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The Efficiency of the Vegetable Market in Northern Thailand

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Abstract
In mountainous areas of Northern Thailand the commercial production of vegetables has become commonplace for many farmers over the past two decades. Vegetables often fetch higher prices than staple crops but also are subject too higher production and marketing risks. The objective of this study is to determine factors influencing market efficiencies in the vegetable markets based on a case study in Northern Thailand. It is hypothesized that the factors influencing market efficiency differ by commodity and that market structures differ significantly among vegetables. Correlation coefficients by Pearson are used to analyze pricing efficiency. In a second step correlation coefficients are expressed as a function of a set of marketing costs, operational costs, margins and qualitative characteristics of the markets. The results show that the Cabbage, Carrot and Onion market are similar in structure and the same factors influence the market efficiency of the latter two markets. In comparison the structure of Tomato market is different and adheres to a different set of assumptions than the other three.

1 Background and Justification of the Study

In mountainous areas of Northern Thailand various types of fruits and vegetables were introduced in the late 1970's early 1980's by various domestic institutions and international organizations (RENARD, 2001). Many of these crops are of temperate nature and grow well in the cooler mountainous regions of the Kingdom. Over the past decades the production and marketing of fruits and vegetables in these mountainous regions has become increasingly commonplace as physical infrastructure and experience in the production of these crops has improved continuously. In addition consumers began to demand more higher value vegetables in response to demand generated out of income increase and tourism.

An increase of marketed crops calls for larger and improved market facilities. If markets function efficiently farmers allocate their resources according to their comparative advantage and intensify their production. In turn an efficient farm marketing system is an important means for raising the income levels of farmers and for promoting the economic development of a country (TAMIMI, 1999). Therefore, this paper will analyze market efficiency for higher value commodities taking vegetables as an example in Northern Thailand. For the analysis four vegetables, cabbage, carrot, tomato and onion were selected, as these are typical temperate vegetables produced in mountainous areas of Northern Thailand. Daily prices were collected at eleven markets over a year's time. In addition information extracted from semi-structured interviews with traders and vendors are used to determine factors influencing market efficiency and to interpret results.

2 Objective and Hypothesis

Market prices for vegetables fluctuate due to various factors such as seasonality, perishability, short shelf life and heterogeneity in product quality. As price volatility can jeopardize farmers' income situation it will be analyzed if price volatility is the result of market and pricing inefficiencies. Thus, the overall objective if this study is to determine the efficiency of the vegetable market in Northern Thailand. More specifically it is the objective to determine which factors influence market efficiency. In this study it is hypothesized that no single explanation can account for the price behavior of all commodities. Instead, each commodity appears to exhibit its own peculiarities and the key to understanding the price behavior of each commodity lies ultimately in the microstructure of the market of each commodity.

3 Methodology

Market efficiency is imperative in market-induced development and key to generating utility and economic growth. In a Pareto optimum sense - market efficiency can be expressed as the consumer surplus plus the producer surplus minus marketing costs. This implies that total surplus is largest when the consumer price is equal to the producer price plus marketing costs (TAKAYAMA AND JUDGE, 1971 ET AL). Thus, market efficiency has two dimensions. First prices must incorporate all available information in order to maximize welfare gains summed from consumer and producer surpluses, and second marketing costs must exclude rents. Therefore, both pricing efficiency and marketing costs are examined in this study.

