Pricing Efficiency in Agricultural Markets: Evidence from the Sugarcane Sector in Laos

**Xomphouthep Phimthong[1], Yohana James Mgale[1],
Ray Munachoonga Sikamwaya[1] and Zhao Guiyu[1*]**

[1]*College of Economics and Management, Jilin Agricultural University, Changchun,
Jilin Province, China.*

Authors' contributions

This work was carried out in collaboration among all authors. Author XP designed the study, wrote the protocol and managed the literature. Author YJM performed the statistical analysis and wrote the first draft of the manuscript. Author RMS helped in literature searches. Author ZG supervised precisely the whole work. All authors read and approved the final manuscript.

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ABSTRACT

This study aims to analyse the relationship between farm gate prices and export prices in the sugarcane sector in Laos. The Johansen cointegration test, Granger-causality test, and the Error Correction Model (ECM) were used to investigate the causality and asymmetry of price transmission between the two market levels. The coefficient of variation values shows that farm gate prices were more volatile than prices at the exporter level. Granger's causality tests show two-way causality between farm and export markets. Further, estimates of the price adjustment process suggest an asymmetric adjustment between producer and exporter prices, in short and long-run. This implies that there is a non-competitive market structure. It is therefore recommended that policies be put in place to ensure the efficient marketing of sugarcane in Laos.

Keywords: Price transmission; price volatility; error correction modelling; sugarcane; Laos.

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Corresponding author: Email: 771975161@qq.com;

1. INTRODUCTION

The agriculture sector is one of the most important economic sectors in Lao PDR. The sector makes a significant contribution to food security and economic growth [1]. In 2018, the sector contributed around 20.9 percent in Laos' gross domestic product, third after service (45.9 percent) and industry (33.2 percent) [2]. The sector also employs around 73.1 percent of the total labor force [2]. However, for a long period of time, agricultural production is Laos remained at subsistence levels using traditional production techniques and characterized by low productivity [3]. The government has been implementing a number of policies to promote agricultural investment, such as the facilitation of export and import. As a result of the massive promotion policies and measures during the last decade, industrial crop plantations have undergone significant change, gradually industrializing and using modern production systems due to the massive influx of investments [3]. Currently, almost 45 percent of farmers produce mainly for sale [3]. Among agricultural products often produced as cash crops are mung-beans, soybeans, peanuts, tobacco, cotton, sugarcane, coffee, and tea.

Sugarcane production plays an important role in the Laos economy, both as a source of foreign exchange and as a livelihood for farmers scattered across various provinces of Lao PDR. This is illustrated by the total area of sugarcane production (30,160 ha), which represents 56% percent of total cultivated area [2]. Of these, more than 78 percent are grown by smallholder farmers and the remaining 22 percent by large private estates [2]. The contribution of the sugars and sugar confectionery export to the country's agricultural exports reached $67.12 million in 2018 (11.3 percent), which places it in 5th position after rubber ($169.67M), edible vegetables and certain roots and tubers ($114.64M), coffee, tea, mate and spices ($99.79M), tobacco and manufactures tobacco substitutes ($77.00M).

Louang Namtha province is one of the main sugarcane and rubber producing areas of Laos with numerous plantations. The province has planted more than 10,337 ha (34.24 percent of total land area for crop production) and produces more than 73,000 tonnes a year [4]. Most of the farmers are smallholders with an average farm size of 2.05 acres. In 2018/19, sugarcane production in Louang Namtha province reached 52.85 percent of the country's total sugarcane production (787,679 tonnes), which represented more than 60 percent of the total production of cash crops in the province [4]. According to Leebouapao and Voladeth [2], the contribution of sugarcane to smallholders' income varies between 50 and 90 percent. This shows that the economic structure of Louang Namtha province is largely based on the sugarcane sector. The province has also been the site of significant investments by China as part of its Belt and Road Initiative.

