“Hedging with commodity futures: evidence from the coffee market in Vietnam”


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# HEDGING WITH COMMODITY FUTURES: EVIDENCE FROM THE COFFEE MARKET IN VIETNAM


## Abstract

In July 2018, the Vietnam Commodity Exchange (VNX) was transferred into the Mercantile Exchange of Vietnam (MXV) to hedge price risks through futures on international commodity exchanges. This research aimed to verify the efficiency of futures on ICE EU and ICE US under the perspective of hedging for Vietnamese coffee, determine optimal hedging ratios and the optimal number of each futures contract, and investigate the feasibility of introducing domestic commodity exchanges in Vietnam. Using the Vector Error Correction Model (VECM), the results show that (1) Robusta futures with expiration dates of January, March, May, and July on ICE EU are efficient hedging tools, but the adverse result is justified for Arabica futures on ICE US; (2) Robusta futures with the expiration date of January are the best in terms of risk management for Vietnamese coffee market; (3) optimal hedge ratio of Robusta futures of around 34% is much lower than ratios showed by previous researches; (4) in the short term, introducing coffee futures into the domestic commodity exchanges is still not feasible in the short term, but should be considered in the long term in Vietnam. This is the first study providing empirical evidence about the hedging role of futures contracts on ICE EU and ICE US, contributing to enrich the existing empirical evidence on the hedging role of futures for the agricultural sector.


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## INTRODUCTION

Since 2000, in an attempt to hedge, the Government of Vietnam was committed to developing commodity exchanges for some crucial agricultural products, including coffee, rice, and rubber, such as Buon Ma Thuot Coffee Exchange Center (BECE) and Vietnam Commodity Exchange (VNX). However, trading results on coffee are modest in terms of value and volume, which means very low liquidity on BECE and VNX. A few years after, on 8th June 2018, the Ministry of Industry and Trade issued license No. 486/GP-BCT, allowing the Mercantile Exchange of Vietnam (MXV) to run businesses. On 17th August 2018, MXV officially launched the nationally centralized commodities exchange, bringing Vietnamese participants' hedging opportunities through trading on ICE EU and ICE US.

The above practice provides us a high motivation to examine if coffee futures trading on international commodity exchanges completes a hedging mission for the domestic spot market. If coffee futures offered by ICE EU and ICE US are really useful financial instruments of risk management for Vietnamese participants, optimal hedging ratios and the optimal number of contracts will be determined. In line with this objective, this research applies Vector Error Correction Model (VECM) to investigate if the long-run relationship between the futures price and domestic price exists and which futures are the best hedging tools for Vietnamese producers. Besides, theoretical frameworks developed by Hull (2012) are also applied to compute optimal hedging ratio and the optimal number of each kind of futures.

To our best knowledge, the contributions of the study are framed in providing empirical evidence indicating if futures trading of Robusta on ICE EU and Arabica on ICE US plays an important role of hedging for Vietnamese participants, as well as what are the optimal hedging ratio and the optimal number of contracts for each kind of futures that they should mention when trading on international commodity exchanges. These important results will be germane to have more efficient risk management in terms of price.

## 1. LITERATURE REVIEW

Since forwarding transactions of agricultural products have become common solutions for risk management in the international markets (Herrmann, 1993), several studies examine the role of futures hedging on prices. However, the research results are not homogeneous with different underlying commodities in various markets.

Janet (1995) questions the futures hedging roles by examining the impact of the futures market on spot prices based on daily observations of the high and low prices of futures, weekly observations of the highest and lowest spot prices of wheat and corn exported in Chicago and mean-variance framework. Thus, the high volume of stockpiled agricultural products would reduce the fluctuation of spot prices by more than 50%. By contrast, the futures market increases the variance of spot prices, enlarging the wheat and corn spot price gap.

Larson et al. (1998) justify futures' role in the economy and their impacts on the volatility of underlying prices in developing countries. Besides, by strongly showing that state interventions in the commodity market to stabilize prices are very costly, ineffective, and accompanied by negative effects when these price stabilization programs fail, the authors encourage countries to promote futures markets as a mechanism to disperse price risks.

