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Price Transmission of Tomatoes to Supply Factories in the Upper Northeastern Region of Thailand: Pairwise Granger Causality Analysis

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Abstract: The research aims to study the price transmission of tomatoes to supply factories in the upper northeastern region of Thailand by considering six provinces in the upper Isan region which are Nong Khai, Roi Et, Sakon Nakhon, Nakhon Phanom, Kalasin, and Bueng Kan by studying monthly time series data from 2011 to 2017. The analysis employs the unit root test and Pairwise Granger Causality. The results reveal that all variables are stationary at the level $I(0)$. The findings of the Pairwise Granger Causality tests revealed that the price of tomatoes to supply factories at Nong Khai and Nakhon Phanom affect prices especially in Sakon Nakhon. The prices in Nakhon Phanom and Bueng Kan affect the price of tomatoes for factories in Nong Khai. Additionally, the price in Nakhon Phanom affects the price of tomatoes to supply factories in Bueng Kan. As a result, the government and related units should search for a mutual measurement that regulates price of tomatoes to supply factories in order to facilitate access to price information and to reduce the price volatility that might occur in each production season.

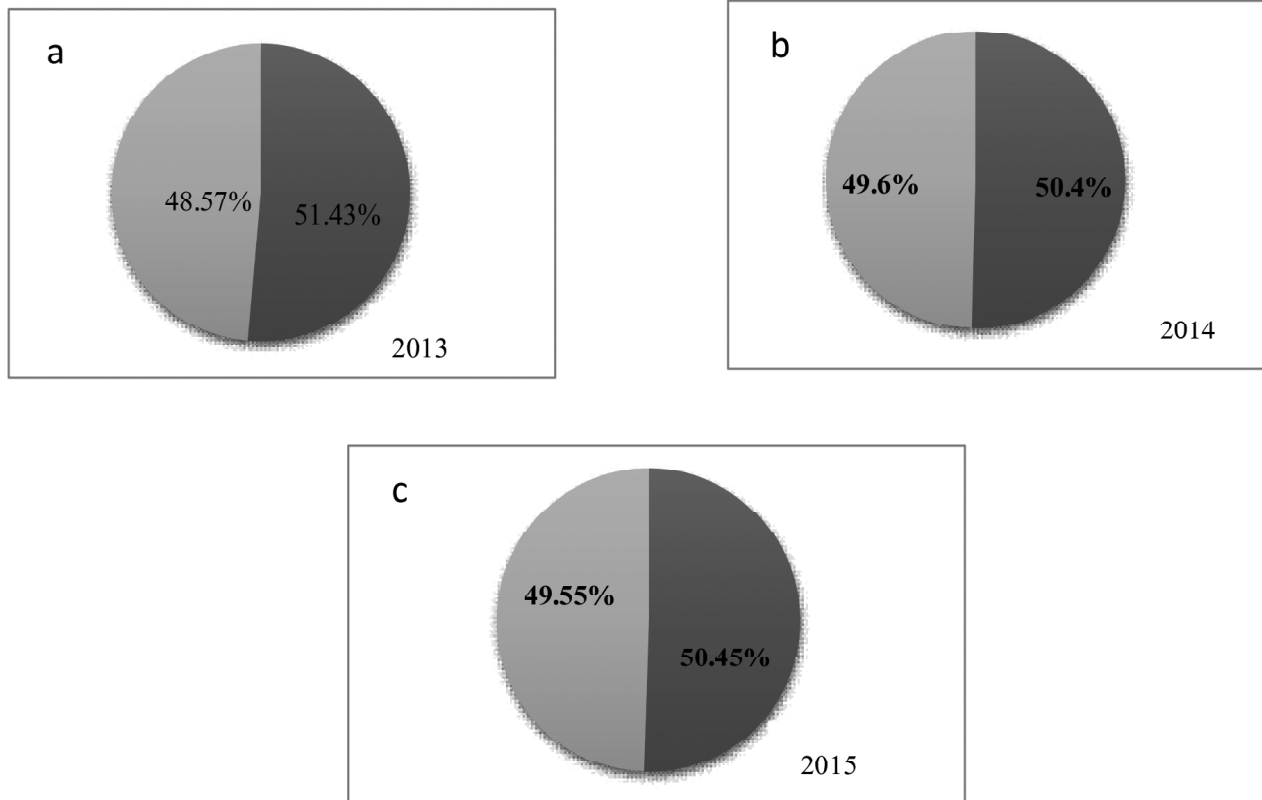
Keywords: Price transmission; tomato; price of tomatoes

