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## Article

# Food system transformation and its impact on smallholder farmers' income and food security in Indonesia

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## GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

# Food system transformation and its impact on smallholder farmers' income and food security in Indonesia

Hery Toiba<sup>1\*</sup>, Tri Wahyu Nugroho<sup>1</sup>, Dwi Retnoningsih<sup>1</sup> and Moh. Shadiqur Rahman<sup>2</sup>

**Abstract:** Transformation of food system in Indonesia can have a profound impact on the supply chain of smallholder farmers. Policymakers are concerned about the impact of “modern food retail penetration” or “supermarket penetration” on Indonesian food chain participants. This study aims to analyze the link between supermarket penetration and smallholder farmers' welfare. Data were obtained from a survey involving 300 smallholder horticulture farmers from two regencies: Malang and Kediri. The data were analyzed to shed light on these issues. Endogenous switching regression was used to analyze the impact of participation in modern food marketing channel on both food security and welfare. The results of the econometric analysis suggest that there is a link between participation in the modern market and food security. In addition, this study also highlights that the presence of a new system of food supply chain is able to increase smallholder farmers' income through the stability of price and demand.



Hery Toiba

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### PUBLIC INTEREST STATEMENT

The study examines the impact of farmers' participation in the modern food retailer market channel on food security and welfare in Indonesia. The results of this study indicate that education, market access, and access to capital determine the participation of farmers in modern retail marketing channels. The research also shows that farmers' involvement in the modern marketing channel can increase gross income and variations in food consumption or increase food security. This study suggests that the presence of a new system in food marketing can increase farmer income through price and demand stability.

**Subjects: Statistics for Social Sciences; Urban Economics; Environmental Economics;**

**Keywords: Food system transformation; food security; endogenous switching regression**

## 1. Background

Indonesia is experiencing the rapid growth of modern food retailers,<sup>1</sup> including hypermarkets, supermarkets, and minimarkets/convenience stores. Dyck et al. (2012) reported that the number of hypermarkets, supermarkets, and mini-markets in Indonesia respectively increased by an average of 56%, 6.8%, 182% annually within a decade (1999–2009). This modern food retail penetration is developing not only in big cities but also in small-town areas. Recently, it has penetrated the countryside. Various groups, including policymakers, non-governmental organizations, and small producers, began to worry about this fact, especially the impact of “modern food retail penetration” on food supply chain actors and consumers in Indonesia (Toiba et al., 2015; Umberger et al., 2015).

Previous research has documented the impact of modern food retail penetration in developing countries including Indonesia. In general, previous studies can be grouped into two main strands. The first focuses on assessing the impact on farmers and the second one focuses on consumers. Previous research focusing on farmers indicates that retail penetration of modern food can be linked to increases in farmer household income and rural poverty reduction (Chege et al., 2015; Maertens et al., 2012), as well as increasing food security (Arda, 2007; Crush & Frayne, 2011). On the other hand, it also increases inequality in rural areas that is getting worse because small farmers may be excluded from participating in the new agribusiness food system (Otsuka et al., 2016).

The second focus of the study is on consumers. The “modern food retail revolution” can be attributed to positive results such as the increasing diversity of diets due to increased competition from new modern retail formats which can provide a wider variety of products (exp. milk, non-traditional fruits, and vegetables) and lower prices, increased security, and high-quality food products (Reardon et al., 2010). Meanwhile, the rapid rise of supermarkets may have a detrimental effect on the existing traditional food retailers. There is evidence that if traditional food retailers are crowded out, poor consumers’ access to fresh and affordable products can be reduced (Schipmann & Qaim, 2010). If fresh food products are less affordable, food quality is likely to be affected. For example, changes in prices and the presence of modern food retail outlets can reduce the consumption of fresh fruit and vegetables, increase the consumption of processed foods, and have implications for health (Hawkes, 2008).

However, there has been no comprehensive research in the impact of the revolution of supermarkets on small farmer welfare and food security in Indonesia still does not exist. Previous studies conducted in Indonesia usually focused only on the food supply chain actors, such as the producers/farmers (Natawidjaja et al., 2007; Sahara et al., 2015), consumers (Toiba et al., 2015; Umberger et al., 2015), and traders (Suryadarma et al., 2010). The simultaneous impact of modern food retail penetration on both the welfare of farmers and food security has not been investigated. Thus, this study aims to enrich the literature that discusses the relationship between modern food retail transformation and its impact on producers and consumers. The results of this study are expected to provide meaningful information for policymakers, especially for understanding the transformation of modern food retailing in Indonesia and its impact on income, food security, and farmer welfare.

The rest of the paper is structured as follows: The next section provides brief overviews of food retail transformation in Indonesia and previous literatures discussing the effect of modern food retailers on smallholders. This is followed by explanations about the theoretical models. The “research methods” section describes data and econometric analysis used in the study. The

empirical findings and discussion are presented in ‘Results and Discussion’. The final sections offers some conclusion and implications.

