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ASSESSING THE RELATIONSHIP BETWEEN INTERNATIONAL MARKET AND AGRICULTURAL COMMODITY EXPORT PRICES: EVIDENCE FROM VIETNAMESE COFFEE

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Abstract

The paper used a cointegration test, the Granger causality test, and a vector autoregression (VAR) model to determine the relationship between the international coffee price on the spot market and the Vietnamese coffee export price from January 2004 to December 2017. The study found international coffee prices to have a significant effect on Vietnamese coffee export prices, but not vice versa. The two variables are not cointegrated with each other at the 99 percent confidence level, but the Granger causality test confirmed that the Vietnamese coffee export price is influenced by the international market price, while the international market price is not influenced by the Vietnamese coffee export price. The results from the VAR model also showed that the dependent variable is mainly impacted by two independent variables in lag 1 and other lags. Overall, the Vietnamese coffee export price did not have an effect on the international coffee spot market price. Therefore, the relationship between the international coffee price and the Vietnamese coffee export price is asymmetric. These results are in accordance with the actual situation since Vietnam is the largest exporter of robusta coffee in the world, but Vietnam is only a "small" country that has no market power in the international coffee market.

Keywords: Co-integration test; Granger causality; VAR model; Vietnamese coffee price.

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ĐÁNH GIÁ MỐI QUAN HỆ GIỮA GIÁ THỊ TRƯỜNG QUỐC TẾ VÀ GIÁ HÀNG NÔNG SẢN XUẤT KHẨU: BẰNG CHỨNG TỪ CÀ PHÊ VIỆT NAM

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Tóm tắt

Nghiên cứu sử dụng kiểm định đồng liên kết, quan hệ nhân quả Granger và mô hình VAR để xác định mối quan hệ giữa giá cà phê quốc tế trên thị trường giao ngay và giá cà phê Việt Nam xuất khẩu từ tháng 01 năm 2004 đến tháng 12 năm 2017. Nghiên cứu đã tìm thấy ảnh hưởng của giá cà phê thế giới lên giá cà phê Việt Nam xuất khẩu, nhưng không có chiều ngược lại. Hai biến này không có mối quan hệ đồng liên kết ở độ tin cậy 99%, nhưng kiểm định quan hệ nhân quả Granger lại chỉ ra rằng giá cà phê Việt Nam xuất khẩu chịu ảnh hưởng của của giá cà phê trên thị trường thế giới, nhưng giá cà phê trên thị trường thế giới lại không chịu ảnh hưởng bởi giá cà phê Việt Nam xuất khẩu. Những kết quả từ việc hồi quy mô hình VAR cũng chỉ ra rằng, biến phụ thuộc chịu ảnh hưởng của hai biến độc lập ở độ trễ 1 và các độ trễ khác. Tóm lại, giá cà phê Việt Nam xuất khẩu không hề có ảnh hưởng lên giá cà phê quốc tế trên thị trường giao ngay. Do vậy, mối quan hệ giữa hai biến là mối quan hệ phi đối xứng. Những kết quả nghiên cứu này phù hợp với thực tế, mặc dù Việt Nam là quốc gia xuất khẩu cà phê robusta lớn nhất nhưng lại chỉ là một nước "nhỏ" không có bất cứ sức mạnh thị trường nào trên thị trường cà phê thế giới.

Từ khóa: Giá cà phê Việt Nam; Kiểm định đồng liên kết; Mô hình VAR; Quan hệ nhân quả Granger.

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Loại bài báo: Bài báo nghiên cứu gốc có bình duyệt

1. INTRODUCTION

Coffee is one of the worldwide most traded commodities, produced in more than 70 developing countries and consumed mainly in developed countries with over US $30.90 billion of total world trade (OEC, 2018). Commercial coffee consists of two main varieties, namely, arabica coffee and robusta coffee. Vietnam is the largest exporter of robusta coffee in the world with an export value of US $3.21 billion (General Statistics Office of Vietnam, 2017). During the fourteen-year period of 2004-2017, the Vietnamese coffee export price moved almost in parallel with the world's robusta coffee price. After a long period of steadily climbing from 30.32 US cents/lb. in 2004 to 101.77 cents/lb. in 2008, Vietnamese coffee export prices had a period of adjustment in the three years from 2008 to early 2011, and the transaction price fell to only 70.00 US cents/lb. The price peaked at 110.16 US cents/lb. in May 2011 before hitting a low of 74.71 US cents/lb. in April 2016. Currently, the Vietnam coffee export price is being traded at approximately 100.00 US cents/lb. (FOB, Ho Chi Minh City price). Despite the fact that the Vietnamese coffee export price is close to the robusta coffee price, it is very difficult to predict since this price fluctuates without any rules (see Figure 1).