Most of the sugarcane produced in Louang Namtha province is exported to China, where it is processed in sugar factories based in Yunnan Province. This means that the existence of fluctuations in the price of sugar in China, which may be linked to changes in consumption and demand, will have an impact on the domestic prices of sugar cane in the province of Louang Namtha province. However, if the marketing system is efficient and markets are perfectly integrated, then price changes at the level of the exporter will be rapid and symmetrically transmitted to producers in Laos. According to Jensen and Møller [5], one of the causes of asymmetric price transmission between vertically connected markets (in a marketing chain) is the existence of non-competitive behavior between intermediary traders, particularly if intermediate traders are in a concentrated market. Generally, middle traders will try to maintain the profit level and will not increase or decrease prices based on the actual price signal. Particularly, intermediary traders react more quickly to rising prices compared to falling prices. In addition, the relatively high transaction costs and long marketing channels also affect the asymmetric price transmission that occurs between farmers and exporters. In both cases, the margin formed during marketing from upstream to downstream (vertical) will be very large and ineffective.

The transmission of sugarcane prices between exporters and producers largely determines the effectiveness of the marketing system concerned. Lack of market integration or market-to-market price transmission has important implications for economic well-being in terms of supporting marketers and the government to make decisions, such as specialization based on comparative advantages and market policy reforms [6,7]. Price transmission studies can provide important information on how price changes from one market to another are transmitted, the degree of market integration as

well as the degree of efficient market functioning [2]. According to Goodwin and Schroeder [8] and Godwin [9], in integrated markets, price information is conveyed more precisely, favoring specialization and marketing decisions, in addition to efficient product movement. In addition, the spatial integration of markets implies a long-term equilibrium relationship [10]. In this sense, in an integrated market, prices tend to be standardized by the action of mechanisms such as arbitrage or substitution because these prices change in a similar way over time. The law of one price (LOP theory) suggests that when transaction costs are abstract, markets linked by trade and the arbitration will have a single price for the homogeneous product considered [6,11].

In this context, the present study aims to analyze how the variations in the prices of sugarcane at the exporters in Yunnan Province (China) are manifested quantitatively and temporally on the prices paid to producers in Louang Namtha province (Laos PDR), with reference to the period from January 2008 to December 2019. Using econometric methods, we seek to verify the existence of a long-term relationship between these two variables; and how changes in sugarcane prices in Yunnan province China are passed on to cane prices in Louang Namtha province over time.

2. REVIEW OF SUGARCANE MARKET STRUCTURE IN LAOS PDR

2.1 The Evolution of the Sugar Industry in Laos

The sugar industry in Laos has evolved since the 1990s with the establishment of contract farming with a Chinese sugar factory located in the Pong district, which borders the Sing district. The local government encouraged farmers to grow sugar cane, while the factory provided technical assistance and financial support. Before sugar became an export product to China, sugarcane productions were mainly at subsistence levels and used traditional production techniques [12]. Only a small quantity of products was sold on the Lao-Chinese border market.

Chinese techniques and technologies, including machinery, fertilizers, and seeds used by sugarcane plantations as well as access to the Chinese market, have transformed the sugarcane industry from subsistence agricultural production to commercial production, which is characterized by the use of more sophisticated techniques and technologies, more intensive production and higher productivity. According to the Laos Ministry of Agriculture, the average productivity of sugarcane plantations in the province is around 76.2 tonnes per ha. It is slightly higher than the value of productivity across the country. In 2019, the district exported 306,476 tonnes of sugarcane to China, with an average export price of 447,669 LAK (Lao Kip) per tonne. The total value of sugarcane exports was estimated to be approximately 137,199.8 million LAK (Lao Kip) in 2019, which is approximately 75% of the total value of district export.

2.2 The Sugar Cane Marketing Chain

The sugarcane marketing chain in Louang Namtha province shows that most farmers sell their products through collectors from private exporters. Farmers cannot sell their products directly to processing factories in China. The behavior of intermediary traders and the absence of formal institutions that regulate trade, such as buying and selling, are expected to increase transaction costs. In addition, Doward et al. [13] explain the role of institutions in reducing transaction costs and risks for farmers in the marketing of their products.

The sugar millers or processors in China (Yunnan Province) convert the raw cane into processed sugar, which includes refined, raw sugar, and other downstream products depending on the target market. From the sugar millers' in China, part of processed sugar is delivered to the domestic market and the other is exported back to Laos. In the Laos market, sugar is sold to wholesalers and retailers for direct consumption, which makes up about 87 percent of the Laos market. Industrial sugar is delivered to downstream industrial users for further processing and constitutes about 13 percent of the market.