## 2. Literature review

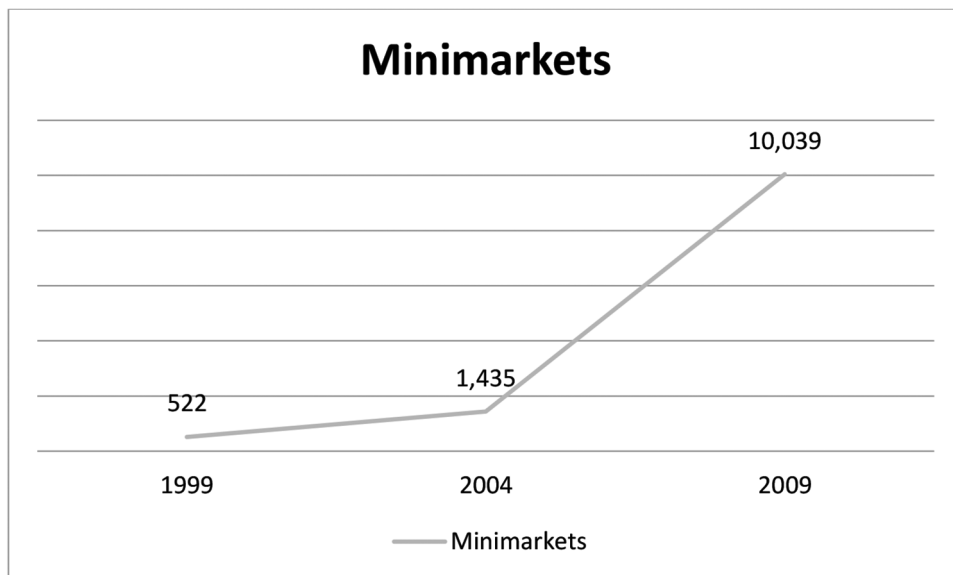
### 2.1. Transformation of food retail in Indonesia

The pattern of food retail transformation in Indonesia is similar to those of other countries in Asia, such as China, Thailand, the Philippines, and Vietnam. At first, modern food retailers served a small group of highly income households in big cities, then subsequently reached the upper middle class in large-medium cities, and then penetrated the lower middle class in the suburbs and even the countryside (Reardon et al., 2012). In Indonesia, for example, from the 1970s and throughout the 1990s, modern food retailers mainly focused on serving the needs of upper-class consumers and expatriates in large cities such as Jakarta. These modern retail outlets are primarily owned and managed by domestic owner (Natawidjaja et al., 2007). In 1996, 940 supermarkets operating in Indonesia were still in Jakarta and managed by local businesses, such as Sarinah. After that, supermarkets grew quite rapidly, although this modern retail expansion had declined significantly due to the 1997 economic crisis that hit the Indonesian economy. However, after the economic crisis, economic conditions in Indonesia began to improve and the development of modern retail increased dramatically. For example, in 1999 the number of modern supermarket outlets was only 1235, but after a decade, the number doubled to 2068 in 2009 (Dyck et al., 2012). Significantly, foreign direct investment (FDI) in the modern food retail sector in Indonesia also increased rapidly in this period, after the Indonesian Government signed a Letter of Intent (LOI) with the International Monetary Fund (IMF) in 1998, allowing direct investment by foreign investors in the Indonesian modern food retail sector.

Foreign companies such as Carrefour (France) and Giant (Malaysia) make direct investments in this modern retail sector. For example, the number of hypermarkets grew significantly from 18 outlets in 1999 to 141 in 2009, and the sales figure grew from US 256 USD million to US 1,897 USD million. In line with the expansion of foreign investment in the food retail sector, the number of domestically owned modern retailers has also increased and domestic modern retailers now compete with multinational retailers. Matahari Putra Prima, for example, has expanded its hypermarket outlets to several cities in Indonesia (KPPU, 2009). In 2009, the number of Matahari Putra outlets reached 26% of the total number of hypermarkets in Indonesia (Dyck et al., 2012). In addition, other domestic business groups such as Para have also acquired 40% of the shares owned by multinational retail company Carrefour (KPPU, 2009).

**Figure 1. Number of minimarkets/convenience stores in Indonesia 1999–2009.**

Source: Dyck et al. (2012).



On the other hand, during the period of 1999 to 2009, the number of minimarkets/convenience stores also increased dramatically, from 522 in 1999 to 10,039 in 2009 (Figure 1) (Dyck et al., 2012). During this time, minimarkets share of modern retail food sales grew from 4% to 28%, while the number of minimarkets increased from 522 in 1999 to

10,039 in 2009 (Dyck et al., 2012). While the number of minimarkets is increasing, the minimarkets are now trying to compete with traditional food retailers in terms of price, quality, variety, and service, which focus not only on high-income urban consumers, but also on consumers in smaller cities and those with lower income (Suryadarma et al., 2010).

## **2.2. The effect of modern food retail development on smallholders**

The development of the retail market model has brought about a consequence of changes in the food procurement system in all downstream areas. This system requires standardization of various supply chain activities at the producer level, especially for small farmers. It is important to remember that in many developing countries, small farmers are often marginalized by new technologies or institutional developments (Otsuka et al., 2016). Therefore, the issue of modern food retail penetration attracts policymakers to find out how the development of the modern food retail market impacts on the welfare of farmers (Reardon et al., 2012).

Studies on the impact of penetration of supermarkets on farmers have been carried out. For example, Hernández et al. (2007) and Neven and Reardon (2006) who found that farmers involved in the supply chain of modern food retailers tended to use higher production inputs and production levels than farmers who did not participate in the supply chain. Rao and Qaim (2011) also revealed relatively similar results that participation in the supply chain of supermarkets in Kenya was able to increase farmers' income. The same thing was found by Sahara et al. (2015) in Indonesia, and Briones (2015) in the Philippines, that the participation of farmers in the supply chain of modern food retailers is able to increase the farmers' net income. In the context of the relationship between the penetration of supermarkets and food security, literature in western countries mostly shows that the presence of modern food retailers is able to increase the food security of the poor (Caillavet et al., 2015; Reardon & Timmer, 2014). In developing countries, Reardon and Timmer (2014) and Arda (2007) report that penetration of modern food retailers is able to provide quality products that are relatively cheaper and better, at least to some urban consumer groups, thus contributing positively to their food security. However, Peyton et al. (2015) report that although modern retail penetration in Cape Town, South Africa was able to increase diversified food source access, it was not able to increase food security.

Several studies also found that the penetration of modern food retail in developing countries was able to reduce poverty (Maertens et al., 2012; Rao & Qaim, 2011). Other studies show different results, that the determination of modern food retailers exacerbates inequality in rural areas because smallholders cannot participate in the new food system (Farina & Reardon, 2000). This is not only because modern retailers prefer to collaborate with larger farmers, but also because small farmers have limitations in terms of capital, technology, and human resource capacity (Otsuka et al., 2016).