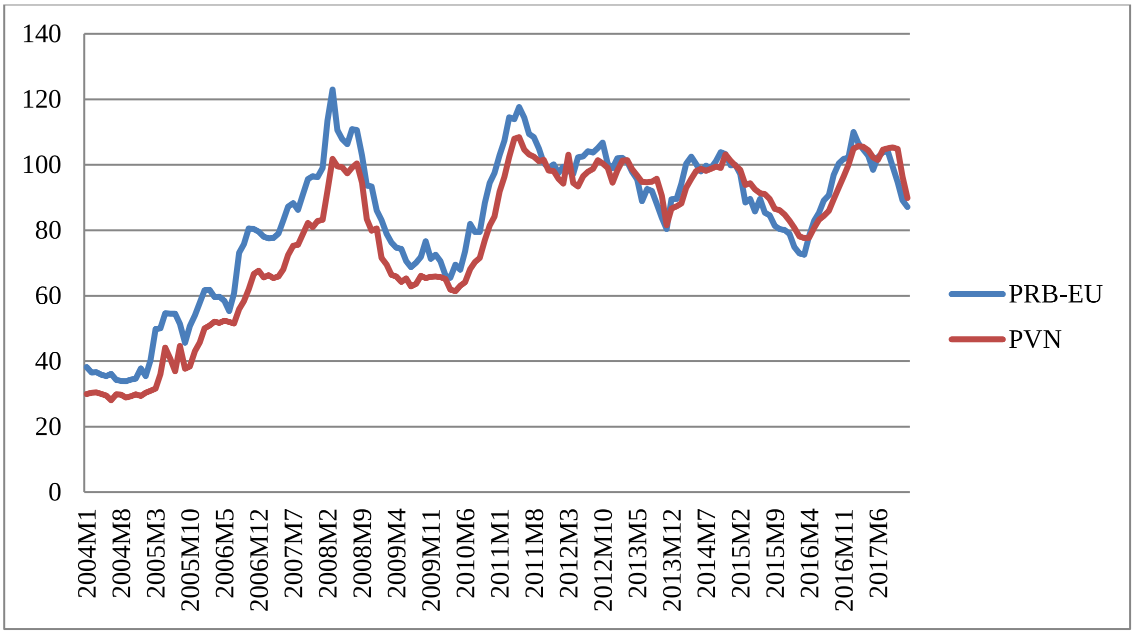

Figure 1. The fluctuating trend of Vietnamese coffee export price and robusta coffee price

Source: General Statistics Office of Vietnam (2017) and the United Nations Conference on Trade and Development (UNCTAD).

Against this background, a profound understanding of the relationship between the two markets is of significance to coffee farmers, exporter-producer companies, and the government of Vietnam to accurately forecast future volatility, which is a critical input to the risk management of price volatility. The purpose of this study, therefore, is to determine the relationship between the international market price and the agricultural commodity export price, with a new research subject and from a new perspective.

Significantly, the price relationship between two commodities or two markets has been studied by many authors. Some papers, such as Acosta, Ihle, and Robles (2014); Alom, Ward, and Hu (2011); Baffes and Gardner (2003); Greb, Jamora, Mengel, Cramon-Taubadel, and Wurriehausen (2016); Hernandez and Torero (2010); Huang, Yang, and Hwang (2009); Minot (2010); Wang and Ke (2005); Zhao and Goodwin (2011) and others used separately several popular models and methods, such as cointegration tests, Granger causality tests, multiple linear regression models, vector autoregressive models (VAR), threshold vector autoregressive (TVAR), autoregressive conditional heteroscedasticity (ARCH) family, and generalized autoregressive conditional heteroscedasticity (GARCH) family models to analyze price transmission comprehensively. In addition, a few studies have addressed price volatility and used combined models (VAR/VECM-DCC-GARCH, VAR/VECM-BEKK-GARCH model), such as Ceballos, Hernandez, Minot, and Robles (2017); Hernandez, Ibarra, and Trupkin (2013); Lee and Valera (2016); Rapsomanikis and Mugera (2011) to deeply analyze the price transmission and volatility spillovers. The main subjects of these studies; however, are the main agricultural commodities, including corn, soybeans, milk, grain, and wheat. In addition, the outcomes of these studies have had mixed results.