JEL: Q1, M2

1. INTRODUCTION

The production of tomatoes to be delivered to factories has expanded to every region of Thailand. The major tomato plantation areas are in the north and northeastern regions. In the northeastern region, the large tomato factories are located in the upper Isan because the climate is appropriate to grow tomatoes. During the cold weather when there is and less humidity, foliar disease of tomatoes is slightly epidemic. Because the area is near the Mekong River, which is rich in natural resources, minerals, and sandy loam, it is best area for tomato farming. There is tomato farming in the south of Thailand as well but due to the tropical climate, there is lower productivity with lower quality.

When considering the tomato farming area in Figure 1, it reveals that the northeastern region is the region which has the highest number of tomato factories. In regard to the statistics report of the Office of Agricultural Economics in the years 2013, 2014, and 2015, the tomato farming area ratio in the Northeastern region as a proportion of domestic tomato farming was 48.57% 49.60% and 50.45%, respectively. The area in the northeastern region which has the highest number of tomato factories is the upper northeastern area.

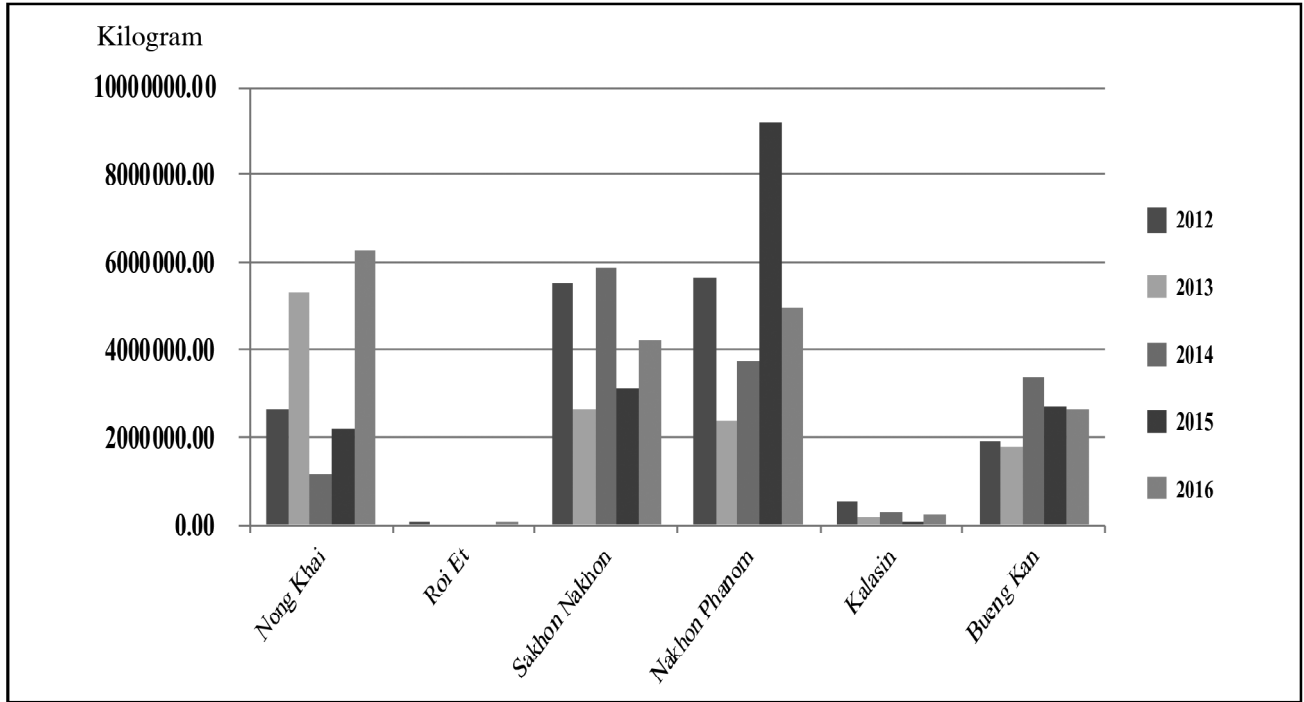


Notes: Calculation from the Communication and Information Centre at the Department of Agricultural Extension (2017)

Figure 1: Tomato farming area ratio of the Northeastern region as a proportion of the total domestic farming area

Due to the appropriate climate and the abundance of national resources that benefit the growth of tomatoes, it is evident that in the upper northeastern region or upper Isan, tomatoes are regarded as one of the most important economic plants and are grown widely by agriculturalists. Regarding the provincial level in the upper Isan, the amount of product harvested is shown in Figure 2.