Pricing efficiency can be defined as the ability of a marketing system to efficiently allocate resources and coordinate the food production and marketing process in accordance with consumer directives (KOHLS AND UHL, 1985). For this study pricing efficiency is measured in terms of correlation of price movements of the same products in different markets *i* and *j*. Here correlation coefficients by Pearson are used to assess the correlation between market pairs (Equation 1) (KOUTSOYIANNIS, 1977).

$$CC_{ij} = \frac{n\sum ij - \sum i \sum j}{\sqrt{\left[n\sum i^2 - (\sum i)^2\right]\left[n\sum j^2 - (\sum j)^2\right]}} \quad (1)$$

The structure of costs have several components, which can be divided into marketing costs, these are costs that vary with traded quantities, such as transport costs. Operational costs are defined as costs independent of the quantity traded, for example market fees; and profits are the residual returns to non-traded inputs such as family labor. An approach to estimate the influencing parameters of market efficiency suggested by Raju and von Oppen (1982) and also used by Tamimi (1999) is followed here as the basis of analysis. This approach captures both pricing efficiency and the structure of costs involved in marketing. In addition to these quantitative factors other qualitative information such as parking availability are included in the model as it is assumed that these factors also influence domestic market efficiency. Thus, pricing efficiency measured as a correlation coefficient is a function of various factors such the distance between two markets D_{ij}, daily stand fee S_{ij}, yearly market entry fee Y_{ij}, income level of consumers W_{ij}, parking availability P_{ij}, hygienic condition of the market C_{ij}, number of hours the market is open per day H_{ij}, where the market is situated T_{ij} and U_{ij}, market margins M_{ij}, and size of the market Sz_{ij} (Equation 2).

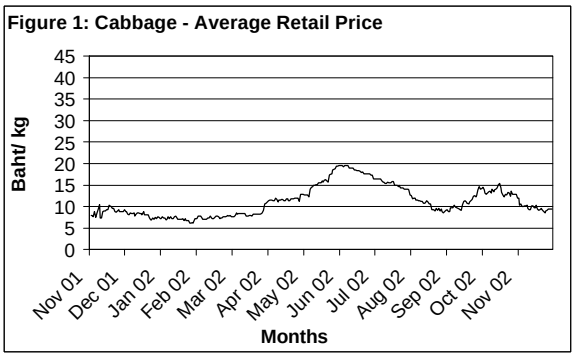
$$CC_{ij} = f(D_{ij}, St_{ij}, Y_{ij}, W_{ij}, P_{ij}, C_{ij,} H_{ij}, T_{ij}, U_{ij}, M_{ij}, Sz_{ij}) \quad (2)$$

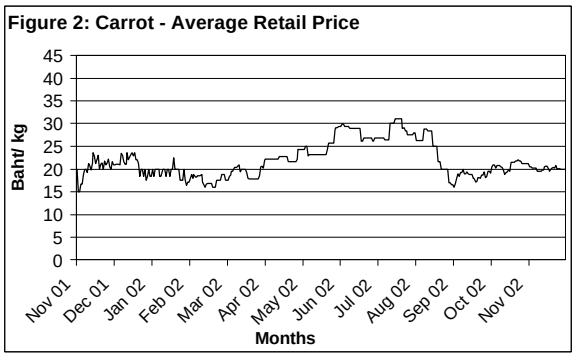
4 Description of the market

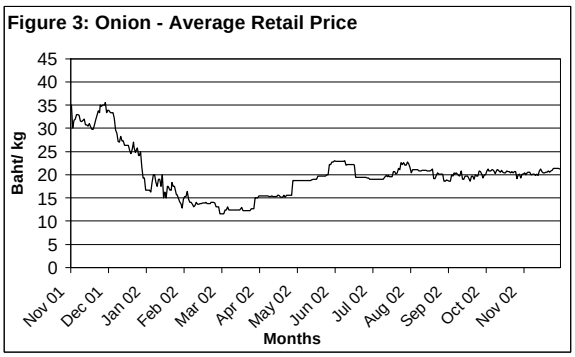
Of the eleven markets used to test market efficiency five are situated within Chiang Mai City, 5 are in outskirt districts of Chiang Mai Province and one market is in the neighboring province Lamphun. In average the markets within the city are spread out over a 3,5 km radius and markets in outskirt districts over a 12 km radius. The market in Lamphun is approximately 35km distant from Chiang Mai City. All markets are retail markets expect for one market located in the city, which is the most important wholesale market of the Northern region. All of the retail markets purchase their commodities from this wholesale market in Chiang Mai City expect for Lamphun and occasionally San Pa Tong market, which also buy from another a wholesale market in Lamphun.