Using the same approach methods, Larson et al. (1998) and Morgan (2000) figure that policies launched by some less developed countries (LDCs), which aim to reduce the negative impact of price volatility in commodity markets, tend to fail because they cannot strongly support small producers and farmers due to some main barriers such as lack of infrastructure, high cost, lack of knowledge, credit risks, basic risks, and low liquidity. Hence, these countries can implement solutions such as supporting policies, technology, infrastructure, etc. In particular, international organizations, governments, and the private sectors should play crucial roles in approaching these risk management tools. Choudhry (2009) agrees that commodity futures facilitate the transfer of risks from keepers of physical goods (hedgers) to investors or speculators in the market.

In terms of the research methodology, it can be seen that previous researches find the correlation between futures prices and spot prices by separately applying different kinds of cointegration, including VECM, VAR, GARCH, or mostly combined methods.

Hudson et al. (1996) collect 81 observations per year for 4 consecutive years and then apply Vector Error Correction Model (VECM) to show that cotton spot prices and futures prices are not correlated, which means that futures market and spot market experience a weak relationship. Using the same approach, Arfaoui (2018) justifies the long-term equilibrium relationship between crude oil spot prices and futures prices on the NYCE from 2007 to 2015. The speed of adjustment to the long-term equilibrium is not high, but faster for refined oil on the spot market.

Dividing the GARCH model into four different versions such as bivariate GARCH, bivariate BEKK GARCH, bivariate GARCH-X, and bivariate BEKK GARCH-X, Choudhry (2009) compares the hedging effect of stockpiled goods against non-stockpiled goods based on futures prices and spot prices of seven agricultural products, includ-



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ing maize, coffee, wheat, sugar, soy, livestock, and live pigs. The results reveal the outstanding performance of the through estimated hedge ratios calculated by the GARCH-X model in all stages, supporting Hudson et al. (1996) and Yang et al. (2001). However, different from Yang and Awokuse's (2003) research results, Choudhry (2009) points out that hedging effectiveness between stockpiled and non-stockpiled goods is quite similar. Nicolau and Palomba (2015) focus on the multivariate VAR model to figure that dynamic interactions between spot prices and futures prices considerably depend on each commodity market's characteristics and justify that spot and futures prices were always correlated.

Yang and Awokuse (2003) choose both VECM and two-variable GARCH as a research framework to justify that futures contracts played an effective hedging role in stockpiled goods. Jackson and Woodruff (2016) apply VECM and GARCH to give empirical evidence about close relationships between spot prices on the domestic coffee market in Ugandan and futures prices on international exchanges. Using OLS, VAR, and VECM models, Wang and Chidmi (2011) determine hedge ratios for cotton in various countries, thereby justify whether cotton futures on the NYCE are a hedging tool. Similarly, Wibowo (2017) investigates the effectiveness of hedging strategies by using three models to estimate the optimal hedge ratio, including OLS, VCEM, and TARCH. Yang et al. (2005) apply all four models, including OLS, VAR, VECM, and multivariate GARCH, based on two approaches: risks – profits comparison and maximizing benefits to compare the hedging effects of optimal ratios.

Table 1 summarizes different methods that previous studies apply to investigate the hedging role of futures.

Besides the hedging role of futures, researchers are also interested in the feasibility of launching it on domestic commodity exchanges. The first study is realized by Black (1986) who shows that the success of the futures contracts strongly depends on the characteristics of the underlying assets and is strictly related to the scope of the cash market, price volatility, the risk reduction effect, and liquidity costs. Tashjian (1995) explores how to design successful futures from two perspectives, such as properties of futures and optimal forms of contracts. Rutten (1998) assesses the potential of futures for tropical plywood. Pennings and Leuthold (1999) examine the correlation between trading volume and hedging effectiveness by taking into account both fundamental and market depth risks and the relationship between underlying characteristics and the probability of using the futures contract. Brorsen and Fofana (2001) emphasize that a dynamic cash market is necessary for the success of futures contract since this variable perfectly predicts the futures contract existence, while other variables, such as vertical integration, homogeneity, and buyer concentration, are also important to explain differences in trading volumes and open interest rates between futures markets.

