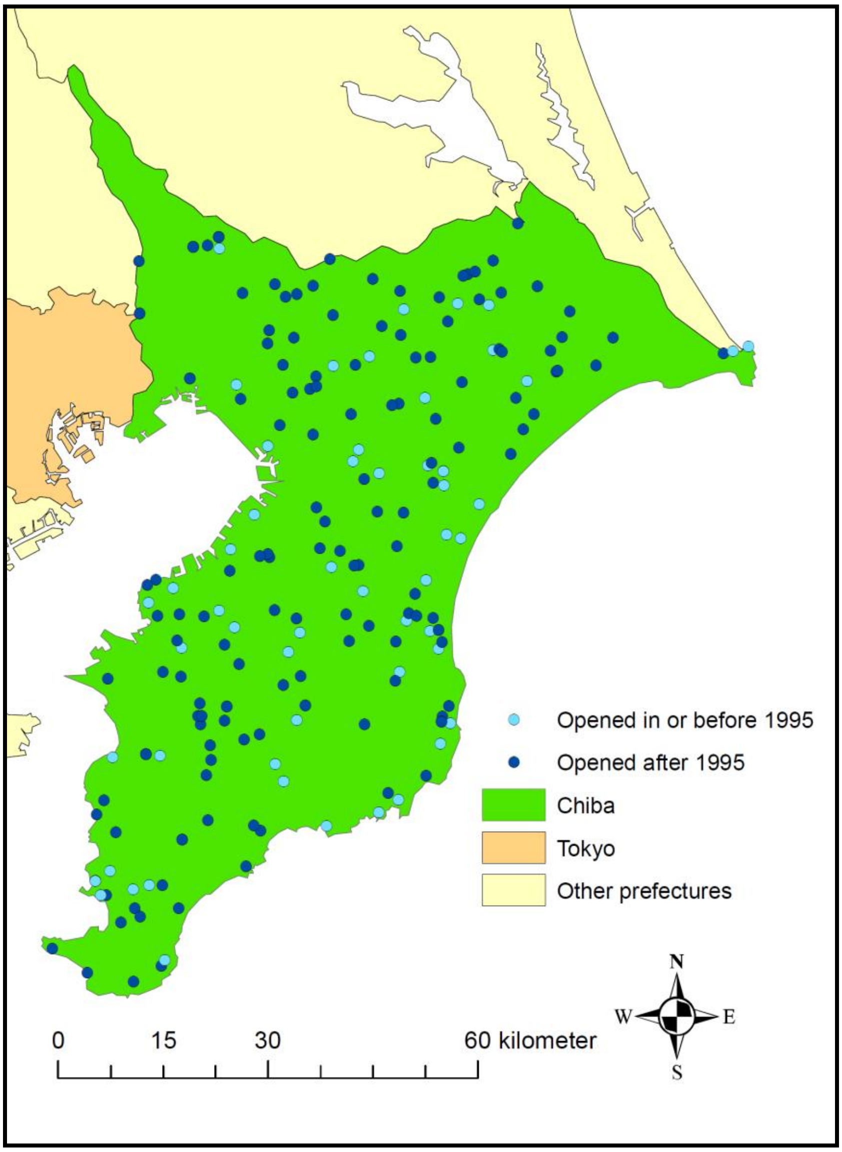

Figure 2. Distribution of local impacts

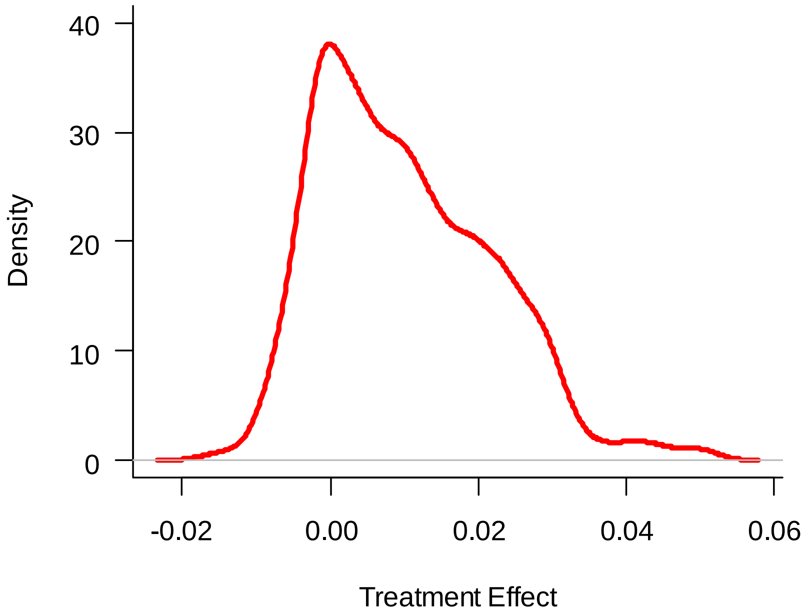

Figure 3. Local impacts of the opening of a new farmers market (percentage point increase in the proportion of vegetable farms)