According to Figure 2, it can be said that the greatest quantity of harvested tomatoes to be delivered to factories are from the upper Isan region. In every province, the quantity is different. In the latest year, Nong Khai harvested 6,296,333 kg. In Sakon Nakhon, 4,195,500 kg. was harvested. In Kalasin and Bueng Kan, the quantities of products were 260,000 kg and 2,641,173 kg, respectively. In total, the product quantity in the Isan region is quite large. In addition, the quantity, in each province may depend on the location of the tomato processing factories and may affect the product price, which is the motivation for production, and the stability or volatility of the price as shown in Figure 3.



Source: Communication and Information Centre at the Department of Agricultural Extension (2017)

Figure 2: Quantity of Harvested Tomatoes

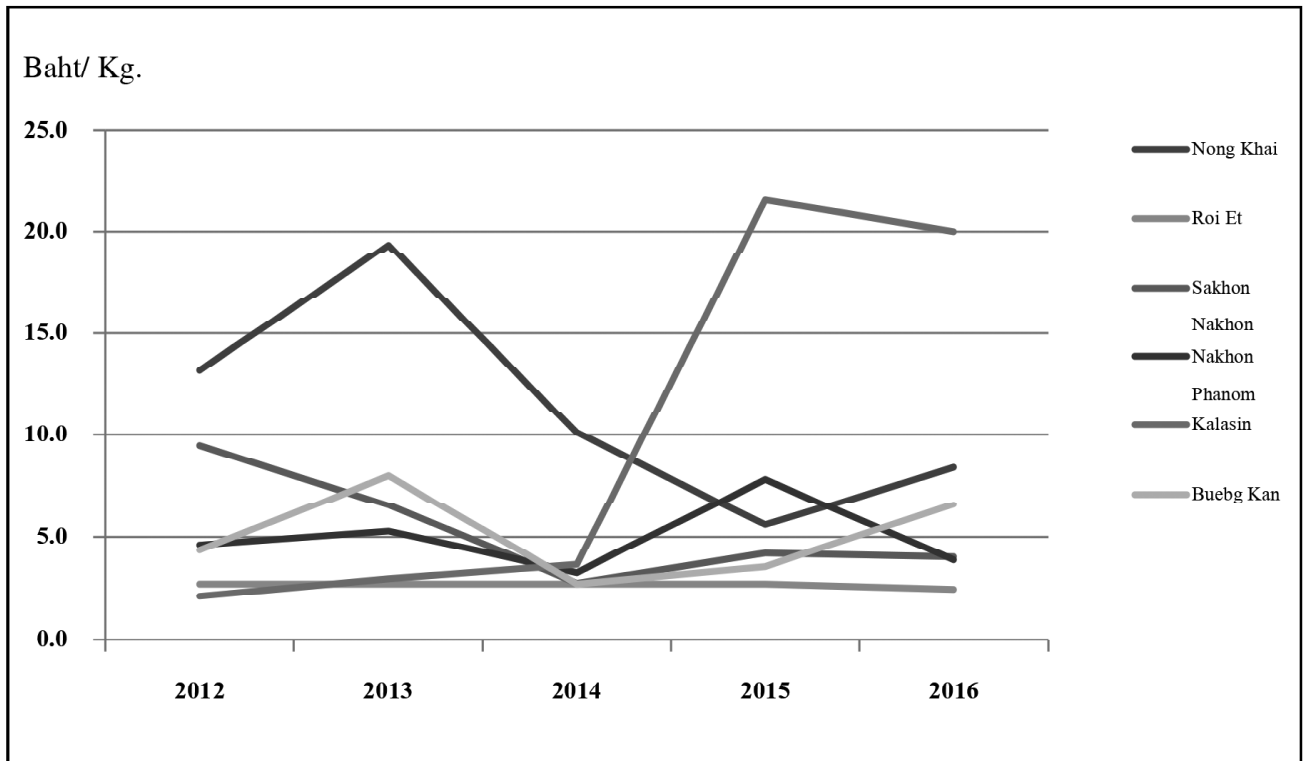


Figure 3: Price of Factory Tomatoes

Normally, there are two types of tomato cultivation, which are farming for consumption and farming for sale. Tomatoes are sold in fresh market and to processing factories and the prices are different for each. Nonetheless, according to Figure 3, it is apparent that during the last five years, the factory price of tomatoes has not been constant; the price has been highly volatile. It is clear that the factory price for tomatoes has fluctuated and is not stability.