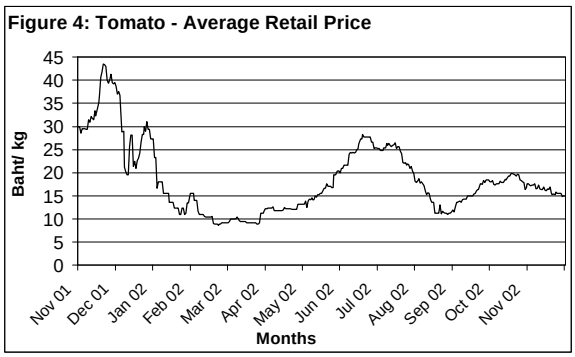
4.1 Market Prices and Margins

As we can see in Figures 1 to 4 the daily price movements over a year are characteristically different between crops. The prices collected relate to one variety and the premium grade (Grade 1 or Grade A) for each individual crop. Cabbage and carrot can be grown all year round and harvested up to three to four harvests per year, however both commodities are most abundant during the winter months due to easier and less costly plant management. For cabbage we can see that seasonal fluctuations are more pronounced than short-term price variations. In comparison carrots seem to have starker fluctuations within a month and less seasonal differences. Both of the top graphs do show higher prices during the rainy season (June to August) and lower prices during the winter months (November to February). Onion shows a very different picture with nearly stable prices from May through November, an increase in December and a continuous fall in prices thereafter until May. Onions are storable products and traders have a cooperative regulating the supply and thus the price. Onions are harvested in winter around January leading to a large supply.









Due to the demand of ready cash for farmers directly after harvest and limitations in storage capacity the amount of onions in the market increases and thus prices fall during the first months after harvest. Tomatoes can be produced all year round and can also be harvested multiple times a year, however tomatoes fluctuate continuously throughout the year. Compared to the other two graphs described previously there is a large difference between the Onion and Tomato price of November 2001 and November 2002 due to an overall higher production in 2002. Average retail prices for the four crops can be seen in Table 1. Cabbage has the lowest price while the other three commodities are higher priced. This is due to the large abundance and its central role as a vegetable in the Thai kitchen. When comparing the product prices across markets we can see that Cabbage and Tomatoes are most expensive at Ton Payom, Onion at San Pa Tong and Carrots at Hang Dong market. Although the highest price by commodity varies across markets in average prices are highest at Ton Payom followed by Hang Dong. The market margins (the difference between the buying (wholesale) and selling (retail) price of a certain product at a specific market) are highest at Hang Dong Market followed by Ton Payom Market. The reason for higher margins of these two markets is related to various factors. Hang Dong market is very new with much space for parking and has a good market infrastructure.

Table 1: Average Prices and Margins by Vegetable and Market (Baht/kg)

		Cabbage		**Carrot**		**Onion**		**Tomato**	
		Price	**Margin**	**Price**	**Margin**	**Price**	**Margin**	**Price**	**Margin**
City Retail	**CM-Gate**	10.22	4.46	19.42	5.10	16.74	4.87	16.22	4.95
	Ton Lamyai	12.66	6.20	19.22	5.04	22.31	5.41	21.00	6.48
	Sompet	12.65	4.48	22.21	4.97	19.22	4.93	18.07	4.88
	Ton Payom	15.54	6.56	26.84	8.77	24.48	8.35	23.53	8.06
	Nong Hoi	9.48	4.77	16.44	4.33	15.82	3.96	15.31	3.79
Outskirt Retail	**Mae Rim**	11.06	4.31	21.21	5.03	19.13	4.53	17.23	4.50
	San Kampaeng	11.26	4.72	20.97	5.38	17.58	4.95	16.34	5.40
	Lamphun	10.91	4.24	17.63	6.12	17.90	3.91	18.74	5.00
	Hang Dong	14.49	7.18	27.36	9.98	24.33	9.35	21.44	7.73
	San Pa Tong	11.26	4.08	22.01	6.47	25.02	4.60	19.95	5.21
Muang Mai Wholesale		6.53	1.99	15.92	1.83	14.45	1.96	12.96	2.18