There are also some researches by Vietnamese scholars on coffee prices in general and Vietnamese coffee prices in particular. These studies mainly used multiple linear regression models and cointegration tests (To, 2015, 2016; Nguyen & Tran, 2015). However, the biggest drawback of multiple linear regression models when estimating time series data is spurious regression if the variables are not stationary at level (Ferson, Sarkissian, & Simin, 2003; Granger & Newbold, 1974; Hamilton, 1994; McCallum, 2010).

To the best of our knowledge, the linkages between the world's robusta coffee price in the spot market and the Vietnamese coffee export price have not been studied by applying a VAR model. In order to address the limitations of previous studies, therefore, this study uses a cointegration test, the Granger causality test, and a VAR model to identify this relationship as well as its trend, equation, and level.

2. LITERATURE REVIEW

As explained above, an enormous amount of literature has used various models, including multiple linear regression models, VAR models, VEC models, ARCH-family and GARCH-family models to find linkages among time series variables. The relationship among time series price variables, including the price transmission between the futures market and spot markets, between international markets and domestic markets, and among commodities has been studied by many researchers, including Baffes and Gardner (2003); Ceballos et al. (2017); Gemech and Struthers (2007); Hong (2015, 2016); Lee and Valera (2016); Phuc and Hong (2014); Rahayu, Chang, and Anindita (2015); Worako, Jordaan, and Van Schalkwyk (2011) among others. Most of these studies concerned the price transmission or the long-run and short-run equilibrium relationships among markets or commodities.

A few studies used VAR, ECM, or VEC models to test the level of transmission of the world price into the domestic and international prices of commodities. For example, Baffes and Gardner (2003) used a VEC model to study eight countries and ten commodities. They found that only Mexican, Chilean, and Argentinean prices allowed a significant pass-through of world price movements. The transmission between the prices of other countries was found to be either low or nonexistent, and the variability of world prices was not reflected in domestic price movements in any significant way. In 2010, Minot used an ECM model to determine the degree of price transmission between world food market prices and the prices of staple foods in sub-Saharan Africa based on more than 60 price series from 11 African countries. The results indicated a long-term relationship with world prices in only 13 out of the 62 African food prices examined. African rice prices are more closely linked to world markets than corn prices. Acosta et al. (2014) also used an ECM model to examine the price transmission from the global market to the domestic market in Panama. They showed that there is a long-run cointegration relationship between global and domestic producers' prices; however, only producers' prices showed significant responses to price disequilibria, which appears to be plausible due to the relative sizes of both markets. Furthermore, the results of the ECM pointed out the potential presence of asymmetric price transmission of global and domestic milk prices, indicating that increases in global prices tend to be transmitted faster to producers' price than decreases.

For forecasting commodity prices of rice and coffee in Vietnam, Nguyen and Tran (2015) developed an efficient maximum likelihood estimation procedure based on the characteristics function. They estimated parameters of a stochastic volatility model with stochastic drift utilizing the time series. Finally, by using the estimated model parameters, they calculated various risk measures, such as value at risk and expected shortfall. Hong (2015) used multiple linear regression models to identify and measure the impact of such factors as exchange rates and gasoline prices on the price of Vietnamese coffee exports for of 2008-2014. A cointegration between the Vietnamese coffee price and the world coffee price, was found. Based on the pairwise Granger test, Hong (2015) found that the world coffee price could affect the Vietnamese coffee price, but not vice-versa. The very significant result of this study is that exchange rates and gasoline prices can affect the export price of Vietnamese coffee. In 2016, Hong again found that Vietnamese coffee prices vary with the trends in world coffee prices. The author used data on the price of Vietnamese coffee over 34 years with cyclic changes consisting of a five-year increase followed by a seven-year decrease. The Brazilian coffee price was found to have an important effect on the Vietnamese coffee export price, which was estimated to go up by 0.31% with a 1.00% increase in the Brazilian coffee price.

There is already a large empirical literature on the relationship between international market prices and domestic prices. However, the conclusions of the literature appear to be mixed. The differences probably arise from different time periods, datasets, frequencies, methodologies, utilized models, and kinds of commodities. Furthermore, although there is some evidence of the influence of these factors on coffee export price, it is still not clear and detailed, especially in the literature on Vietnamese coffee.

In an effort to overcome the limitations of previous research and the lack of multiple regression models, this paper attempts to analyze the linkage between the international coffee price on the spot market and a new research subject–the Vietnamese coffee export price–by applying a cointegration test, the Granger causality test, and a VAR model.