As previously mentioned, it is clear that the market price and the factory price for tomato is highly volatility and unstable. There have been no studies of this issue in the upper northeastern area. In consequence, there should be a study on the price transmission for tomatoes at factories in the upper Isan region as to how the factories in each province affect the tomato prices in other provinces and how the price of each province affects the prices in other provinces.

As a result, the study should include the price behavior in every province and includes the prices in other province. This may lead to better marketing planning for tomatoes at factories in the upper northeastern region. The development of policy innovations related to tomatoes for factories will allow agriculturalists to receive the highest benefits from sales and limit the volatility of tomato prices.

The study on the price transmission of tomatoes at factories in the upper north eastern region included 6 provinces which are Nong Khai, Roi Et, Sakon Nakhon, Nakhon Phanom, Kalasin, and Bueng Kan. In these 6 provinces the quantity of tomatoes for factories represents 50% of the entire production tomatoes for factories in the entire country. The next section presents the relevant literature; section 3 describes the research methodology which covers the data and data analysis, section 4 presents the empirical results, and section 5 presents the conclusions.

2. LITERATURE REVIEW

In a market driven economy, the pricing mechanism is expected to transmit orders and directions to determine the flow of marketing activities. Pricing signals guide and regulate production, consumption and marketing decisions over time, form and place (Kohls and Uhl, 2002: pp.159-160). Identifying the causes of price differences in interregional or spatial markets has therefore become an important economic analytical tool to better understand markets.

Spatial market integration refers to co-movements or the long run relationships of prices. It is the relationships of prices in terms of space, time and from markets under competitive market condition (Kohls and Uhl, 2002: pp.160). Where there are two market for agriculture products, the price is assumed to be integrated which results in an identical price in both markets (Barrett, 1996). Therefore, market integration can be measured by price transmission. In particular, price transmission has a potential role for agriculture products because, based on theory, it is assumed to be a perfectly competitive market.

In the case of price transmission, market integration theory was employed to explain integration in the market. Price transmission is currently a very popular concept among agricultural economists. The price transmission concept follows market integration based on the Law of One Price theory (Barrett, 1996; Ravallion, 1986). In addition, there are many products that have been studied in terms of the price transmission concept such as the cantaloupe market, the fish market and the rice market.

In this study, the focus is on tomatoes for factories in upper North-eastern Thailand, The factory tomato can be assumed to be an endogenous product. It is also produced in many places in the North-

eastern region of Thailand. In addition, the factory tomato is not supported by the Thai government. Hence, the regulation of fluctuations in factory tomato prices in each province of the north-eastern region could help to improve the process of price transmission.

3. RESEARCH METHODOLOGY

3.1. Data

The study on the price transmission of tomatoes for factories in the upper North eastern region included 6 provinces which are Nong Khai, Roi Et, Sakon Nakhon, Nakhon Phanom, Kalasin, and Bueng Kan. Secondary data were collected from the Communication and Information Centre at the Department of Agricultural Extension in Thailand. The study applied monthly time series data from 2011 to 2017 due to the increasing tendency of the production quantity.

3.2. Data analysis

The quantitative analysis applied to analyze the objectives of the study on the price transmission of tomatoes for factories in the upper Northeastern region was the unit root test by employing Dickey & Fuller (1981). The variable needs to be stationary at the level or $I(0)$. Then we can proceed to the Pairwise Granger Causality test which is a common way to test causal relationships between two variables as proposed by Granger (1969). The details are as follows:

Pairwise Granger Causality tests the variables “and “using the equation shown below (price transmission model of tomato).

$$\Delta P_{it} = \alpha_1 e_{t=1} + \sum_{i=1}^k \Delta P_{jt} + \varepsilon_{it} \quad (1)$$

$$\Delta P_{jt} = \alpha_2 e_{t=1} + \sum_{i=0}^k \pi_i \Delta P_{it} + \varepsilon_{it} \quad (2)$$

Substitute

Price of tomatoes for factories in a province = i

Price of tomatoes for factories in a province = j

Setting ($i \neq j$)

i = Price of tomatoes for factories in Nong Khai, Roi Et, Sakon Nakhon, Nakhon Phanom, Kalasin, and Bueng Kan

J = Price of tomatoes for factories in Nong Khai, Roi Et, Sakon Nakhon, Nakhon Phanom, Kalasin, and Bueng Kan

P_{it} and P_{jt} have the cointegration relation to each other when the coefficient α_1 , α_2 , at least 1 value is not equal to 0.