## **3. Methodology**

A number of methods are used in this study, both descriptive statistics and the econometric approach. The econometric approach used in this study includes analysis of endogenous switching regression and analysis of Average Treatment Effect (ATE). Endogenous switching regression analysis was used to estimate factors that explain why farmers participate or not participate in modern food retail supply chain channels. Both of these analyses were used to see the impact of the penetration of modern food retailing on income, food security and poverty of farmers.

### **3.1. Model specification**

The empirical model of the supply chain selection of the modern food retail market adopts the concept of Ma and Abdulai (2016). Mathematically, it can be formulated as follows:

$$D_i^* = Z_i\beta + \mu, D_i = 1 \text{ if } D_i^* > 0 \tag{1}$$

Where  $D_i^*$  is the difference between the expectation of net profit from participating farmers and not.  $D_i$  is a variable dummy indicator, which will be equal to one for households participating in the supply chain of the modern food retail market and 0 if the opposite. Meanwhile,  $Z_i$  is a vector of farmers' socio-economic factors,  $\beta$  is a vector of estimator parameters of the model, and  $\mu$  is a confounding factor which is assumed to be normally distributed.

### 3.2. The estimation of impacts and bias selection

The main concern of this research is assessing how farmers' participation in the supply chain of modern food retailing impacts on their income, food security and welfare. Suppose that the vector of the outcome variable (net return) is a linear function of the vector of the explanatory variable,  $X_i$ , for which we can formulate the outcome into the following equation:

$$Y_i = X_i\alpha + D_i\gamma + \varepsilon_i \tag{2}$$

Where  $Y_i$  is the outcome variable vector;  $X_i$  is a vector of independent variables, such as social-economic variables, household demographics, assets, farming characteristics, location characteristics, food security status, and poverty status. Meanwhile,  $D_i$  in the dummy variable is the participation of farmers in the supply chain of modern food retailing.  $\alpha$  and  $\gamma$  show parameter estimates of the equation of the outcome;  $\varepsilon_i$  shows a random error term.

In Equation (2), we can know that the participation of farmers in the supply chain of modern food retailing is exogenous. However, decisions in participating in the supply chain are inherently dependent on the characteristics of the farmers. Therefore, estimating Equation (1) using the least squares method (OLS) is not appropriate and tends to produce a biased estimate (Ma & Abdulai, 2016). Furthermore, unobservable factors might influence the confounding variable  $\mu$  in Equation (1) and the confounding variable  $\varepsilon_i$  in the equation of outcome (2) simultaneously. As a result, the correlation between the two variables is not zero ( $\text{corr}(\mu_i, \varepsilon_i) \neq 0$ ). The next result, estimation will produce a biased estimate. To overcome this problem, Endogenous Switching Regression (ESR) was used as suggested by Lokshin and Sajaia (2004).

### 3.3. Endogenous switching regression

To estimate the endogenous switching regression model, two stages of completion are needed. The first step is to choose equations based on the function dichotomy criteria of the choice of participation in the modern supply chain as shown in Equation (1). In the second step, two equal participation regimes and inclusion are specified as outcomes of interest. Mathematically, the two regimes of this model can be expressed as follows:

$$\text{Regime1} : Y_{iM} = X_i\beta_{iM} + \varepsilon_{iM} \text{ if } D_i = 1 \tag{3a}$$

$$\text{Regime2} : Y_{iN} = X_i\beta_{iN} + \varepsilon_{iN} \text{ if } D_i = 0 \tag{3b}$$

Where  $Y_{iM}$  and  $Y_{iN}$  are respectively outcome variables such as income and food security from participating farmers and those who do not participate in the modern food retail supply chain. Meanwhile,  $X_i$  denotes a vector of exogenous variables that affect outcome variables;  $\varepsilon_i$  is the error term variable of the outcome equation.

In the simultaneous estimation, the  $Z_i$  variable in Equation (1) is still possible to overlap with the variable of  $X_i$ . Correct identification requires at least one variable in  $Z_i$  that does not appear to be a variable in the vector of  $X_i$ . Therefore, the choice of Equation (1) is estimated based on all the explanatory variables in the outcome equation plus one or two instrument variables. The instrument variable requirement is that the variable must have a strong influence on the dummy

variable of participation in the modern retail supply chain, but the instrument variable must not correlate with the outcome variable.

Variable of  $X_i$  in Equations (3a) and (3b) actually accommodates the observed factors to reduce the bias selection issue. Nonetheless, unobserved factors could still lead to correlations with error term in participation model (1) and outcome Equations (3a and 3b)— $(\mu_i, \varepsilon_i) \neq 0$ . The model of ESR emphasizes the issue of bias selection resulting from factors not observed as missing variable problems. In particular, after estimating the participation equation in the modern supply chain, the inverse mills-ratio  $\lambda_{iM}$  dan  $\lambda_{iN}$  and covarian of error terms  $\sigma_{\mu M} = \text{cov}(\mu_i, \varepsilon_{iM})$  and  $\sigma_{\mu N} = \text{cov}(\mu_i, \varepsilon_{iN})$  are calculated and linked to equation on (4a) dan (4b):

$$Y_{iM} = X_i \beta_{iM} + \sigma_{\mu M} \lambda_{iM} + \gamma_{iM} \quad \text{if } D_i = 1 \tag{4a}$$

$$Y_{iN} = X_i \beta_{iN} + \sigma_{\mu N} \lambda_{iN} + \gamma_{iN} \quad \text{if } D_i = 0 \tag{4b}$$

Where  $\lambda_{iM}$  and  $\lambda_{iN}$  are controls for bias selection, the result of unobserved factors while  $\gamma_{iM}$  and  $\gamma_{iN}$  are error terms which have an average of zero. To estimate the system equation between the participation model and the outcome model, the FIML method was used.