3. RESEARCH METHODOLOGY

3.1. Co-integration test

In the 1980s, Engle and Granger proposed the concept of cointegration (Engle & Granger, 1987). If the time series (*t = 1, 2, ...*) becomes stationary after *d* differences, and the sequence difference is *d – 1* times, then the sequence X_t is called a *d*-ordered single integer sequence, denoted as $X_t \sim I(d)$. If two time series X_t and Y_t are both *I(d)*, any linear combination of X_t and Y_t will be also *I(d)*. If, however, there exists a vector, such that the combination $s_t = aX_t + bY_t$ is $I(d-c)$ $(d \geq c \geq 0)$, then X_t and Y_t are called *(d-c)* order cointegrated. For those time series variables that are non-stationary, if some of their linear combinations are stationary, the linear combination reflects the long-term equilibrium relationship between the variables, which is the cointegration relationship.

Testing cointegration is a significant step to check whether empirically meaningful relationships exist in the model or not. If variables have different trend processes, they cannot stay in a fixed long-run relationship, implying that you cannot model the long-run, and there is usually no valid basis for inferences based on standard distributions. If cointegration is not found, it is necessary to continue working with variables in differences instead. The cointegration relationship among variables can be tested by using the Johansen cointegration method (Johansen & Juselius, 1990) and the Engle-Granger two-step cointegration method (Engle & Granger, 1987).

3.2. Granger causality test

The Granger causality test (Granger, 1969) assumes that most of the information about the predictions of *y* and *x* is contained in their time series. The test requires the estimation of *y* and *x* by the following regressions:

$$y_t = \sum_{i=1}^{q} \alpha_i x_{t-i} + \sum_{j=1}^{q} \beta_j y_{t-j} + u_{1t} \quad (1)$$

$$x_t = \sum_{i=1}^{s} \lambda_i x_{t-i} + \sum_{j=1}^{s} \delta_j y_{t-j} + u_{2t} \quad (2)$$

where x_t, y_t, represent two variables; y_{t-j}, x_{t-i} denote the lag of y_t, x_t, respectively; α_i, β_j, λ_i, δ_j denote the coefficient estimation of the lag term; *i, j, q, s* denote lag order; u_{1t} and u_{2t} are white noise and assumed to be irrelevant.

Equation (1) assumes that the current *y* relates to lags of *y* itself and past values of *x*, and Equation (2) assumes similar behavior for *x*. For Equation (1), the null hypothesis is $H_0: \alpha_1 = \alpha_2 = ... = \alpha_q = 0$; for Equation (2), the null hypothesis is $H_0: \delta_1 = \delta_2 = ... = \delta_s = 0$. Values of the F-statistic and p-value will be used to decide to not reject the null hypothesis if the p-value is greater than 5% or to reject it if the p-value is less than 5%.

3.3. VAR model and VEC model

The vector autoregression model (VAR) was introduced as a technique that can be used by macroeconomists to characterize the joint dynamic behavior of a collection of variables without requiring strong restrictions to identify underlying structural parameters (Sims, 1980). It has become a prevalent method of time series modeling.

The VAR model can be expressed as:

$$z_t = A_1 z_{t-1} + A_2 z_{t-2} + ... + A_p z_{t-p} + Bv_t + \varepsilon_t \qquad (3)$$

where z_t is a *k*-dimensional vector of the endogenous variables, *t* is the number of observations, *p* is the order of the lagged variable, and v_t is the *d*-dimensional exogenous variable vector. The (k x *k*) dimensional matrices $A_1, ..., A_p$ and (k × *d*) dimensional matrix B are the coefficient matrices to be used for estimation, and ε_t is a vector of *k*-dimensional disturbances. Generally, *p* and *R-squared* must be large enough to fully reflect the dynamic characteristics of the VAR model. But the accuracy of the model does not depend on how big *p* is, so an equilibrium must be established between *p* and *R-squared*. This equilibrium can be determined by five criteria: LR, FPE, AIC, SC, and HQ.

The *Eviews 8.0* software was used to estimate and test the hypotheses of the above model.

4. EMPIRICAL ANALYSIS

4.1. Selecting variables, model and data description

4.1.1. Selecting variables and data description

Because all of the Vietnamese coffee traded on the spot market is robusta coffee, the robusta coffee price on the spot market directly and immediately influences Vietnam's future domestic coffee price. Nowadays, robusta coffee is mainly traded on the London International Financial Futures and Options Exchange (LIFE), as are many primary commodities such as rice, gold, copper, oil, coffee, sugar, and so on. These commodities are traded on two markets, the spot market and the futures market. For the reasons given above, this study selected two variables, the Vietnamese coffee export price and the robusta coffee price on the spot market (representing the international price). Their price histories are shown in Figure 1.