3. MATERIALS AND METHODS

3.1 Study Area

The study was conducted in the Sing district in Luang Namtha province located in the northern part of Lao PDR, where sugarcane plantations are abundant. Sugarcane produced in this area is exported to China. The Sing district is located in Luang Numtha province, about 60 km north of the provincial capital. The district covers an area

of 1,430 square km (142,957 ha) and is bordered by the Yunnan Province of China in the north, Long district in the south, Numtha district in the east, and Myanmar in the west. The topographical and climatic conditions are excellent for agricultural production, including rubber and sugarcane plantations. In addition, the district has good road and information links with China, especially with the Yunnan Province, which further facilitates trade. A paved road crosses the district and connects the area with China while an international border gate serves as the main gate for trade with China. The main economic activity in the district is agriculture, which contributed about 70 percent of its total production value and employed over 80 percent of its labor force in 2018.

3.2 Data

This study uses secondary data, namely time series data, in the form of monthly prices from January 2008 to December 2019. The data consists of sugarcane price data at the producer level in Luang Namtha province (Laos PDR) and prices at the exporter level in Yunnan Province (China). The time-series data set consists of 132 observations obtained from the Ministry of Agriculture, Louang Namtha Provincial Department of statistics, the Laos Association of Exporters, as well as the results of previous studies relating to this research. To supplement information, primary data was obtained from direct interviews with traders involved in the system of marketing sugarcane in Louang Namtha province such as farmers, collectors, and exporters.

3.3 Methods

The first step in any time series analysis is to check the stationarity test. This test is carried out to test the characteristics of the data used. Stationarity is closely linked to the consistency of the movement of time series data. A series is said to be stationary if its values of statistical parameters (mean values and variances) are constant over time, followed by covariance values between two periods, which only depend on the interval between the two. Conversely, time-series data would not be stationary if there is a trend in the mean value or variance. In this case, we applied the Augmented Dickey-Fuller Generalised Least Square (ADF-GLS) test. However, in order to take into account the seasonality of the sugarcane markets, we applied the seasonal unit root test for the monthly data developed by Frances [14].

3.4 Cointegration Test

A cointegration test is performed to see whether there is a long-term relationship between the variables which, although not individually stationary, but the linear combination between these variables can be stationary [15]. Two or more variables which are stated to be cointegrated means to have a long-run equilibrium relationship. In this study, we use the Johansen Maximum Likelihood test proposed by Johansen [16]. Johansen has provided two likelihood-based measures for testing the hypothesis of no cointegration, namely the trace test $\left(\lambda_{trace}(\tau)\right)$ and the maximum eigenvalue test (λ_{max}). The null hypothesis used in the λ_{trace} tests are $H_0: r \leq 0$ or there is no cointegration relationship and $H_0: r \leq 1$ or at most, there is one cointegration equation. If the statistical test is greater than the critical value, then H_0 is rejected, meaning that there is a cointegration relationship.

3.5 Causality Test

Causality test aims to determine the two-way relationship (cause and effect) between the tested variables. This study uses the Granger-Lee [17] causality test because it can be used on cointegrated variables. Causality test is done to see whether the variables tested have a reciprocal relationship or not, or in other words whether between variables there is a causal relationship. The granger causality method in its application is used to prove whether the price movement of the upstream sector is the main determinant of the price movement in the downstream sector, or whether the price movement in the upstream sector is more determined by transactions that occur between marketing actors in the downstream sector. If the test results show a causal relationship, then the price asymmetry testing can be done using the ECM (Error Correction Model) method.