### 3.4. The estimation of treatment effect

The Average Treatment Effect (ATT) of an intervention/involvement in the program can be derived from the endogenous switching regression coefficient. In particular, observed and unobserved counterfactual outcomes can be calculated as follows:

Farmers participating in the modern food retail supply chain:

$$E[Y_{iM}|D = 1] = X_i \beta_{iM} + \sigma_{\gamma M} \gamma_{iM} \tag{5a}$$

Farmers who do not participate in the modern food retail supply chain:

$$E[Y_{iN}|D = 1] = X_i \beta_{iN} + \sigma_{\gamma N} \gamma_{iN} \tag{5b}$$

Therefore, the expected outcomes in Equations (5a) and (5b) are used to reduce the unbiased treatment effect (ATT).

$$ATT = E[Y_{iM}|D = 1] - E[Y_{iN}|D = 1] \tag{6}$$

### 3.5. Method for addressing potential endogeneity

To estimate Equation (1), an issue needs to be considered, that is the possibility of an endogenous problem in explanatory variables, such as farmer credit access. Some traders affiliated with the modern market help farmers obtain good credit from financial institutions. Thus, farmers' access to credit as a variable can be endogenous, so that access to credit may potentially be determined by the decision to participate in modern food market channels.

Considering that the nature of the dependent variable is dichotomous, this research uses the approach suggested by Rivers and Vuong (1988) to address the potential endogeneity problem. This approach involves determining the credit access variable as a function of all independent variables in participation model, as well as the instrument variables in the first stage of the regression as follows:

$$G_i = Z_i \beta + I_i \omega + \varepsilon_i \tag{7}$$

Where  $G_i$  is an observed potential endogenous variable such as access to credit, while  $Z_i$  is a vector of household and socioeconomic characteristics of farmers, and  $I_i$  is an instrument variable. The variable must have a very strong influence on potential variables that are endogenous but do not directly affect the variable of modern market participation. Therefore, an instrument variable,



namely the distance to formal financial institutions, is included in Equation (7). We expect that the variable influences access to farmers' credit. On the other hand, it does not affect the choice of market channel. Estimation results of both the observed variables and the residue from Equation 7 are then used in the equation of participation in the modern market channel as follows:

$$D_i^* = Z_i\delta + G_i\eta + R_iK + v_i \quad (8)$$

Where  $R_i$  is the residual variable of Equation (8). According to Wooldridge (2010), by adding an appropriate residual variable from the estimated variables that have the potential endogenous variable, this variable will become an appropriately exogenous variable because the residual variable serves as the control function. This approach will produce robust results. To test endogeneity, Hausman test will be used (Wooldridge, 2015).

### 3.6. Specification model and hypothesis

In this section, we will present the model specifications of the econometric analysis used and the hypothesis of the relationships between the variables. There are four econometric models presented in this section. The first is the participation model in the supply chain that will endogenous switching models.

To estimate the impact of participation on the supply chain of modern retail, endogenous switching regression was used. The general model of channel choice equation used in this study like in Equation (8)

$$D_i^* = Z_i\delta + G_i\eta + R_iK + v_i \quad (9)$$

Where  $D_i^*$  is the dummy participation variable of farmers in the supply chain of modern Z food retailing is a vector of the socio-economic characteristics of farmer households. Vector  $Z_i$  shows the socioeconomic variables of farmer households, including gender, age, education of the head of the family, experience, number of family members, dummy children under five year olds, land area, income, employment outside the agricultural sector, trader network, dummy credit access, dummy capital access, road access and agricultural market.  $R_i$  is as mentioned before. Regression coefficient signs of age, number of family members, and dummy children are expected to negatively affect the participation of modern retail supply chains (Sahara et al., 2015). Meanwhile, education, experience, land area, income, employment outside the agricultural sector, dummy credit access, dummy capital access, dummy agricultural market, road access, public facilities access, trader network are expected to positively affect the participation of modern retail supply chains (Sahara et al., 2015).

This study hypothesizes that farmer participation in the supply chain of modern food retailers can increase income, consumption, food security and reduce poverty. Gross income variables are measured using indicators of farming income in units of million/ha. Meanwhile, food security variables are measured using the Coping Strategies Index (Maxwell & Caldwell, 2008) and the Food Consumption Score (Hoddinott & Yohannes, 2002). Poverty status is measured by the head count index and poverty gap index. The head count index measures the percentage of the population living below the poverty line using the World Bank purchasing power parity approach that is US 1.08 USD per capita/day. The poverty gap index measures the average value of the poverty gap ratio with the poverty line (Haughton & Khandker, 2009).

### 3.7. Data collection

To address each aim, data from farmer household surveys which were conducted from May, 2018 to July, 2018 was analyzed. The sample of the study included 300 households from two residences (Malang and Kediri) in East Java. The survey sample in the study is farmers selling chillies to supermarket channels and traditional market channels. Supermarket channel samples were obtained from 75 farmers who sold to supermarket channels. The names of the

samples were obtained from interviews with supermarket managers, wholesalers in both Malang and Kediri. Meanwhile, the list of farmers was obtained by random sampling, because there was no list or census of chilli farmers in Indonesia. We chose two regencies in East Java Province, Malang and Kediri. The two regions were chosen because they are the main producers of chillies in East Java Province and there are many farmers who sell their chillies to modern market channels. We used a multistage sampling procedure for selecting sub-districts, villages and chilli farmers. We employed systematic random sampling method to choose three villages from each sub-district, resulting in 6 villages. From 6 villages, we obtained 225 farmers who used traditional market channels. The surveys were conducted via face-to face interviews with the chilli farmers using a structured questionnaire. The survey instrument was developed after reviewing the relevant literature and interviewing key informants from government, traders, and farmers. The instrument was refined after pre-tests had been conducted.