Source: Survey Data: Own calculation

Either market margins are higher due to the higher attractiveness of the market or there is a bias in the data as the prices were only collected from one retailer. Other explanations such as distance to wholesale market and other marketing cost do not hold as in comparison other markets in the outskirts of Chiang Mai such as San Pa Tong Market have higher marketing costs with a lower marketing margin. The higher marketing margins for Ton Payom market can be explained by

higher market and stands fees, greater distance to the wholesale market and its location in a neighborhood with average to higher incomes compared to other retail markets in the city.

5 Results

5.1 Results of Correlation coefficients

After looking at price movements over time, average prices and margins between markets, the question arises if the price movements at different markets correlate with each other. Although simple graphs could give some insight into the relationship between markets a statistical approach also tests the significance of the relationship between markets. Correlation coefficients are one analytical approach to examine pricing efficiency and in this study also used as a variable for further analysis on market efficiency in section 5.2. In this study the correlation coefficient between each possible combination of market pairs was calculated by crop. Before running the correlation analysis scatter plots were viewed to determine whether or not a linear relationship exists between all market pairs. Only markets with a linear relationship to each other were included in the correlation analysis as correlation coefficients are only suitable for testing linear relationships. For this analysis the price of the premium grade (meaning Grade 1 or A) is used for each crop except for Carrot. Vegetables are graded according to size, other visual characteristics and freshness, however no strict guidelines exist. Particularly in regard to size it is more difficult to grade carrots than the other round vegetables. The greater heterogeneity in visual differences of carrots leaves more room for interpretation in grading; therefore a mixture of Grade 1 and 2 is used in the correlation analysis of Carrot. During analysis it was identified that Carrots Grade 2 of Nong Hoi, Hang Dong, Lamphun and San Pa Tong correlate strongest with Carrot Grade 1 of the remaining markets. In Table 2 a summary of the results based on averages depicts the relationship between markets. In the first row the average correlation coefficient between all five markets within the city (as described in Table 2) equally ten market pairs are shown. The other groups in the first column can be explained in the same manor.

Table 2: Averages of Correlation Coefficients between Regional Groups

Market Groups	Cabbage	Carrot	Onion	Tomato
City – City	0.69**	0.53**	0.70**	0.75**
Outskirts – Outskirts	0.61**	0.58**	0.58**	0.73**
City – Outskirts	0.67**	0.58**	0.65**	0.72**
City – Muang Mai	0.85**	0.70**	0.87**	0.90**
Outskirts – Muang Mai	0.80**	0.79**	0.89**	0.92**
Total Average	**0.70****	**0.61****	**0.68****	**0.76****

** Correlation is significant at the 0.01 level

The average correlation between markets within the city is higher than between markets in the outskirts of the city. This is natural as the distance between markets in the city is less than between markets in the outskirts. Only the carrot market does not depict this causality, as there are two wholesale markets, Muang Mai Market in Chiang Mai City and Pratu Lee market in Lamphun used as references to determine Carrot price. The importance of this additional wholesale market in the outskirts seems to provide the retailers in the area with clearer price information than the markets in city have on Carrots. For Carrot, Onion and Tomato the coefficients are higher between the

market in the outskirts of Chiang Mai and Muang Mai market than between the City Retail Markets and Muang Mai Market. Only for cabbage is there a slightly stronger correlation between the retail markets in the city. The reason for these differences can be explained by the dominance of Muang Mai Market in Cabbage trade in Northern Thailand. Chiang Mai is the central gathering point to collect cabbage to be sent to Bangkok and other parts of Central Thailand. The market of the other three crops is not as heavily concentrated in Chiang Mai City as in the case of Cabbage.