According to Von Cramon-Taubadel and Loy [18], the asymmetric transmission model is specified as in equations 1 and 2 whereby the lagged error correction term $(Z_{t-1}$ or $ECT)$ is decomposed into positive and negative components:

$$\Delta PP_t = \alpha_0 + \sum_{i=1}^{n} \beta_{PP}^{-} \Delta PP_{t-1}^{-} + \sum_{i=0}^{n} \beta_{PE}^{-} \Delta PE_{t-1}^{-} + \pi_1 Z_{t-1}^{-} + \sum_{i=1}^{n} \beta_{PP}^{+} \Delta PP_{t-1}^{+} + \sum_{i=0}^{n} \beta_{PE}^{+} \Delta PE_{t-1}^{+} + \pi_2 Z_{t-1}^{+} + \varepsilon_t \ (1)$$

$$\Delta PE_t = \alpha_0 + \sum_{i=1}^{n} \beta_{PE}^{-} \Delta PE_{t-1}^{-} + \sum_{i=0}^{n} \beta_{PP}^{-} \Delta PP_{t-1}^{-} + \pi_1 Z_{t-1}^{-} + \sum_{i=1}^{n} \beta_{PE}^{+} \Delta PE_{t-1}^{+} + \sum_{i=0}^{n} \beta_{PP}^{+} \Delta PP_{t-1}^{+} + \pi_2 Z_{t-1}^{+} + \varepsilon_t \ (2)$$

Table 1. Descriptive statistics of nominal monthly sugarcane prices at producer and exporter levels

	Mean	Minimum	Maximum	St. Dev	Skewness	Kurtosis	CV
LogPP[1]	12.247	9.934	13.376	0.711	-0.705	3.085	0.058
LogPE[2]	12.713	11.444	13.784	0.519	-0.269	2.225	0.041

[1] *The logarithm of producer prices*
[2] *The logarithm of exporter prices*

Where, PE_t is the price of sugarcane at the producer level (farmer), PE_t is the price of sugarcane at the exporter level, and Z_{t-1} is an error correction term (ECT). The presence of asymmetrical price transmission in the short run is tested by using the following hypothesis $H_0: \sum_{i=1}^{n} \beta^{-} = \sum_{i=1}^{n} \beta^{+}$, while in the long run is tested through $H_0: \pi_1 = \pi_2$. The hypothesis tests are carried out using the F test (Wald test). The plus (+) and minus (−) signs in the model indicate an increase and decrease in price. In this study, all the statistical testing procedures were estimated using EViews 11.

4. EMPIRICAL RESULTS AND DISCUSSION

Before commencing the estimation of the cointegration and causality test, one must identify the time-series properties of the data set. To address this, Elliott et al. [19] proposed a test to detect the non-stationarity of series using the modified version of the ADF test, known as the ADF-GLS test whereby the time series is transformed via a generalised least squares (GLS) regression before performing the test. The number of optimal lags was determined using the Akaike information criterion (AIC), the Schwarz information criterion (SC) and the Hannan-Quinn criterion (HQ). Table 2 depicts the results of unit root tests based on ADF-GLS on levels and the first difference of the variables. The null hypothesis of the ADF-GLS test is that the variable has a unit root (non-stationary). The results of the unit root test reveal that all series are I (1). Each producer (farm gate) and export price series has one seasonal unit root, but not at the corresponding frequencies. Therefore, there is no seasonal cointegration between the price series. This means, structural breaks are insignificant and are therefore not taken into account.

Table 2. Unit root test results[1]

Variables	Model	ADF-GLS	
		Level	First difference
Producers (farm gate)	Trend and intercept	-2.519	-7.751***
	Intercept only	-0.808	-4.857***
Exporters	Trend and intercept	-2.377	-6.924***
	Intercept only	-0.607	-5.582***

*Notes: *** reject the null of unit root at 0.001 significance level*
[1]*Price series are in natural logarithim*

Table 3. Johansen cointegration test results

Eigenvalue	Trace Test		
	Null	λ-trace	0.05 critical value
0.259	$r = 0$	30.725** (0.000)	25.873
0.076	$r \leq 1$	6.341 (0.325)	12.512

*Note. ** denotes rejection of the hypothesis at the 0.05 level*
The critical values are calculated using the approach in MacKinnon et al. (1999)

The cointegration test was then performed using the Johanssen [16] trace statistics test to find out the relationship between price series. The results in Table 3 show that the null hypothesis of no cointegration between the price series was rejected at a 5% significance level. This implies that there is a strong long-run co-integration between producers' prices and exporters' prices.