Based on studies of Black (1986) and Pennings and Meulenberg (1998), Bergfjord (2007) measures the volume of future contracts (V) through contract size (FCZ) and cash market size (CS),

**Table 1.** Methods used to examine the role of hedging on prices of commodity futures

Source: Authors' summary.

| No. | Author(s) | Methods |
|---|---|---|
| 1 | Janet (1995) | Mean-variance analysis |
| 2 | Yang and Awokuse (2003) | VECM and GARCH |
| 3 | Yang and Allen (2005) | OLS, VAR, VECM, multivariate GARCH |
| 4 | Kumar et al. (2008) | OLS, VAR, VECM |
| 5 | Choudhry (2009) | GARCH, BEKK GARCH, GARCH-X, BEKK GARCH-X |
| 6 | Jackson and Woodruff (2016) | VECM and GARCH |
| 7 | Wibowo (2017) | OLS, VECM, TARCH |
| 8 | Arfaoui (2018) | ARDL bounds testing approach and VECM |
| 9 | Hudson et al. (1996) | Cointegration and VECM |
| 10 | Wang and Chidmi (2011) | OLS, VAR, VECM |
| 11 | Nicolau and Palomba (2015) | Recursive analysis based on the multivariate VAR model |

hedging ratio (HR), and velocity (VC) and then points out that a futures contract for salmon will be successful if the volume of futures contracts is large enough. Similarly, Hosseini-Yekani et al. (2009) identify significant determinants, such as relative basic risk (RB), spot price fluctuation (SPF), cash market size (CMS), liquidity cost (LC), homogeneity (H), and commercialization rate (CR) when studying the futures market in Iran.

In Vietnam, some researches are focusing on risks caused by fluctuations in prices of agricultural products, such as those of Nguyễn Lê Tường Vy (2007), Nguyễn Thị Ngọc Trang (2011), Tô Thị Kim Hồng (2016), Dinh Xuan and Nguyen Quoc (2016), as well as some researches about the cointegration relationship between Vietnam's exported coffee price and the world coffee price in the period 2008–2014, including that of Nguyễn Văn Phúc and Tô Thị Kim Hồng (2014). Besides, Nguyễn Lương Thanh (2010), Dinh Xuan and Nguyen Quoc (2016), Nguyễn Phước Kinh Kha (2014), Nguyễn Thị Nhung and Trần Thị Thanh Tú (2017) also show the importance of derivatives operations for Vietnamese participants. It can be seen that there is no research using an econometric model to examine the role of price hedging of futures for Vietnamese agricultural products in general and coffee in particular.

# 2. METHODOLOGY AND HYPOTHESES DEVELOPMENT

## 2.1. Research design

The study is designed with three specific steps. Firstly, the research examines the futures price hedging role through the correlation between the spot price and futures price on ICE EU and ICE US. Secondly, the optimal hedge ratios are calculated if futures strongly support risk management. Finally, the study investigates the feasibility of introducing coffee futures exchange into the domestic exchange market.

## 2.2. Data source

Both primary and secondary data are used in this research. The secondary data include FOB Ho Chi Minh price and the daily trading price of coffee futures with different expiration dates on the ICE US for Arabica and the EU ICE for Robusta. There are 6 Robusta futures contracts on the ICE EU with expiration dates in 2020, namely January, March, May, July, September, and November (Table 2) and 5 Arabica futures contracts, which expire in March, May, July, September, and December (Table 3). All of the above secondary data are collected from Thomson Reuters Datastream. The re-

**Table 2.** Information about Robusta futures contracts on ICE EU

Source: Authors' calculations based on Thomson Reuters Datastream.

| Contract | Period | Observations |
|---|---|---|
| LIFFE – Robusta Coffee Jan 2020 | 06/01/2018 – 01/10/2020 | 421 |
| LIFFE – Robusta Coffee Mar 2020 | 07/26/2018 – 01/10/2020 | 382 |
| LIFFE – Robusta Coffee May 2020 | 09/25/2018 – 01/10/2020 | 339 |
| LIFFE – Robusta Coffee Jul 2020 | 11/27/2018 – 01/10/2020 | 294 |
| LIFFE – Robusta Coffee Sep 2020 | 01/28/2019 – 01/10/2020 | 250 |
| LIFFE – Robusta Coffee Nov 2020 | 03/29/2019 – 01/10/2020 | 206 |