5.2 Results of the Regression Analysis

Correlation coefficients determine the efficiency of a market in regard to price finding. For this study the following factors described in Table 3 are postulated to be influencing pricing efficiency. These factors were chosen on the basis of information collected from vendors during interviews at the different markets as important factors for market efficiency. In a regression analysis as explained in section 3 it is tested in which way these factors influence pricing efficiency or not.

Table 3: Overview of exogenous variables

Variables	Description	Measurement
Distance (D_{ij}):	The distance in km between market pairs	Kilometers
Stands (St_{ij}):	the daily fee in Baht vendors pay per stand size and	Thai Baht/ 1.5m x 1.0m stand and day
Yearly (Y_{ij}):	The yearly fee vendors have to the market administration	Thai Baht/ year
Wealth (W_{ij}):	The level of income of the neighborhood the market is situated in.	Rank: 1 = lower income 2 = mediocre income 3 = higher income
Park (P_{ij}):	The availability of parking opportunity for cars.	Rank: 0 = none 1 = limited 2 = plentiful
Cleanliness (C_{ij}):	The hygienic conditions of the market. Judged by eye and vendor and consumer opinions	Rank 1 = poor 2 = medium 3 = good
Hours (H_{ij}):	Number of hours a market is open in a day	Number of hours/ day
Tourist (T_{ij}):	Whether or not the market is close to the tourist areas	Dummy: 1 = in a tourist areas 0 = not in tourist area
Urban (U_{ij}):	Whether the market is located within Chiang Mai City or on the outskirts	Dummy: 1 = Rural 0 = Urban
Margins (M_{ij}):	The margin between selling and buying price by crop	Baht/ kg
Size (Sz_{ij}):	The number of stands at a market	No. of crops

For the regression analysis market pairs were used as a basis of calculation for all variables. For the endogenous variable CC_{ij} correlation coefficients depict a market pair. For the variable distance market pairs are measured as the distance in kilometers between two markets. The average between two markets is used as a proxy to pair markets for all other exogenous variables. The results of regression analysis differ between individual vegetables. The significant coefficients do not always carry the expected sign. For the variable distance a negative sign is expected, as it is logical that there is a stronger correlation between market prices with a shorter physical distance between each other. Distance is identified as a significant variable for Carrot and Tomato, however the coefficient for Carrot carries a positive sign. This is due to the fact explained above that a second wholesale market outside of Chiang Mai city has a strong influence on price determination. At markets in this study vendors and traders must pay stand fees, while only some of the markets collect a yearly market entry fee. It is assumed that higher stand fees lead to higher costs without

additional benefit, which will be compensated by an increase in price and thus market margins. An increase in market margins leads to distortions and decrease in pricing efficiency. Markets charging a yearly market entry fee typical provide retailers and traders with better services than those who do not collect such a fee. These services include access to utilities such as water and electricity, garbage disposal and sweeping and maybe even some type of storage facilities. Thus, it is assumed that markets with a strong management system are more efficient than those without and therefore a positive sign is expected. Two factors that attract consumers to a market are its cleanliness and parking availability. It is assumed that both variables carry a negative sign as these factors increases consumers willingness to pay more for vegetables in exchange for a higher degree of convenience, thus distorting pricing efficiency. It is assumed that market efficiency increases the longer a market is open per day. Markets in wealthier neighborhoods attract more demanding consumers that look for high product quality and attractive markets. Therefore, it is assumed that markets in higher income neighborhoods, located in the city and near the tourist center are more developed and in turn more efficient. For all of the variables just discussed stand fees, market entry fees, parking availability, cleanliness and location of market, carrot and onions carry the expected sign. For Tomato all of these variables carry the wrong sign except for wealth. The exact reason for this is not known. However, during interviews with tomato traders it was discovered that many traders were engaged in providing farmers with informal contracts and in buying tomatoes at the farm. Thus, other assumptions seem to hold for the tomato market. For cabbage stand fees and wealth carry signs opposite to expectations and no explanation could be found.

