Paper/Poster Title	Economic effects of organic farming in Taiwan: Empirical evidence from population-based farm household data

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Abstract	*200 words max*

Organic farming has been viewed as one of the promising farming practices of sustainable agricultural production. Evaluating the economic effects of organic farming is important while promoting environmental-friendly policies. Contributing to the considering the four major components of the cropping system and spatial agglomeration comparison, this study looks into three kinds of economic performances- sales revenue, cost and profit, for rice farm households in Taiwan using large-scale national data drawn from the 2015 agriculture census. We apply the analysis of local indicators of spatial associations to gain a better understanding of the patterns of organic farming clusters. The spatial clusters are then incorporated into the Probit-2SLS Instrumental variable model to examine the economic effects of organic farming, Although the results indicate adoption of organic farming has a negative effect on rice farms' economic performances, the spatial agglomeration of organic farms can significantly moderate the reduction, especially in the profit outcome. Furthermore, applying the heterogeneous average treatment effect approach outlined in Cerulli (2014), we find that the treatment effect of organic farming varies with the farmland area and the number of hired workers on the farm.

Keywords	Organic farming, causal effect, farm household analysis, spatial agglomeration, heterogeneous treatment effects
JEL Code	Sustainable Development Q01; Micro Analysis of Farm Firms, Farm Households, and Farm Input Markets Q12; Valuation of Environmental Effects Q51 see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction	*100 – 250 words*

Organic farming has been viewed as one of the promising farming practices in the sustainable food production trend. While the benefits of organic farming are obvious to environmental conservation and human health from the society's perspectives, the financial consideration, i.e. whether organic farming can sustain or even result in higher returns, plays an important role in farmers' decision-making concerning adoption. As rice has been a major food crop in Asian countries, this paper examines the treatment effect of organic farming adoption for rice farms in Taiwan using agriculture census data which is composed of more than 700,000 farm households. Our first contribution to the existing literature is to examine the economic effects of organic farming based on an integrated model considering the complete four major components of the cropping system—climate, genotype, management and soil.

Another contribution of this research is to investigate whether the economic effects of organic farming are dependent on spatial agglomeration. As the two key elements to cropping systems, climatic conditions and soil qualities may be spatially correlated with economic outcomes, we construct a spatial analysis framework by controlling for the climatic and land productivity to provide more accurate estimates of the cluster effect. Furthermore, we provide analyses of the heterogeneous response to treatment of organic adoption following the procedure outlined in Cerulli (2014). Under the heterogenous assumption, treatment effects may vary with farm characteristics including farmland scale, hired labor and farm household characteristics, etc.

Methodology	100 – 250 words

Methodologically speaking, organic adoption and economic performance are influenced by observed farm characteristics and environmental factors, and some unobservable factors, such as farmers' attitude, risk aversion, and other psychological factors. As the psychological factors related to farmers' adoption and economic outcomes of organic farming adoption are unobservable in the census data for our analysis, this could potentially result in a selection bias. To address the selection bias problem, we apply Probit-2SLS instrumental variable (IV) method in the binary treatment model under homogenous and heterogeneous assumptions. Since the organic adoption decision is a binary treatment, the use of the linear instrumental variable method represents some kind of misspecification and thus leads to inefficiency. Probit-2SLS instrumental variable (IV) method can provide consistent estimates of average treatment effects by fitting binary treatment models under selection-on-unobservables. Considering the treatment effect of organic farming may differ depending on the farm characteristics like land scale, farming experience, etc, we also examine this heterogeneous response to treatment following the procedure outlined in Cerulli (2014).

Results	100 – 250 words

Three measures of rice farm households' economic performances are examined in this study—sales revenue, production costs and profit. We found organic adoption leads to negative economic effects, resulting in negative differentials on average by approximately $4,800, $4,400, and $865 respectively in sales revenue, farming cost and profit. Such a result suggests that the price premium for organic rice cannot cover the reduction of output level and the lower input investment in organic farming, As for the spatial agglomeration of organic farming, this research identifies the organic clusters using local indices of spatial autocorrelation (LISA) analysis. It is found that the organic hotspots locate in northern and eastern Taiwan. Comparing average treatment effect estimates between hotspot and non-hotspot farms, we find the negative differentials in outcome variables are significantly lower in farms located

in the organic hotspot area. It is notable that the result concerning the average treatment effects of profit suggests that organic farming adoption no longer leads to the reduction in profitability of rice farms. Moreover, under the heterogeneous assumption, our results confirm the presence of heterogeneous response to the treatment. The average treatment effect of organic adoption is found to vary with the farmland area and the number of hired worker.

Discussion and Conclusion	*100 – 250 words*

This study finds that organic farming impact negatively on the sales revenue and profit from agricultural products, but its impact on cost is also negative. Since the price of organic fertilizers in Taiwan is much higher than chemical ones, the reduction in costs for organic farming suggests the tendency of less investment of intermediate input in organic production. It's worth mentioning that the negative treatment effect of organic farming on costs is smaller in hotspot area, suggesting these farms might spend more on their organic input or invest on farming facilities. Moreover, the treatment effect becomes positive in hotspot farms though not significantly different from zero, indicating the cluster of organic farming is beneficial for ameliorating the economic disadvantages of organic farming. The evidence showing that organic farming did not bring positive (even negative) economic effect on rice farming in Taiwan suggest the need for a more ambitious policy to further promote this environmental-friendly farming management. The promising result of organic agriculture agglomeration suggests the promotion programs need to be spatially targeted to achieve the policy aims of promoting organic farming.

Further, we identify the heterogeneous treatment effects, showing that rice farm's characteristics differentiate the average treatment effects of organic farming. In our findings, the farm's characteristics like farmland area and number of hired workers are found to make significant influence on the average treatment effects of organic farming adoption. From this result, we conclude that some farms with specific characteristics will benefit more from the adoption of organic farming.