**Table 3.** Information about Arabica futures contracts on ICE US

Source: Authors' calculations from Thomson Reuters Datastream.

| Contract | Period | Observations |
|---|---|---|
| CSCE-COFFEE 'C' MAR 2020 | 04/05/2017 – 11/29/2019 | 128 |
| CSCE-COFFEE 'C' MAY 2020 | 06/08/2017 – 11/29/2019 | 120 |
| CSCE-COFFEE 'C' JUL 2020 | 08/03/2017 – 11/29/2019 | 112 |
| CSCE-COFFEE 'C' SEP 2020 | 10/05/2017 – 11/29/2019 | 103 |
| CSCE-COFFEE 'C' DEC 2020 | 01/04/2018 – 11/29/2019 | 91 |


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search also uses statistics reported by the Vietnam Coffee and Cocoa Association (VICOFA) and the Ministry of Agriculture and Rural Development in Vietnam.

In terms of primary data, the research collects them through in-depth interviews with experts about the feasibility of introducing coffee futures into the domestic commodity exchange. Based on 6 determinants proposed by Hosseini-Yekani et al. (2009), criteria are divided into 4 groups, such as volatility of the coffee spot price, liquidity, homogeneity, and objective factors like legal framework, infrastructure, awareness of participants. Then, questionnaires are developed on a Likert scale from 1 to 5 (where 1 is the lowest rating and 5 is the highest rating) and contain two parts. There are 6 general questions in part 1 and 12 questions in part two, which consists of 2 questions for spot price volatility criteria, 4 questions for liquidity, 2 questions for homogeneity criteria, and 3 questions for objective factors, as well as 1 question about the importance of each criterion (Appendix 1).

## 2.3. Methods of data analysis

- Verifying the correlation between spot prices and futures prices of coffee.

The research estimates the correlation between the spot price and futures prices of coffee through 6 steps (see Figure 1).

### Step 1. Stationarity test (unit root test)

The study applies the Augmented Dickey-Fuller test to test price data stationarity. There are three basic regression models:

- No constant, no trend: $\Delta P_{0,t} = \beta P_{j,t-1} + u_t;$
- Constant, no trend: $\Delta P_{0,t} = \alpha + \beta P_{j,t-1} + u_t;$
- Constant and trend:

$$\Delta P_{0,t} = \alpha + \beta P_{j,t-1} + \lambda_t + u_t,$$

where $P_0$ – spot price of coffee (domestic price), $P_j$ – futures price of coffee on international commodity exchanges, $\Delta P_{0,t}$ – change in spot rate on the domestic market at time $t$, $\lambda_t$ – trend variable.

There are two hypotheses:

$H_0$: $\beta = 0$ *the time series is non-stationary.*
$H_1$: $\beta < 0$ *the time series is stationary.*

If the absolute value of $t$-statistics is bigger (or smaller) than the absolute value of criteria value $\tau$

Source: Authors.