**Table 1. Definitions and summary of selected variables used for analysis endogenous switching regression model**

Variable	Definition	Mean	SD
Gross Income	Logarithm of total gross income for farming per hectare	8.40	1.55
Food Cope Strategies	The total score of food cope strategies	42.17	15.50
Food Consumption Scores	The total score of food consumption	32.36	3.18
Total income	Logarithm of family's total income	17.24	0.44
Modern market participation	Dummy modern market participation, 1 if modern, 0 otherwise	0.25	0.43
Age	Respondents' age (in year)	46.68	11.44
Age square	Square of respondents' age (in year)	2309.7	1086.1
Child5	Dummy having children above 6 year olds, 1 if having, 0 Otherwise	0.26	0.48
Experience	Experience in farming activities	23.45	11.92
Education	Education duration (in year)	8.14	2.73
Off-farm	Dummy 1 if having off-farm job, 0 Otherwise	0.52	0.50
Household size	The number of family members	3.60	1.00
Asset	Dummy asset owned, 1 if having an asset, 0 otherwise	0.45	0.50
Areal size	Farm land size (hectare)	0.44	0.39
Credit access	Dummy credit access 1 if having credit access, 0 otherwise	0.53	0.50
Social capital	Dummy 1 if having social capital, 0 otherwise	0.89	0.31
Road access	Time to reach the nearest asphalt road (minute)	2.62	2.16
Public facilities	Time to reach the nearest public facilities(minute)	17.46	12.31
Trade network	Number of traders who are known by farmers	1.98	0.89
Agricultural market	Dummy 1 if having agricultural market access, 0 otherwise	0.23	0.42
Financial distance	Time to reach the nearest formal financial institution (minute)	16.20	12.34

## 4. Results and discussions

### 4.1. Descriptive statistics of selected variables used in the endogenous switching regression model

Table 1 presents the definitions and summaries of the variables used in the analysis of this study. The non-independent variable used in the analysis of the Endogenous Switching Regression (ESR) model is a dummy variable of participation in modern marketing operations. Farmers selling chillies to traders affiliated with wholesalers who will later supply to modern markets are given value 1. On the other hand, others are given 0, if farmers use traditional marketing channels, where farmers sell their crops to alleys who will later sell them to the next traders who will sell in traditional markets or directly to end consumers in traditional markets. The outcome used in this study includes gross income per hectare, food security indicators (food consumption score and index of food scope strategies), as well as poverty status out-come that are deducted by proxy for per capita income of family members. From Table 1, it can be seen that the value of the food coping strategy averages 42.17. This shows that respondents in general have a relatively low level of food insecurity because of the relatively high or large number of strategies that can be implemented to overcome unfavourable situations including situations where access to food is low. This table also shows the relative average food consumption score (FCS). FCS is calculated by multiplying the weight set by the frequency of food from each food group which includes food groups of grains, tubers, beans, vegetables, fruits, meat, milk and eggs, oil and fat and spices. These results indicate that in general farmers are in a borderline position on the status of food security. In other words, the level of food security is relatively good

This table also shows that there are around 25 percent of the sample farmers participating in the modern marketing channel. The average age of the sample farmers is 46.68 years. This indicates that the average chilli farmers in the study area are relatively old. This phenomenon is at least in line with the portrait of the average age of farmers in Indonesia. This might affect the productivity of the farmers. Only 26 percent of sample households have children under the age of five (toddlers). On average, the sample farmers started to become a farmer in a relatively short time span of more than two decades. Their average farming experience is around 23 years. In terms of education level, the average level of education is not too high at 8.14 years. Almost half of the farmer respondents have a second main job outside the activities in the agricultural sector. The average number of trainee family members is not so high, which is around the average of 3.6 points. This means one general family consists of a father and mother and two other family members such as children, parents or other families. More than 45% of the farmers have valuable assets such as two-wheeled vehicles, four-wheeled vehicles, or livestock which can be used as collateral for loans or additional capital for farming if they really need it.

The average land area owned by farmers is 0.44 hectares. This average figure is higher compared to the average land ownership of food commodity farming in general in Indonesia. Nearly 60% of the farmers revealed that they had loans from various funding sources, such as national banks, community credit banks, traders or friends or family. Likewise, almost 90% of the sample farmers feel that they can access funding from various sources. Table 1 also shows that accessing paved roads is easy, which only requires an average time of less than three minutes. Access to public facilities such as extension offices and health facilities does not require much time. It takes around 17 minutes. At least, the sample farmers knew 2 traders who might be willing to buy their crops. Twenty three percent of the respondents revealed that they knew the closest agricultural market in the district where they live.

The average differences in characteristics of the respondents who participate in modern channels and traditional channels are shown in Table 2. The table indicates that there are differences in gross income per hectare between the two groups. Farmers who participate in modern marketing channels tend to have higher gross income than those participating in traditional marketing channels.