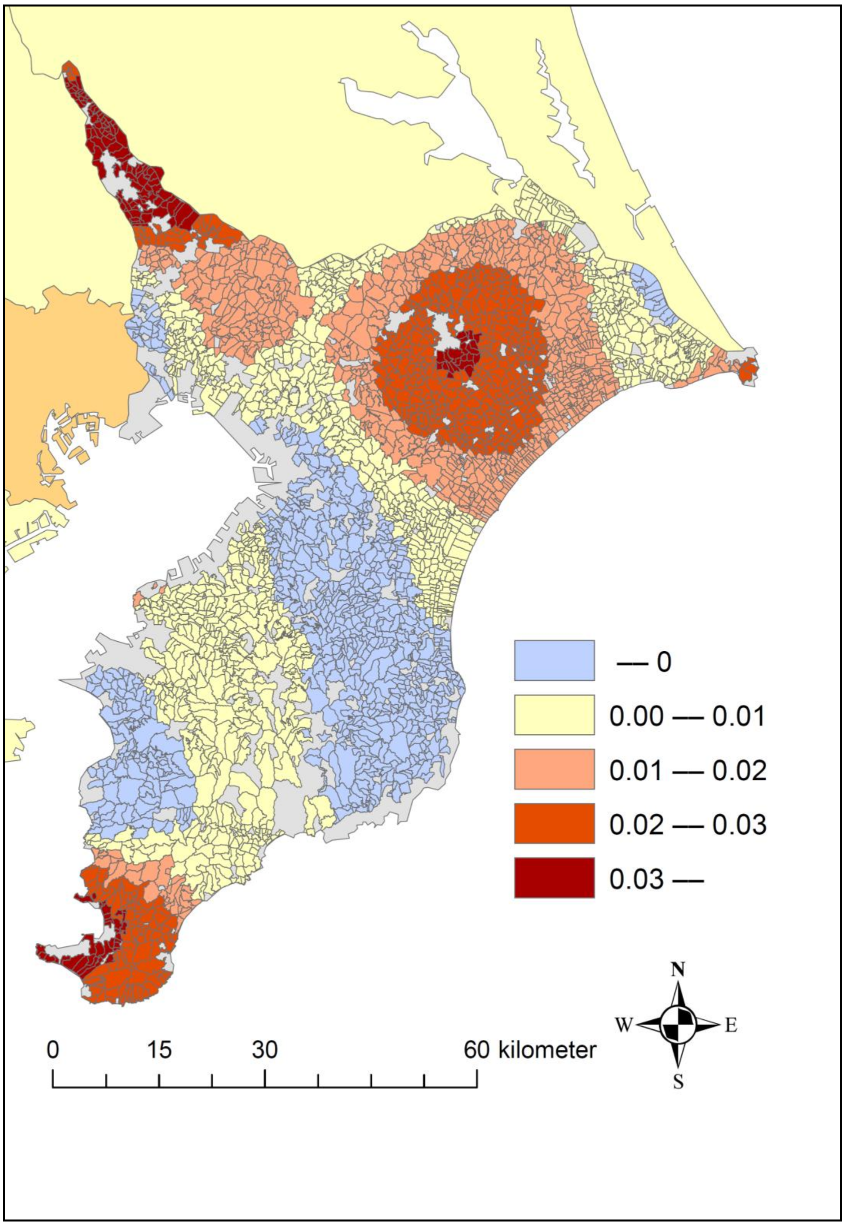

Figure 4. Potential determinants of local impacts: (a) population density (persons/km^2), (b) distance to the nearest supermarket (km), (c) share of andosols in total arable land (%), and (d) road density (km road/km^2).