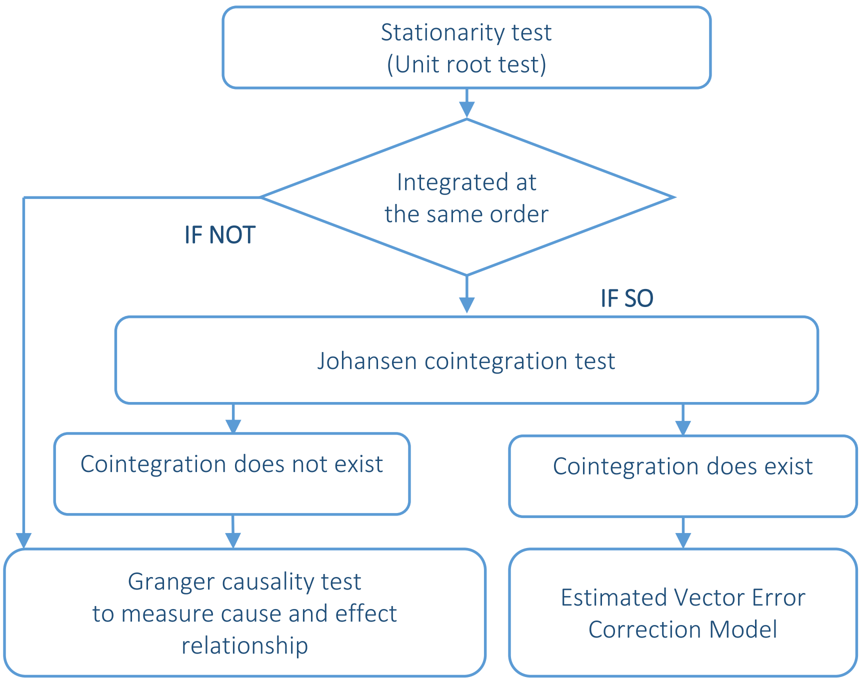


**Figure 1.** Implementation procedure of data analysis

on the Mackinnon table, the hypothesis $H_0$ is rejected (or accepted), and the series is stationary (or non-stationary).

## Step 2. Determining optimal lag

To determine the optimal lag length, the study uses all of the different criteria, such as Akaike information criterion (AIC), Schwarz information criterion (SC), FPE criterion (final prediction error), and Hannan-Quinn information criterion (HQ). It then selects the one with the lowest statistic value as the optimal lag length.

## Step 3. Co-integration test

To confirm if spot prices and futures prices are cointegrated, the research applies the Johansen cointegration test through 2 criteria: Max Eigenvalue test and Trace test. There are two hypotheses:

$H_0$: *No cointegrating equation between spot prices and futures prices.*

$H_1$: *Co-integrating equation between spot prices and futures prices.*

The hypothesis $H_0$ will be rejected if the Trace and Max Eigenvalue statistic value is more than 5% critical value. If futures contract price does not cointegrate with the spot price, the study will perform the additional step 6.

## Step 4. Vector Error Correction Model (VECM)

An estimated VECM is as follows:

$$\Delta P_{j,t} = \beta_0 + \sum_{i=1}^{n} \beta_i \Delta P_{j,t-1} + \sum_{i=1}^{n} \delta_i \Delta P_{0,t-1} + \omega \mu_{t-1} + v_t, \quad (1)$$

Co-integrate equation (long-run model):

$$\mu_{t-1} = ETC_{t-1} = P_{j,t-1} - \beta_0 - \beta_1 P_{o,t-1}. \quad (2)$$

while $P_{o,t}$ – spot price of coffee on the domestic at time $t$, $P_{j,t}$ – future price of coffee on international commodity exchanges at time $t$, $\Delta$ the difference in price, $\mu_{t-1}$ – the lagged value error correction term, $v_t$ – white noise error term.

The first equation describes both the short-run and long-run dynamics between the spot price and futures price, while the second one only focuses on the long-run relationship. $P_{o,t}$ and $P_{j,t}$ experience a long-run relationship when the cointegration coefficient equation is between –1 and 0 at the statistical significance. The coefficient of ETC $\omega$ indicates how quickly the dependent variable $\left(P_{j,t}\right)$ returns to equilibrium after a change in the independent variable $\left(P_{o,t}\right)$.

## Step 5. Stability test of VECM model

The study ensures the model's stability by using the inverse roots of the characteristic AR polynomial test and CUSUM test. Besides, the study verifies the autocorrelation of residuals through VEC residual serial correlation LM tests on EViews 10 software. If the results show that *p*-value at lag order *h* less than the significance of 5%, the hypothesis $H_0$ is accepted.

## Step 6. Granger causality test

In the case of futures contract price do not have a cointegration with the spot price, the study will perform the Granger causality test to consider the short-term causal relationship between the coffee futures price and coffee spot price in Vietnam.