**Table 2. Average difference of variable characteristics of farmers between participating in modern and traditional marketing channels**

Variable	Modern channel (n = 75)		Traditional channel (n = 225)		Difference
Gross income	9.05	(0.15)	8.18	(0.1)	-0.86***
Food Cope Strategies	46.97	(2.11)	40.56	(0.94)	-6.41***
Food Consumption Scores	33.24	(0.31)	32.07	(0.22)	-1.17***
Household income	17.28	(0.04)	17.23	(0.03)	-0.05
Age	51.43	(1.28)	45.1	(0.74)	-6.32***
Age square	2766.65	(136.19)	2157.36	(67.39)	-609.29***
Child5	0.21	(0.05)	0.28	(0.03)	0.07
Experience	28.99	(1.43)	21.6	(0.75)	7.38**
Education	7.71	(0.35)	8.28	(0.17)	0.57
Off-farm	0.63	(0.06)	0.48	(0.03)	-0.15**
Household size	3.45	(0.13)	3.64	(0.06)	0.19
Assets	0.65	(0.06)	0.39	(0.03)	-0.27***
Land size	0.44	(0.05)	0.43	(0.03)	0.00
Credit access	0.37	(0.06)	0.59	(0.03)	0.21***
Capital access	0.96	(0.02)	0.87	(0.02)	0.09***
Road access	2.15	(0.26)	2.78	(0.14)	0.63**
Public facilities	7.53	(0.5)	20.77	(0.82)	13.24***
Trade network	2.31	(0.12)	1.87	(0.05)	-0.44***
Agricultural market	0.57	(0.06)	0.12	(0.02)	0.33***

Note; \*\*\*,\*\*,\* denote significance on 10%, 5%, and 1 % respectively and numbers in parentheses indicated standard deviation values

Likewise, when viewed from good food security indicators with food coping strategy indicators and food consumption scores, it can be seen that the average farmers who participate in modern marketing channels have better food security compared to those who use traditional marketing channels. Even so, seen from the total income proxy with the family's total food and non-food expenditure, there seems to be no significant difference between the two groups of farmers. Table 2 also shows that on average, the farmers participating in modern markets are older and have more experience compared to those who participate in traditional markets. Although the average education level of modern farmers tends to be lower than traditional farmers, there is no statistical difference in the average education between the two groups of farmers. In general, there is no difference in the number of family members and ownership of land area between these two groups of farmers. Farmers who participate in the modern market tend to have more valuable assets and greater access to capital than traditional farmers. Interestingly, farmers who participate in traditional markets, on the contrary, have more access to credit from various sources. In general, farmers who participate in modern markets have easier access to transportation, infrastructure, and public facilities. They also have more networks with marketing institutions than farmers who participate in traditional markets.

#### **4.2. Results of estimating factors affecting participation in modern and traditional markets and their impacts on income, food security and welfare**

Estimation results from the Endogenous Switching Regression (ESR) model and ATT are presented in Tables 3–7. As mentioned earlier, the Full Information Maximum Likelihood (FIML) approach was used to predict two models simultaneously, namely the selection model (participation model) and outcome model (farming gross income, food cope strategies, food consumption, scores, total income). Tables 4–7 present the results of analysis of factors that determine farmer participation in modern markets and their impact on gross income, food security and proxy welfare with total household expenditure. The estimated results of the Average Treatment Effects (ATT) are presented in Table 7.

**Table 3. Determinants of participation in modern marketing channels and its impacts on gross revenue per farmer**

Variable	Participation		Gross income per Ha			
			Modern channel		Traditional channel	
Constanta	-0.45	(2.14)	15.42	(2.36)***	17.8	(1.07)***
Age	-0.06	(0.07)	0.12	(0.06)**	0.02	(0.04)
Age square	0.00	(0.00)	0.00	(0.00)**	0.00	(0.00)
Child5	0.13	(0.31)	0.38	(0.35)	-0.16	(0.20)
Experience	0.01	(0.01)	0.01	(0.01)	0.00	(0.02)
Education	-0.04	(0.04)	0.08	(0.04)*	-0.03	(0.04)
Off-farm	0.27	(0.34)	-0.54	(0.38)	0.14	(0.27)
Household size	-0.07	(0.12)	-0.07	(0.15)	0.20	(0.10)**
Assets	-0.12	(0.33)	-0.22	(0.45)	0.27	(0.31)*
Land size	-0.28	(0.37)	-0.76	(0.43)*	-0.66	(0.42)
Credit access	0.28	(0.28)	0.52	(0.4)	-0.72	(0.35)**
Capital Access	1.16	(0.63)*	0.33	(1.24)	-0.26	(0.4)
Road access	0.46	(0.19)**				
Public facilities	-0.17	(0.07)**				
trade_know	0.16	(0.11)				
Agricultural market	1.87	(0.46)***				
Res (Fin_distance)	0.17	(0.45)				
lns1			0.2	(0.16)*		
lns2					0.63	(0.06)**
Log likelihood	-662.65					
Wald test of indep. eqns.	3.74*					

Note; \*, \*\*, \*\*\* denote significance on 10%, 5%, and 1 % respectively and numbers in parentheses indicated

The second columns Tables 3–6 presented the estimates of the residual terms from the first-stage regression for endogenous variable. The tables indicated that residual terms are not statistically significant. It means that the coefficients have been consistently estimated (Wooldridge, 2010).

From Tables 3–6, it appears that the main determinant of farmer participation in the modern market is the distance to paved roads and access to capital. The easier it is to access paved roads and capital for farming, the greater the opportunities for participation in modern marketing channels. This finding is consistent with the findings of Maertens et al. (2012) in Sub-Saharan Africa, and Rao and Qaim (2011) in Kenya, Africa. The studies suggest that easy market access and access to capital tend to encourage farmers to be involved in more modern food systems.

Table 3 also shows that more educated farmers are more likely to have the opportunity to participate in modern markets than traditional farmers. This result is in line with the findings of Rao and Qaim (2011) and Sahara et al. (2015). The influence of educational variable on this participation may be understood, considering that someone who has a relatively good education will be able to gather more information, select the benefits of information, and make use of decisions compared to someone who has a lower level of education.