After identifying co-integration between the two price series, the Granger causality test is carried out to determine the direction of price transmission. In the vertical case, the price shock caused by changes in demand (transmission of prices from downstream to upstream) will have a price transmission effect different from the shock due to changes in supply (price transmission upstream to downstream) [20]. From Table 4, it can be seen that the causal relationship between producer prices and export prices is two way. This means that the price of sugar cane in Laos is determined on the supply and demand side; in other words, the price relationship between the exporter and the producers influences each other. According to Abidoye and Labuschagne [21] and Chen and Saghaian [22], prices at the demand side can be influenced by an increase in population and income while prices at demand side can be influenced by production and season factors (i.e., weather, pest and diseases, cost of inputs, etc.).

4.1 Testing for Asymmetric Price Transmission

Asymmetric tests are carried out to determine whether price transmission occurs perfectly between farmers and exporters. The study uses the AECM model developed by Von Cramon-Taubadel and Loy [18], where asymmetric price transmission is analyzed on the basis of short-run and long-run transmissions. Asymmetric short-run price transmission is analyzed on the basis of the value of the coefficient of the independent variables, while the long-term transmission is based on the value of the error correction term (ECT) coefficient. ECT^+ illustrates the condition of price deviation when it is above the long-run equilibrium line, i.e., when a decline in upstream sugarcane prices is not followed by a downward price decline. ECT^-

describes the condition of price deviation when it is below the long-term equilibrium line, i.e., when an increase in upstream sugarcane prices is not followed by an increase in downstream prices.

The results of the price transmission process in Table 5 show that price transmission in the short term between producers and the exporter market descriptively responds differently. On the other way, there is a difference in the reaction of the export price to the positive and negative shock to producer prices. Based on this, it can be said that the change in the price of sugarcane at the exporter market level was significantly caused by changes in the exporter's market price in the previous period. In the exporter market price in the previous period $(t-1)$, the two variables showed a different level of significance that was only significant in decline in export market price in the previous period. This means that if there is a decline in the prices of the export market in the previous period, it will be responded to by the price at the export market level in the current period, but if there is an increase in the previous period, then it will not be responded to by the current market price of the export market.

In the long-run transmission between producers and exporters, it was observed that the values of ECT^+ and ECT^- were significant. The ECT^+ coefficient shows that when the difference is greater than the equilibrium line (increase in producer price), the price of sugarcane at the exporter level will not adjust down. In other words, when there is a deviation due to falling prices at the producer level, prices at the exporter market level will fall and return to equilibrium in the next month. While the ECT^- value indicates that deviations that occur when it is under the equilibrium line will definitely return to the equilibrium line. The balance adjustment period is based on the coefficient value of approximately one month. In other words, when there is a deviation due to price increases at the producer level, prices at the exporter market level will rise and return to equilibrium in the next month. According to the sign and significance of the coefficient variables of ECT^+ and ECT^- it can be concluded that the transmission of sugarcane prices at the producer level to exporter prices is asymmetrical.

Table 4. Estimates of granger causality test

Causality	Number of lags	t-statistic	Prob.
Producer → Exporter	1	-5.021***	0.000
Exporter → Producer	1	-4.493***	0.000

*Note: *** significance level at 0.001 level, → direction of causality*

Table 5. Estimated results of the asymmetric model[1]

Variable	Producer → Exporter	Variable	Exporter → Producer
ΔPE_{t-1}^{-}	0.016 (0.962)	ΔPP_{t-1}^{-}	-0.251*** (0.001)
ΔPE_{t-1}^{+}	-0.903*** (0.001)	ΔPP_{t-1}^{+}	-0.173 (0.502)
ΔPP_{t}^{-}	-0.025 (0.761)	ΔPE_{t}^{-}	-0.086 (0.812)
ΔPP_{t}^{+}	-0.029 (0.783)	ΔPE_{t}^{+}	-0.049 (0.583)
ΔPP_{t-1}^{-}	0.014 (0.850)	ΔPE_{t-1}^{-}	0.074 (0.261)
ΔPP_{t-1}^{+}	-0.016 (0.873)	ΔPE_{t-1}^{+}	-0.066 (0.852)
ECT^{-}	0.057 (0.031)	ECT^{-}	0.025 (0.733)
ECT^{+}	-0.091*** (0.003)	ECT^{+}	0.054*** (0.000)
Constant	-21.924 (0.187)	Constant	-51.296 (0.005)
R^2	0.483	R^2	0.224
R^2-adj	0.472	R^2-adj	0.206
Log-likelihood	-2330.038	Log-likelihood	-2394.492
F-statistic	41.585 (0.000)	F-statistic	12.841 (0.000)