There are bivariate regressions of the form:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \ldots + \alpha_l Y_{t-l} + \beta_1 X_{t-1} + \ldots + \beta_l X_{-l} + \varepsilon_t,$$

$$X_t = \alpha_0 + \alpha_1 X_{t-1} + \ldots + \alpha_l X_{t-l} + \beta_1 Y_{t-1} + \ldots + \beta_l Y_{-l} + u_t.$$

- Computing optimal hedge ratios and the optimal number of contracts.

According to Hull (2015), The minimum variance hedge ratio (also called the optimal hedge ratio – $h^*$) depends on the relationship between changes in the spot price $(\Delta S)$ and changes in the futures price $(\Delta F)$, during a period equal to the life of the hedge. The formula for $h^*$ is as follows:



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$$h^* = \rho \frac{\sigma_s}{\sigma_f} = \frac{Covariance\ of\ sport\ and\ futures\ price}{Variance\ of\ futures\ price},$$

where $\rho$ – the correlation coefficient between the futures price and the spot price, $\sigma_s$ – the standard deviation of $\Delta S$, $\sigma_f$ – the standard deviation of $\Delta F$.

To calculate the number of contracts that should be used in hedging, the optimal number of contracts is given by the following formula:

$$N^* = \frac{h^* Q_A}{Q_F},$$

where $Q_A$ – size of position being hedged (units), $Q_F$ – size of one futures contract (units), $N^*$ – optimal number of futures contracts for hedging.

- Evaluating the feasibility of introducing coffee futures contracts on the domestic commodity exchange.

The research evaluates the feasibility of introducing coffee futures contracts on domestic commodity exchange by summarizing average scores of 4 main determinants, such as spot price volatility criteria, liquidity, homogeneity, and objective factors.

# 3. EMPIRICAL RESULTS

## 3.1. Data description

Figure 2 compares coffee prices on the domestic market in Vietnam and coffee futures prices on ICE EU and ICE US. It can be seen that there is a downward trend in both spot and futures prices of Robusta from 2018 to 2019. Price movements for Arabica are quite different from Robusta when this kind of coffee experiences a slight increase at the end of 2019. Moreover, the change in coffee prices in Vietnam is quite similar to that in futures prices on ICE US and ICE EU.

Tables 4 and 5 give statistics about spot prices and futures prices for Robusta and Arabica accordingly. It can be seen that max, min, and mean values of coffee spot prices always smaller than those of futures prices on ICE EU and ICE US. Coffee futures prices also have a significantly higher standard deviation than that of spot prices, which means that the latter does not fluctuate as futures prices. Moreover, this index slightly goes down according to the maturity of futures contracts. In other words, the longer maturity is, the smaller the standard deviation is.

Source: Thomson Reuters Datastream.

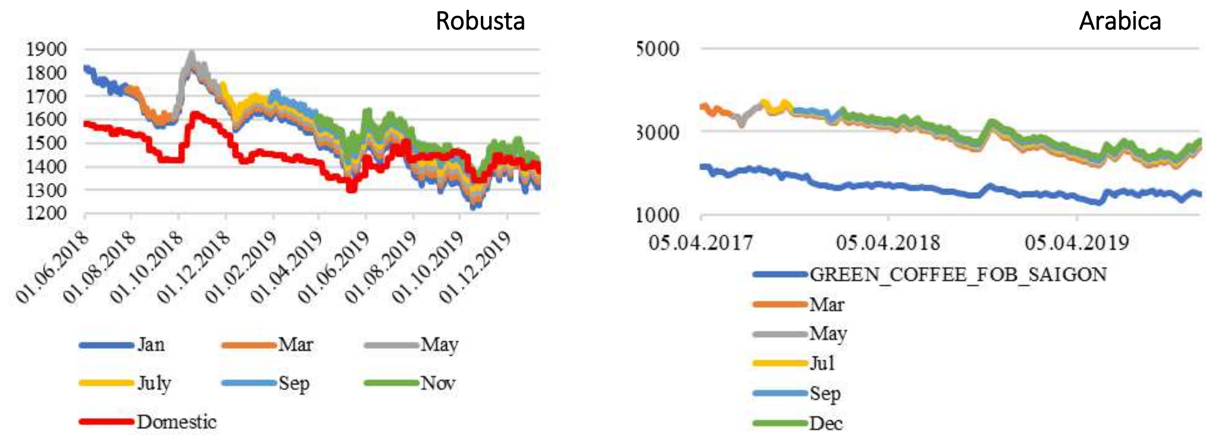


**Figure 2.** Movements of coffee spot prices in Vietnam and coffee futures prices on ICE EU and ICE US

**Table 4.** Statistics of data on futures prices and spot prices of Robusta coffee

Source: Authors' calculation based on data collected from Thomson Reuters Datastream.