Table 4: Results of Regression Analysis

Variables	**Coefficients**			
	Cabbage	***Carrot***	***Onion***	***Tomato***
Distance	- 0.001	0.003**	- 0.002	- 0.001*
Stands	0.003	- 0.024**	- 0.071**	0.132**
Yearly	0.000**	0.000**	0.000**	-0.000**
Park	- 0.213	- 1.489**	- 3.833*	6.142**
Cleanliness	0.078	- 0.649**	- 1.999**	2.389**
Hours	0.030	0.159**	0.484**	- 0.885**
Wealth	- 0.245*	0.219*	0.484**	0.472**
Tourist	- 0.151	1.665**	2.975**	- 1.393**
Urban	0.119	2.802**	7.082**	- 11.759**
Margins	- 0.130**	0.481**	0.990**	- 1.865**
Size	- 0.006	-0.005**	-0.013**	0.038**
R^2	0.545	0.707	0.637	0.767

For both of the margins and size a negative sign is expected. In theory smaller market margins indicate a better pricing and marketing efficiency. However, only Cabbage and Tomato carry the expected sign. No explanation could be found why pricing efficiency increases when margins increase for Carrot and Onion. In the information gathered from vendors and traders it was discovered that price agreements were more common when many sellers were selling the same products at the market compared to if the product could only be purchased from few stands. This implies a decrease in market efficiency the larger the market is. All of the vegetables carry the expected sign again except Tomato, which can be explained by the same reasoning mentioned above.

Summary

This study focused on determining the marketing efficiency in a two-step approach. First, correlation coefficients are used to test the degree of covariability of prices between two markets. In the second step the factors influencing the price correlation of market pairs is determined. The results of the correlation analysis determine a marked relationship between all market pairs for all vegetables at a significant level. In the four individual regression analysis the factors influencing market efficiency are identified. All four models are well fitted, however the assumption made on how each factor influences market efficiency does not hold across the different vegetable markets. Thus, the hypothesizes can be accepted as each commodity exhibits its own peculiarities and the key in understanding the price behavior of each commodity lies in the microstructure of the market. The Tomato market shows strong dissimilarities compared to the other three markets. The factors influencing the efficiency of the Tomato market underlie other assumptions than those postulated for the other three crops.

Unfortunately, it was not possible to include more quantitative data such as average turnover of crops by trader or total arrival of products. Nevertheless the combination of analytical tools and selection of variables produce statistically convincing and interesting results. From this study an important learning can be drawn; it has given quantitative evidence that qualitative factors such as the cleanliness of a market and parking availability do matter in regards to market efficiency and have an impact on pricing efficiency for domestic markets.

References

BARRETT, C.B. (2001). Measuring Integration and Efficiency in International Agricultural Markets. Review of Agricultural Economics Vol. 23, No. 1: 19 - 32.

KOHLS, R.L. AND UHL, J.N. (1985). Marketing of Agricultural Products, 6th edition. New York: McMillan Press

KOUTSOYIANNIS, A. (1977). Theory of econometrics, 2nd edition. London, UK: McMillan Press

RAJU, V.T. AND VON OPPEN, M. (1982). Marketing efficiency for selected crops in Semi – Arid Tropical India. Economic Program. Progress Reports 32, International Crops Research Institute of the Semi – Arid Tropics (ICRISAT). Hyderabad, India: ICRISART.

RENARD, R.R. (2001). Opium reduction in Thailand 1970-2000 – A thirty-year journey. Bangkok, Thailand: Silkworm Books

TAMIMI, T. (1999). Investigating production opportunities, marketing efficiency and option of trade for fruits and vegetables in Palestine. Stuttgart, Germany: Verlag Ulrich E. Grauer