*Note: *** significance level at 0.001 level,*
[1] Probability values in parentheses

Furthermore, in the short-run price transmission between exporters and producers, the results show that significant changes in the price of sugarcane at the producer level were due to changes in producer prices in the previous period $(t-1)$. The variable that showed a significant result was when there was an increase in prices.

Furthermore, in the short-run price transmission between exporters and producers, the results show that significant changes in the price of sugarcane at the producer level were due to changes in producer prices in the previous period $(t-1)$. The variable that showed a significant result was when there was an increase in prices. This means that if there is an increase in producer prices in the previous period, it will be responded to by the price at the producer level in the current period, but if there is a decrease in the previous period, then it will not be responded to by the current producer price.

The long-run transmission of exporter market prices to producer prices shows a significant ECT^{-} value. The coefficient value of ECT^{-} shows that when price deviations fall below the equilibrium line will certainly return to the equilibrium condition. That is to say, when prices in the exporter market increase, producer prices also go up and then return to equilibrium in the next 6 months.

The results of the Wald test in Table 6 show that in the short and long run, the transmission of sugarcane prices between farmers to exporters and between exporters to farmers is asymmetrical. These results conform to the descriptive test, where there are different responses between positive shock and negative shock. The results suggest that asymmetric adjustments in the long-run relationship may be due to an abuse of market power by one of the marketing intermediary and the existence of an asymmetric short-run relationship may be due to the adjustment costs such as storage, transportation, etc. These adjustment costs are additional costs that marketing actors must bear to adjust prices [23,24]. Generally, intermediate traders will try to maintain the profit level and not raise/lower prices based on the actual price signal. Without market power, prices will rise and fall smoothly and any deviation will return to their long-run equilibrium.

Table 6. Wald test estimation results

Price relation	Hypothesis	F-statistic	Prob.	Transmission
Producer → Exporter	$\Delta PE_{t}^{-} = \Delta PE_{t}^{+}$	41.724	0.001	Asymmetric
	$ECT^{-} = ECT^{+}$	7.681	0.013	Asymmetric
Exporter → Producer	$\Delta PP_{t}^{-} = \Delta PP_{t}^{+}$	5.283	0.025	Asymmetric
	$ECT^{-} = ECT^{+}$	15.192	0.000	Asymmetric

Note: → the direction of causality

5. CONCLUSION

Based on the results and discussion we can conclude that, that the sugarcane market in Laos PDR has not been efficient. Sugarcane prices at producer level are more volatile compared to exporter's market prices, which can be seen from the results of the coefficient of variation (CV) analysis which shows that sugarcane prices at producer level have the greatest value than prices at the level of exporters. Asymmetric price tests show that the short-run and long-run relationship is asymmetrical, meaning that the price changes between the variables have not been perfectly transmitted and that there is an uncompetitive market structure.

The findings suggest that there is a need for the government to monitor and support both sugarcane production and marketing. Efforts can be made to improve irrigation networks, expanding farming areas, and providing subsidies (fertilizer and other farm implements) to maintain sustainable sugarcane production. For the case of enhancing sugarcane marketing efficiency and minimizing asymmetric price transmission, efforts can be made to improve marketing infrastructures and increasing assess to market information, such as the availability of sugarcane price data reports on a daily basis. The data is expected to help both producers and exporters to access price information effectively and efficiently. Furthermore, there is also a need to increase farmers' access to credit from cooperatives or government institutions. Indeed, farmers in the study area can only access credit from traders, which results in a weak negotiating/bargaining position for farmers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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