### 5. Standard deviation values

An interesting thing from the results of this study is that farmers who have more land and more family members are less likely to participate in modern markets. This may be because wider farmers may not want to be bound by just one trader. Another explanation is that farmers who have more land might have had a good relationship with older traders, which are usually

**Table 4. Determinants of participation in modern marketing channels and its impacts on food cope strategies**

Variable	Participation		Food Cope Strategies			
			Modern Channel		Traditional Channel	
Constanta	-1.21	(2.16)	12.06	(26.01)	40.85	(6.58)***
Age	-0.04	(0.07)	1.30	(0.80)	-0.47	(0.31)***
Age square	0.00	(0.00)	-0.01	(0.01)	0.01	(0.00)**
Child5	0.12	(0.27)	-2.95	(3.71)	-2.27	(1.21)***
Experience	0.01	(0.01)	-0.34	(0.20)	-0.45	(0.09)
Education	-0.02	(0.04)	1.42	(0.49)	0.06	(0.26)
Off-farm	0.10	(0.39)	8.08	(3.30)**	-1.29	(1.30)***
Household size	-0.16	(0.14)	3.13	(1.59)	3.01	(0.72)***
Assets	-0.16	(0.25)	2.57	(4.15)	9.67	(1.75)***
Land size	0.12	(0.29)	-16.80	(5.86)***	-7.03	(1.26)***
Credit Access	0.40	(0.27)	-11.60	(4.11)**	-7.11	(1.58)***
Capital Access	0.83	(0.47)**	-1.71	(4.96)	-0.38	(1.22)
Road access	0.43	(0.16)***				
Public transportation	-0.10	(0.03)***				
Trader network	0.24	(0.12)**				
Agricultural market	1.65	(0.37)***				
Res (Fin_distance)	0.13	(0.34)				
lns1			2.55	(0.1)7***		
lns2					2.23	(0.01)***
Log likelihood	-1221.1					
Wald test of indep. eqns.	0.89					

Note; \*,\*\*,\*\*\* denote significance on 10%, 5%, and 1 % respectively and numbers in parentheses indicated standard deviation values

traditional channel alleys. Maintaining long-term relationships with marketing agencies might be one of the explanations why broad farmers and generally wealthy farmers are reluctant to use new marketing channels.

In contrast to the results of the average difference test where farmers who have valuable assets tend to choose modern channels, after paying attention to the characteristics of farmers, other variable households, precisely the farmers who have assets tend not to choose modern channels. One explanation is that ownership of valuable assets such as vehicles, especially four-wheeled vehicles, provides flexibility to farmers in choosing buyers of their crops, so that they tend not to sell on one hand, which might reduce the chances of farmers participating in modern markets.

### 5.1. The estimation of Average Treatment Affect (ATT)

The results of the estimation of treatment effect (ATT) that indicate the impact of farmer participation in the modern retail marketing channel on farmers' gross income per hectare are presented in Table 7. There is heterogeneity of the impact of farmer participation on modern market channels, although farmer participation in modern markets can increase gross income and farm household consumption. However, it is unable to improve household food coping strategies and the total income of modern farmers.

The test results of the difference between farmers' gross income per hectare show that farmers involved in modern markets tend to have higher gross income per hectare compared to traditional

**Table 5. Determinants of participation in modern marketing channels and its impacts on food consumption scores**

Variable	Participation		Food Consumption Scores			
			Modern channel		Traditional channel	
Constanta	-1.42	(1.74)	28.6	(4.59)***	32.35	(3.89)***
Age	-0.01	(0.07)	0.14	(0.14)	-0.03	(0.16)
Age square	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Child5	0.09	(0.24)	-0.08	(0.79)	0.79	(0.55)
Experience	0.01	(0.01)	-0.02	(0.03)	-0.1	(0.04)***
Education	-0.04	(0.04)	0.11	(0.09)	0.12	(0.09)
Off-farm	0.06	(0.30)	-1.03	(0.79)*	-0.72	(0.46)
Household size	-0.12	(0.12)	0.63	(0.26)*	0.77	(0.27)***
Assets	-0.03	(0.25)	1.75	(0.84)	1.11	(0.51)**
Land area	-0.05	(0.24)	-1.46	(1.33)	1	(0.46)**
Credit access	0.49	(0.24)	-0.16	(0.57)	-1.97	(0.58)***
Capital access	0.64	(0.46)	-0.47	(1.19)*	-2.82	(0.65)***
Road access	0.34	(0.10)***				
Public facilities	-0.1	(0.02)***				
Trader network	0.19	(0.11)***				
Agricultural market	1.25	(0.50)***				
Res (Fin_distance)	0.21	(0.46)				
Ins1			0.9	(0.12)***		
Ins2					1.09	(0.11)***
Log likelihood	-819.43					
Wald test of indep. eqns.	3.14					

Note: \*, \*\*, \*\*\* denote significance on 10%, 5%, and 1 % respectively and numbers in parentheses indicated standard deviation values

farmers (see different test tables). This result is in line with the results of the ATT value estimation which is accommodating the possibility of selection bias in the selection of research samples. The results of the study show that participation in modern market channels can significantly increase gross income per hectare of chilli farmers by 1.86 percent. This result is consistent with the findings of Rao and Qaim (2011) in Kenya. This result implies that the modern delivery channel is able to guarantee the stability of prices received by farmers so as to enable gross income received by farmers to be relatively better than traditional farmers. One of the most important benefits of the involvement of farmers in modern retail channels is the guarantee of marketing and price stability. These two aspects are often not found in most traditional farmers, so that price volatility is something that continues to stick to the lives of traditional farmers.

Table 7 also shows that farmer participation in modern markets is able to increase farmers' food consumption scores. By being involved in the modern market, farmers' consumption scores increased by 4.19 percent compared to traditional farmers. This indicates that farmers' involvement in modern markets tends to increase farmers' food security because farmers are able to diversify the food intake they consume daily as shown by the relatively high food consumption scores.