The monthly average price of the above two variables is based on data collected from January 2004 to December 2017, with 168 observations for each variable. The

Vietnamese coffee export price (PVN) was converted from the Government Statistics Office of Vietnam reports, and the robusta coffee price in the spot market trading on LIFE (PRB_EU) was converted from UNCTAD. All of the data have been seasonally adjusted using Census X12. Descriptive statistics of the variables can be seen in Table 1.

Table 1. Descriptive statistics

Statistical indicators	PVN	PRB_EU
Mean	78.1624	83.6566
Median	84.2567	88.4101
Maximum	108.4201	122.9824
Minimum	28.0353	33.8568
Std. Dev.	23.4345	21.6552
Skewness	-0.7705	-0.7917
Kurtosis	2.4319	2.8144
Jarque-Bera	18.8796	17.7920
Probability	0.0001	0.0001
Sum	3131.2800	14054.3000
Sum Sq. Dev.	91712.1600	78314.5400
Observations	168.0000	168.0000

Source: Calculated by the authors using *Eview 8*.

As can be seen in Table 1, the mean value of the Vietnamese coffee export price is less than that of the international robusta coffee price, while the value of the standard deviation of the Vietnamese coffee export price is not. Hence, the Vietnamese coffee export price is less than the international robusta coffee price, but its fluctuation is greater. The two variables are skewed left (skewness is less than 0). In addition, the values of the Jarque-Bera test and the p-values indicate that the two variables are not normally distributed.

4.1.2. Selecting the model

- Unit root test

Table 2. ADF and Phillips Perron test results

Variable	(C,T,L)	ADF t-statistic	PP t-statistic	1% level	5% level	Conclusions
PVN	(1,1,13)	-1.8489	-2.0156	-4.0143	-3.4371	Non-stationary
DPVN	(1,1,13)	-9.6096	-9.7825	-4.0143	-3.4371	Stationary
PRB_EU	(1,1,13)	-2.1702	-2.1209	-4.0143	-3.4371	Non-stationary
DPRB_EU	(1,1,13)	-9.7707	-9.7703	-4.0143	-3.4371	Stationary

Notes: C is constant or intercept, T is trend, and L is lag selection; D represents the first-order difference of the time series.

Source: Calculated by the authors using *Eviews*.

The estimation will start with the unit root test. According to Schwert (2002) the lag difference is (Pmax) = $[12.(T/100)^{1/4}]$ where T is the number of observations. The model uses monthly data from January 2004 to December 2017 with 168 observations. Therefore, Pmax=13. Thirteen lags are used to test that the variables are stationary. The stationarity is tested using the Augmented Dickey-Fuller (ADF) and Phillips Perron tests (PP). Table 2 describes the ADF and PP test results at the level and first difference. In both tests, the null hypothesis is that there exists a unit root for each variable.

After the test, the two variables are stationary at first difference at the 1% level, meaning that all of the variables are integrated in the same order.

- Determination of Lags

Table 3 reports lag-order selection statistics. The authors use the lowest value of five criteria, namely, LR (Likelihood - Ratio), FPE (Final Prediction Error), AIC (Akaike Information Criterion), SC (Schwarz Information Criterion), and HQ (Hannan-Quinn Information Criterion) as a primary concern to determine the lag length (Ng & Perron, 2001). Based on the result of these criteria (which is indicated by an asterisk in Table 3), we perform further tests with Lag (4).

Table 3. Determining Lag Length for the VAR Model

Lag	LR	FPE	AIC	SC	HQ
0	NA	16466.4800	15.3848	15.4233	15.4005
1	816.7044	95.3116	10.2329	10.3482	10.2797
2	34.8281	80.0368	10.0582	10.2504*	10.1362*
3	10.5444	78.5425	10.0393	10.3084	10.1486
4	13.6186*	75.4580*	9.9991*	10.3451	10.1396
5	2.2930	78.1308	10.0337	10.4565	10.2054
6	7.7903	77.9192	10.0307	10.5304	10.2336
7	1.5810	81.0572	10.0698	10.6464	10.3039
8	1.2971	84.4864	10.1107	10.7642	10.3761

Source: Calculated by the authors using *Eviews*.