| Contracts | Max | Min | Mean | Standard deviation |
|---|---|---|---|---|
| LIFFE-ROBUSTA COFFEE JAN 2020 ($) | 1,861.00 | 1,227.00 | 1,534.91 | 159.29 |
| LIFFE-ROBUSTA COFFEE MAR 2020 ($) | 1,875.00 | 1,252.00 | 1,531.13 | 144.80 |
| LIFFE-ROBUSTA COFFEE MAY 2020 ($) | 1,887.00 | 1,277.00 | 1,536.08 | 143.46 |
| LIFFE-ROBUSTA COFFEE JUL 2020 ($) | 1,751.00 | 1,304.00 | 1,519.95 | 112.09 |
| LIFFE-ROBUSTA COFFEE SEPT 2020 ($) | 1,720.00 | 1,330.00 | 1,513.19 | 95.05 |
| LIFFE-ROBUSTA COFFEE NOV 2020 ($) | 1,640.00 | 1,358.00 | 1,501.78 | 66.27 |
| DOMESTIC SPOT ($) | 1,626.54 | 1,298.56 | 1,456.09 | 71.88 |

**Table 5.** Statistics of data on futures prices and spot prices of Arabica coffee

Source: Authors' calculation based on data collected from Thomson Reuters Datastream.

| Contracts | Max | Min | Mean | Standard deviation |
|---|---|---|---|---|
| CSCE-COFFEE 'C' MAR 2020 ($) | 3,677.27 | 2,146.18 | 2,897.36 | 462.27 |
| CSCE-COFFEE 'C' MAY 2020 ($) | 3,701.52 | 2,197.99 | 2,898.41 | 438.70 |
| CSCE-COFFEE 'C' JUL 2020 ($) | 3,723.57 | 2,247.59 | 2,901.79 | 422.43 |
| CSCE-COFFEE 'C' SEP 2020 ($) | 3,527.36 | 2,292.78 | 2,880.79 | 378.73 |
| CSCE-COFFEE 'C' DEC 2020 ($) | 3,551.61 | 2,358.92 | 2,863.98 | 328.59 |
| GREEN COFFEE – FOB SAIGON ($) | 2,158.00 | 1,290.00 | 1,661.36 | 224.42 |

## 3.2. The results of estimating Vector Error Correction Model (VECM)

### 3.2.1. *Robusta*

By regression with intercept and trend, the result shows that all the series of spot prices in Vietnam and the series of futures prices have trend and intercept (Appendix 2). Then, different criteria like AIC, SC, HQ show that prices of Robusta in Vietnam and all Robusta futures contract prices have an optimal lag of 1 (Appendix 3). The Trace and Max-Eigenvalue tests (Appendix 4) indicate a cointegration (long-term relationship) at the 5% significance level between Robusta spot prices and futures with expirations of January, March, May, and July. However, there is no cointegration relationship at the 5% significance level between Robusta spot prices and futures with September and November expirations. Therefore, the study continues to perform the Granger causality test to estimate the causal relationship between Robusta futures contracts' prices expire in September and November with spot prices. The study then uses the series after the first differencing to estimate the VECM model (Appendix 5). Table 6 summarizes the VECM results, showing the overall relationship and the long-term relationship between price volatility of futures contracts expire in January, March, May, and July with price volatility of Robusta spot prices.

It can be seen that there is an optimal lag of 1 for Robusta prices series at the beginning, while after the first differencing, this number is 0. Moreover, the volatility of futures prices and spot prices is unpredictable and less affected by the price changes in the short term.