This research also reveals interesting results. One of which was that farmers who did not participate in modern market channels tend to have a scoping strategy in overcoming conditions where food access and availability were limited or disturbed. This result, as shown in Table 7, shows that farmer participation in modern marketing operations decreases the value of food cope strategies by 5.06 percent. One explanation for this result is that farmers in this group often face uncertainty in

**Table 6. Determinants of participation in modern marketing channels and its impacts on household income**

Variable	Participation		Household Income			
			Modern channel		Traditional channel	
Constanta	-0.09	(2.14)	-0.02	(0.01)***	16.72	(0.66)
Age	-0.07	(0.07)	0.00	(0.00)	0.00	(0.02)
Umur2	0.00	(0.00)	0.19	(0.07)**	0.00	(0.00)
Child5	0.20	(0.35)	0.00	(0.00)	0.12	(0.11)
Experience	0.01	(0.01)	0.03	(0.01)***	0.00	(0.00)
Education	-0.02	(0.04)	-0.22	(0.07)***	0.01	(0.01)
Off-farm	0.35	(0.29)	0.09	(0.03)***	-0.05	(0.10)
Household size	-0.09	(0.13)	0.04	(0.08)	0.10	(0.05)**
Assets	-0.10	(0.26)	0.22	(0.08)***	0.29	(0.13)**
Land size	0.06	(0.27)	-0.06	(0.07)	0.47	(0.16)***
Credit access	0.19	(0.28)	-0.39	(0.07)***	-0.22	(0.12)*
Capital access	0.78	(0.47)*	0.23	(0.04)***	0.12	(0.17)
Road access	0.30	(0.18)*				
Public facilitation	-0.12	(0.05)**				
Trade network	0.25	(0.11)***				
Agricultural market	1.50	(0.54)***				
Res (Fin_distance)	0.12	(0.35)				
Ins1			-1.02	(0.45)**		
Ins2					-0.95	(0.14)***
Log likelihood	-225.542					
Wald test of indep. eqns.	0.79					

Note; \*, \*\*, \*\*\* denote significance on 10%, 5%, and 1 % respectively and numbers in parentheses indicated standard deviation values

price and income. So, they tend to be able to apply coping strategies such as reducing food portions, changing food types, or taking important actions such as finding work outside the village or city or send children to work outside the village or abroad. This result is also in line with the average treatment effects (ATE) of income (measured by proxy for total family expenditure) where farmers who live below and above poverty line, groups of farmers who are not involved in modern markets, tend to have a higher total income than farmers involved in modern markets. One possible explanation is that the coping strategies carried out by these groups by looking for and/or sending a family member out of the village or abroad are able to provide more income to the family.

### 6. Conclusion and implication

The study analyzed the impact of the penetration of modern food retailing on food security and small holder farmers' welfare by using data obtained from a survey involving 300 farmers from 2 villages in Malang and Kediri Districts. Samples of this study were farmers involved in the supply chain of modern and traditional food retailers, which were determined using the simple random sampling method. The study used the Endogenous Switching Regression (ESR) to estimate factors that explain why farmers choose to participate or not to participate in modern retail supply chains. Average Treatment Effect (ATE) and endogenous switching regression analysis to evaluate the impact of farmer participation in the modern food retail supply chain for income, food security and poverty status of farmers. The results of this study indicate that education, market access and access to capital determine the participation of farmers in modern retail marketing channels. The ATE results show that farmers' involvement in the modern marketing channel can increase gross income and variations in food consumption or increase food security (as one indicator of diversity of food accessibility). Nonetheless,



**Table 7. Impact of farmer participation in modern marketing channels on gross income, food security and welfare of farmers**

Outcome	Outcome average				ATT	t-Value	Change (%)
	Modern channel	Traditional channel	ATT	t-Value			
Gross Income	18.39 (0.78)	18.05 (0.78)	0.34	2.60**	1.87		
Food Coping Strategies	46.91 (13.77)	49.41 (12.95)	-2.50	2.23**	-5.06		
Food Consumption Scores	33.23 (1.36)	31.90 (1.26)	1.84	7.12**	4.19		
Household income	34400000 (7340000)	39100000 (9094986)	-7922931	-7.26	-12.02		
Over poverty line	34200000 (11300000)	42100000 (9874534)	-4646514	-1.57	-18.77		

Note: \*\*, \*, and 1 % denote significance on 10%, 5%, and 1 % respectively and numbers in parentheses indicated standard deviation values

participation in modern food systems has not been able to improve the coping strategies of farmers in facing situations where food access has limitations or disturbances. Likewise, farmer participation in modern food systems has not been able to encourage farmers to gain access to other livelihoods.

This study provides information that the presence of a new system in marketing can at least increase farmer income through price and demand stability. This brings the implication that the improvement of smallholder farmer income could be done by encouraging the cooperation between farmers and actors in the marketing system that have a relatively stable demand from consumers. By encouraging cooperations with agribusiness actors/business entities that have been established, it is expected that the certainty of prices and demand for farmers will be even greater. The model that can be developed can be in the form of marketing contracts or farming contracts with farmers to be alternatives that can be offered to improve farmers' welfare. The next implication is that this can lead to increased purchasing power, consumption that indirectly strengthens the food security of engaged farmers.

One aspect this research has not addressed is whether the increase in farm income from the participation results is used for saving or agricultural investment or health investment or even for consumptive purposes so that it is unable to increase income generating activities such as farmers who are not involved in the system modern retail marketing that have a higher total income. Further research is needed to find out how the income is allocated for various activities and their impact on productivity and health of farmer families.

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#### Note

1. Modern food retailers refer to hypermarkets, supermarkets, and minimarkets. Hypermarkets are very large modern stores that occupy more than 8,000 square meters, have at least 10 or more cash registers, and sell both food and other groceries. Supermarkets are medium to large modern stores that occupy between 300 and 8,000 square meters, have 3–9 cash registers, and sell both food and other groceries. Convenience stores, or minimarts, are small modern

stores with 1–2 cash registers (Suryadarma et al., 2010). I use the term *supermarkets* as shorthand for different groups of modern food formats, and I differentiate the group (hypermarkets, supermarkets, and minimarkets) only when necessary.

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