If $\alpha_1 \neq 0$ and $\alpha_2 \neq 0$ represents P_{jt} affects P_{it}

If $\alpha_1 \neq 0$ and $\alpha_2 \neq 0$ represents P_{it} affects P_{jt}

If $\alpha_1 \neq 0$ and $\alpha_2 \neq 0$ represents P_{it} and P_{jt} have not effect.

4. EMPIRICAL RESEARCH

The unit root test tests the variables with a stationarity quality. With the Augmented Dickey Fuller (ADF) test by Mackinnon (1996), the 6 variables in the research are the Price of tomatoes for factories in Nong Khai (P_1), Price of tomatoes for factories in Roi Et (P_2), Price of tomatoes for factories in Sakon Nakhon (P_3), Price of tomatoes for factories in Nakhon Phanom (P_4), Price of tomatoes for factories in Kalasin (P_5), and Price of tomatoes for factories in Bueng Kan (P_6). According to Unit root test of these variables shown in Table 1, the result shows that the every variable in this study has a stationarity quality. As in the test, all variables consist of intercept, trend and intercept, and lastly no trend and intercept. It is evident that every variable has a stationarity level or I(0) with reliability at 99%; therefore, the causality testing by Pairwise Granger Causality can proceed.

Table 1
Unit root test results

Variables	Intercept		Trend and intercept		None	
	t-Statistic (Lag)	stationary	t-Statistic (Lag)	stationary	t-Statistic(Lag)	stationary
P_1	-3.77*** [0]	I(0)	-3.79** [0]	I(0)	-2.76**[0]	I(0)
P_2	-6.54*** [0]	I(0)	-5.90***[0]	I(0)	-6.41***[0]	I(0)
P_3	-6.11*** [1]	I(0)	-6.25***[1]	I(0)	-2.89**[2]	I(0)
P_4	-4.408***[0]	I(0)	-4.40** [0]	I(0)	-2.57**[0]	I(0)
P_5	-3.00** [1]	I(0)	-3.51** [1]	I(0)	-2.01** [1]	I(0)
P_6	-3.88** [0]	I(0)	-3.88** [0]	I(0)	-2.79**[0]	I(0)

Note: ** and *** at the 95% and 99% respectively

Prior to the next process, the Lag selection process, there should be a characteristic that turns disturbance ε_t gain White noise quality. In this case, it is an effort to eliminate the disturbance's advanced relation problem and to prevent the loss of the variable's independence at the same time. Regarding AIC and SC from the Table 2, the lags that provides the lowest values of AIC and SC are different, whereas Lag AIC gives the lowest value at Lag 1 with AIC = 28.00* and Lag SC gives the lowest value at Lag 1 with SC = 29.38*. It can be concluded that the appropriate Lag is Lag 1.

Table 2
Lag testing

Lag	AIC	SC
0	32.3306	32.5265
1	28.0010*	29.3719*
2	28.0774	30.6233
3	28.6893	32.4103
4	28.8651	33.7610

Note: * Lag critical value point

In the next step, from Table 3, which presents the price transmission of tomatoes to supply factories with the Pairwise Granger Causality test (Granger, 1969), it is demonstrated that the price of tomatoes to supply factories in Nong Khai (P_1) is not the cause affecting the price of tomatoes to supply the factories in Roi Et, Nakhon Phanom, Kalasin, and Bueng Kan. The price of tomatoes to supply factories in Nong Khai is the cause affecting the price of tomatoes to supply factories in Sakon Nakhon only at 99% reliability.

Although the price of tomatoes to supply factories in Nong Khai is not the cause affecting the price of tomatoes to supply factories in other provinces, some provinces are the cause affecting the price of tomatoes to supply factories in Nong Khai, which is Nakhon Phanom and Bueng Kan at 95% reliability. Moreover, the price of tomatoes to supply factories in Roi Et does not affect the price of tomatoes in Sakon Nakhon, Nakhon Phanom, Kalasin, and Bueng Kan. The prices of tomatoes to supply factories in Sakon Nakhon, Nakhon Phanom, Kalasin, and Bueng Kan do not affect the prices of tomatoes to supply factories in Roi Et. Next, the price of tomatoes to supply factories in Sakon Nakhon does not affect the price of tomatoes in Nakhon Phanom, Kalasin, and Bueng Kan.