4.2. The empirical analysis

4.2.1. Co-integration test

Cointegration rank is estimated using Johansen methodology. Johansen's approach (Johansen & Juselius, 1990) derives from two likelihood estimators for the cointegration rank: a trace test and a maximum eigenvalue test. The results of the cointegration test are shown in Table 4. The results show that there is no cointegrating equation at the 0.05 level between the variables, meaning there is no long-term relationship between the two variables from 2004 to 2017. This study does not find the same results as Hong (2016) and Phuc and Hong (2014). The differences may come from the difference in selecting the number of variables and the time interval. From our results, the VAR (4) model is the most suitable.

Table 4. Cointegration rank test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.0500 Critical Value	Prob.**
None	0.0609	14.1086	15.4947	0.0800
At most 1*	0.0235	3.8737	3.8415	0.0490
Trace test indicates no cointegration at the 0.05 level.				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen. Statistic	0.0500 Critical Value	Prob.**
None	0.0609	10.2349	14.2646	0.1970
At most 1*	0.0235	3.8737	3.8415	0.0490

Notes: Maximum eigenvalue test indicates no cointegration at the 0.05 level.
Source: Calculated by the authors using *Eviews*.

4.2.2. Granger causality test

The results of the cointegration test show that there is no long-term equilibrium between the two variables, but only a short-term relationship. Therefore, the causal analysis needs further verification. A Granger causality test with a Lag (4) was conducted to verify the causal relationship between the two variables. Estimation results for Granger causality between the variables are presented in Table 5. The authors use F-statistics and probability to test causality between the variables with the null hypothesis of no Granger cause among those variables.

Table 5. Partial Granger causality test results

Null Hypothesis	Obs.	F-Statistic	Prob.
D(PRB_EU) does not Granger cause D(PVN)	164.0000	18.3100	3.E-12
D(PVN) does not Granger cause D(PRB_EU)		1.0500	0.3834

Sources: Calculated by the authors using *Eviews*.

Table 5 provides the results of the pairwise analysis. Significant probability values denote rejection of the null hypothesis. In this study, based on the F-statistic and p-value, the null hypothesis will be rejected if the p-value is less than 0.05, and vice versa. Then, PRB_EU has “Granger cause” with PVN unidirectional at a 5% significance level, but not vice versa. Hence, Vietnamese coffee absolutely does not have the dominant power in the world coffee market. The relationship found between the robusta coffee spot market price and the Vietnamese coffee export price is very realistic and consistent with the study of Phuc and Hong (2014). Despite the fact that Vietnam is the world's biggest exporter of robusta coffee and the second largest exporter of coffee in the world after Brazil, the price of Vietnamese coffee entirely depends on world coffee prices. The main reason is that more than 90% of the total coffee production is used for export (while this proportion of Brazil is only 60%), and domestic consumption accounts for a small proportion (approximately 10%) (ICO, 2017 and author's calculation). Being dependent on the world coffee market creates a huge risk for coffee enterprises as well as coffee growers in Vietnam when the price of coffee fluctuates.

4.2.3. Vector autoregression model (VAR model)

Because no cointegration leads to no long-run relationship between variables, the VAR model can be applied to analyze the relationship between the two markets in the short-run. The VAR model shows the relationship between the variables from January 2004 to December 2017 with standard errors in parentheses, t-statistics in brackets as follows:

Table 6. Unrestricted Vector Autoregression Estimates of PVN and PRB_EU

	D(PVN)	D(PRB_EU)
D(PVN(-1))	-0.3447 (0.1024) [-3.3651]	-0.1677 (0.1530) [-1.0961]
D(PRB_EU(-1))	0.5634 (0.0678) [8.3042]	0.3500 (0.1014) [3.4535]
D(PVN(-2))	-0.2539 (0.1013) [-2.5075]	0.0613 (0.1513) [0.4052]
D(PRB_EU(-2))	0.2662 (0.0804) [3.3125]	0.0017 (0.1201) [0.0142]
D(PVN(-3))	0.0147 (0.1007) [0.1462]	-0.2408 (0.1505) [-1.5999]
D(PRB_EU(-3))	0.2011 (0.082) [2.4537]	0.1420 (0.1224) [1.1600]
D(PVN(-4))	0.0222 (0.0841) [0.2640]	0.0159 (0.1257) [0.1269]
D(PRB_EU(-4))	0.0726 (0.0801) [0.9076]	0.1351 (0.1196) [1.1294]
C	0.2234 (0.2150) [1.0394]	0.2361 (0.3211) [0.7352]

Source: Calculated by the authors using *Eview 8*.

Table 6 shows that the most recent previous price has the largest influence on the current Vietnamese coffee export price. In particular, the price of robusta coffee on the spot market in the most recent previous period has the greatest impact on the current Vietnamese coffee export price.

In terms of the direction of influence, among previous periods of Vietnamese coffee export price, the first and the second previous period variables have a negative effect on the dependent variable, while the others have a positive impact on PVN. Meanwhile, all previous periods of robusta coffee spot market price have a positive impact on PVN.

4.2.4. Impulse response function (IRF) and variance decomposition analysis

In the final step of the empirical modeling analysis, the author defines the response to PVN when there is a shock in the international market price and itself. In this regard, the generalized impulse-response functions derive from the VAR model for two variables. The optimal lag lengths in the VAR system are determined via the Schwartz information criterion with Lag (4).

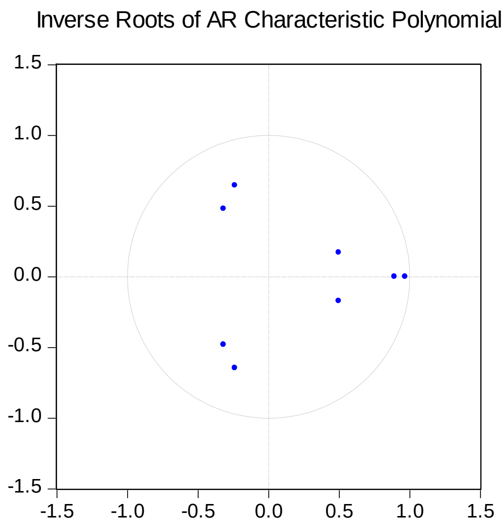

Figure 2. Inverse roots of AR characteristic polynomial

Source: Drawn by the authors using *Eviews*.

Figure 2 shows that all roots of the VAR model are within the unit circle. Hence, the VAR system satisfies the stability condition.

- Impulse Response Function (IRF)

In practical applications, the VAR model generally does not analyze how the change of one variable affects another variable. It examines the dynamic structural analysis of variables as well as the dynamic influence of one error term of the model or the overall impact of receiving some kind of shock. Also, the economic interpretation of the single parameter estimation is relatively difficult when the impulse response analysis is required. This article selects the most commonly used analysis, Cholesky orthogonal impulse response, which is shown in Figure 3.

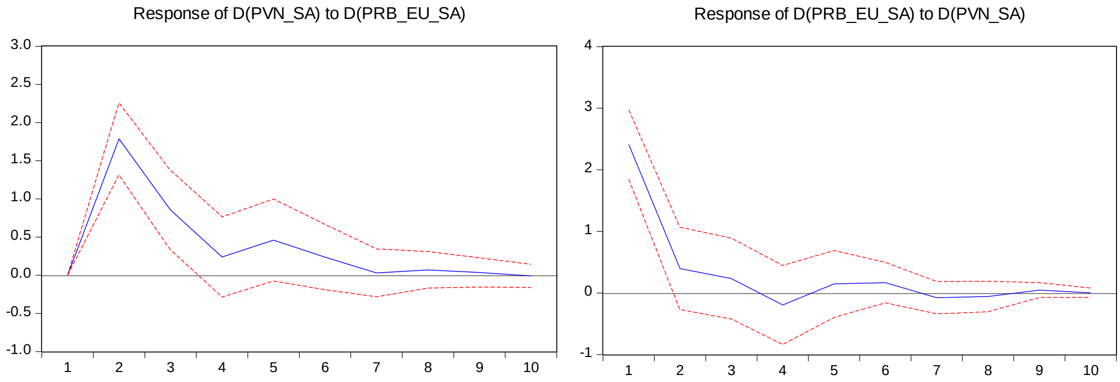

Figure 3. Response to Cholesky one S.D. Innovation +/- 2SE

Source: Drawn by the authors using *Eviews*.

This section analyzes the response of the robusta coffee price to the Vietnamese coffee export price and vice versa. Figure 3 illustrates that when getting a shock, the changes in Vietnamese coffee export price will directly affect the international market price, but this response is not stable. The maximum value is approximately 1.7% in period 1 and it decreases to zero after nine periods. On the other hand, the response of the international market price to a shock in the Vietnamese coffee export price is not steady either. The trend is mainly decreasing from period 1 to period 10. Overall, the relationship between the two price series is closely related since the EU is the biggest market for Vietnamese coffee exports. The influence of the international market price on the Vietnamese coffee export price is higher than the impact of the Vietnamese coffee export price on the international market price.