Table 3
Pairwise Granger Causality Results

<i>Pairwise Granger Causality</i>	<i>Level of Confidence</i>	<i>Type for Causality</i>
$P_1 \longleftrightarrow \times P_2$		No causality
$P_1 \xrightarrow{\quad} P_3$ $\leftarrow \times$	99%	Uni-directional causality
$P_1 \xrightarrow{\quad} \times P_4$ \leftarrow	95%	Uni-directional causality
$P_1 \longleftrightarrow \times P_5$		No causality
$P_1 \xrightarrow{\quad} \times P_6$ \leftarrow	95%	Uni-directional causality
$P_2 \longleftrightarrow \times P_3$		No causality
$P_2 \longleftrightarrow \times P_4$		No causality
$P_2 \longleftrightarrow \times P_5$		No causality
$P_2 \longleftrightarrow \times P_6$		No causality
$P_3 \xrightarrow{\quad} \times P_4$ \leftarrow	95%	Uni-directional causality
$P_3 \longleftrightarrow \times P_5$		No causality
$P_3 \longleftrightarrow \times P_6$		No causality
$P_4 \longleftrightarrow \times P_5$		No causality
$P_4 \xrightarrow{\quad} P_6$ $\leftarrow \times$	95%	Uni-directional causality
$P_5 \longleftrightarrow \times P_6$		No causality

Source: From calculation

For Bueng Kan, the tomato price is not the cause affecting the price of tomatoes to supply factories in Sakon Nakhon as well. Only the price of tomatoes to supply factories in Nakhon Phanom is the cause affecting the price of tomatoes to supply factories in Sakon Nakhon at 95% reliability. However, the price of tomatoes to supply factories in Nakhon Phanom is not the cause affecting the price of tomatoes to supply factories in Kalasin and the price of tomatoes to supply factories in Kalasin is not the cause affecting the price of tomatoes to supply factories in Nakhon Phanom.

On the other hand, the price of tomatoes to supply factories in Nakhon Phanom is the cause affecting the price of tomatoes to supply factories in Bueng Kan at 95% reliability, but the price of tomatoes to supply factories in Bueng Kan is not the cause affecting the price of tomatoes to supply factories in Nakhon Phanom. Finally, the price of tomatoes to supply factories in Kalasin and the price of tomatoes to supply factories in Bueng Kan do not affect each other.

5. CONCLUSIONS

From the study of the price transmission of tomatoes to supply factories in the upper Isan region, according to the Pairwise Granger Causality test, the price of tomatoes to supply factories in Nong Khai and Nakhon Phanom are the cause affecting the price only in Sakon Nakhon while the price of tomatoes to supply factories in Nakhon Phanom and Bueng Kan are the cause affecting the price only in Nong Khai. The price of tomatoes to supply factories in Nakhon Phanom is the cause affecting the price of tomatoes to supply factories in Bueng Kan.

Apart from the aforementioned examples, the tomato price in each province has no causality. This indicates that the price of tomatoes to supply factories or the price of products in one province may depend on the distance from the production location to the factory when the factory is located in another province, and the price of tomatoes or the product of the province where the factory is situated may affect the price of tomatoes or products in another province.

As mentioned above, and in accordance with the study on price transmission of tomatoes to supply factories in the upper Isan region, the change in the tomato price at the provincial level influences the change in tomato price in other provinces. It might include changes at the provincial and the regional level as well.

From the results, the government and related units should have common measurements for the price policy of tomatoes to supply factories which are appropriate to every province in order to enhance the understanding of the information on tomato prices in the harvesting season. Moreover, they should plan the production of tomatoes which are sent to major processing factories in the upper northeastern region so that the tomato products can be delivered to the factories continuously, resulting in the stability of buying prices and decreasing the volatility of tomato prices in every province.

In addition, the government and related units should enhance policy innovation affecting tomatoes to increase the product's values for the agriculturalists so that they can receive greater benefits. Furthermore, when the products enter the market, they will be accepted as a result of their higher quality. The government should promote and develop tomato farming by transferring knowledge and technology to the farmers, which will decrease their problems in tomato cultivation.

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