After determining the response of the variables to a shock, this study next examines the volatility variance of the Vietnamese coffee export price under the influence of the international market price.

- Variance decomposition analysis

From Table 7, when the forecast period is 1, the variance of the Vietnamese coffee export price changes from 100%, while the contribution from the international market price is zero percent. There is a slight decline from 69.6% in period 2 to 64.5% in period 10. The contribution from the international market price to the change in the variance of the Vietnamese coffee export price is not in the same, it increases from zero in period 1 to 35.5% in period 10. The study also observes 36.7% changes in the international market price from the level of the Vietnamese coffee export price, which is 63.3% of their participation in period 1. The analysis found that as the forecast period increased, the effect of the international market price to self-variance is not stable, while the contribution of the Vietnamese coffee export price to the variance of international market price is the same. At the tenth forecast period, the variation of the international market price data is 65.4% from itself and 34.6% from the Vietnamese coffee export price.

Table 7. Variance decomposition of PVN and PRB_EU

	Variance decomposition of PVN			Variance decomposition of PRB_EU		
Period	S.E.	D(PVN_SA)	D(PRB_EU_SA)	S.E.	D(PVN_SA)	D(PRB_EU_SA)
1	2.6668	100.0000	0.0000	3.9839	36.6784	63.3216
2	3.2396	69.6076	30.3924	4.1546	34.6409	65.3591
3	3.3503	65.0956	34.9045	4.1622	34.8277	65.1723
4	3.4186	65.9906	34.0094	4.1912	34.5668	65.4332
5	3.4497	64.8208	35.1792	4.2064	34.4376	65.5624
6	3.4584	64.5283	35.4717	4.2099	34.5383	65.4617
7	3.461	64.5739	35.4261	4.2108	34.5580	65.4420
8	3.4617	64.5473	35.4527	4.2112	34.5697	65.4303
9	3.4621	64.546	35.454	4.2115	34.5775	65.4225
10	3.4622	64.5469	35.4531	4.2115	34.5775	65.4225

Source: Calculated by the authors using *Eviews*.

Overall, from the order of the variance decomposition analysis, the response of the international market price to the Vietnamese coffee export price is slightly higher than the reaction of the Vietnamese coffee export price to the international coffee price. This evidence also illustrates that there is a relationship between the two price series, of which the international market price plays a guiding role.

5. CONCLUSIONS

The fluctuation of agricultural product prices is always a difficult issue for countries with developing agricultural sectors, like Vietnam. Coffee export prices, for example, always fluctuate unpredictably, which directly affects not only the export turnover but a large number of farmers' incomes as well.

Using time series data from January 2004 to December 2017, this paper investigated the price transmission of the international market price on the Vietnamese coffee export price. The results demonstrated that the two variables are not cointegrated with each other at the 99% confidence level. The Granger causality test confirmed that the Vietnamese coffee export price is influenced by the international market price, but not vice versa. The results from this study also showed that the dependent variable is mainly impacted in period 1 by two independent variables with coefficients of 0.3447 and 0.5634, respectively. Meanwhile, the Vietnamese coffee export price did not affect the robusta coffee spot market price. Therefore, the transmission from the international coffee price to the Vietnamese coffee export price is asymmetric. The Vietnamese coffee export price did not have an influence on the world coffee spot market price. Vietnam is only a "small" country in the international coffee market, although Vietnam is the second biggest exporter and producer of robusta coffee in the world. The world coffee price provides a basis to calculate the Vietnamese coffee export price, but not vice versa. This conclusion is in accordance with the actual situation of the Vietnam coffee industry nowadays.

In summary, the findings of this article contribute in a practical way to further improving studies of price transmission using time series data. The findings provide further evidence confirming the relationship between international market prices and agricultural commodity export prices. In regard to practical significance, the results of this study can help coffee enterprises and coffee farmers clearly understand the fluctuation of Vietnamese coffee export price in order to form appropriate strategies.

However, there are still some limitations in this paper. The restrictions can be a hint for future research. In that respect, future studies can extend the literature at least in two ways so as to provide some new insights. Firstly, a VAR model could still be applied, but the number of independent variables or the time interval could be extended. Secondly, researchers could increase the number of independent variables and use another model, such as a structure vector autoregressive model, a panel vector autoregressive model, a Markov switching vector autoregressive, or combine vector autoregressive- and GARCH-family models with the same data. These approaches would probably provide significant new research insights into the relationship between international market prices and agricultural product export prices.

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