The main feature of the VECM is finding any imbalance and redirecting system variables back to equilibrium. Figure 3 shows that the coefficient $\omega$ of contracts expiring in January, March, May, and July is from –1 to 0, which means that Robusta futures with expirations of January, March, May, and July can serve as tools of hedging price risks for Robusta in Vietnam.

Appendix 6 shows of stability test for VECM. AR characteristic tests for all VECM models show that all the inverse roots of the characteristic AR polynomial have modules less than 01 and lie inside the unit circle, which means that all VECM models ensure stability and sustainability. The CUSUM tests also show that the cumulative sum of recursive residuals' movement is always between the two critical lines of 5%, showing the coefficient's stability in VECM models.

After testing the stability of VECM, the research continues to test the autocorrelation of residuals. As a result, all futures contracts have p-values less


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**Table 6.** Estimated VECM and cointegrating equation (long-run model) between Robusta spot prices and futures prices on ICE EU

Source: Authors' calculation.

| Contracts | Estimated VECM | Cointegrating equation (long-run model) |
|---|---|---|
| Futures JAN 2020 | $\Delta y_t = -0.776809xETC_{t-1}$ | $\mu_{t-1} = ETC_{t-1} = y_{t-1} - 0.926826x_{t-1}$ |
| | $D(D1ROBUSTA\_JAN) = C(1) \cdot \begin{pmatrix} D1ROBUSTA\_JAND(-1) - \\ -0.926826 \cdot D1ROBUSTA\_DOMESTIC(-1) \end{pmatrix}$ | |
| Futures MAR 2020 | $\Delta y_t = -0.709954xETC_{t-1}$ | $\mu_{t-1} = ETC_{t-1} = y_{t-1} - 0.988258x_{t-1}$ |
| | $D(D1ROBUSTA\_MAR) = C(1) \cdot \begin{pmatrix} D1ROBUSTA\_MAR(-1) - \\ -0.988258 \cdot D1ROBUSTA\_DOMESTIC(-1) \end{pmatrix}$ | |
| Futures MAY 2020 | $\Delta y_t = -0.680318xETC_{t-1}$ | $\mu_{t-1} = ETC_{t-1} = y_{t-1} - 1.018290x_{t-1}$ |
| | $D(D1ROBUSTA\_MAY) = C(1) \cdot \begin{pmatrix} D1ROBUSTA\_MAY(-1) - \\ -1.018290 \cdot D1ROBUSTA\_DOMESTIC(-1) \end{pmatrix}$ | |
| Futures JUL 2020 | $\Delta y_t = -0.993795xETC_{t-1}$ | $\mu_{t-1} = ETC_{t-1} = y_{t-1} - 0.472955x_{t-1}$ |
| | $D(D1ROBUSTA\_JUL) = C(1) \cdot \begin{pmatrix} D1ROBUSTA\_JUL(-1) - \\ -0.472955 \cdot D1ROBUSTA\_DOMESTIC(-1) \end{pmatrix}$ | |

than 5% significance level. Therefore, the hypothesis $H_0$ is accepted, which means that there is no autocorrelation at lag order $h$ (with $h = 1$). In other words, there is no autocorrelation at lag order 1 of VECM. Moreover, testing the Granger causality between September and November futures prices with Robusta's spot prices in Vietnam indicates a Granger causality of volatility in futures prices for spot prices (with a $p$-value of 0.0114 and 0.0282). However, the opposite is not true because the $p$-value of 0.8011 and 0.8470 for September and November futures accordingly are more than 5% significance level (Appendix 7).

### 3.2.2. *Arabica*

The ADF test shows that these series do not satisfy the 5% significance level in the range of data collected on Arabica futures and spot prices. After the first differencing, all of the series have no trend and no intercept and satisfied the 5% significance level (Appendix 9). Spot prices and all futures prices have a lag of 1 (Appendix 10). New series have a lag of 0. Trace and Max Eigenvalue tests show no significant cointegration at 5% significance level between spot prices and futures prices (Appendix 11). Therefore, the VECM model cannot be applied.

Source: Authors' calculation.

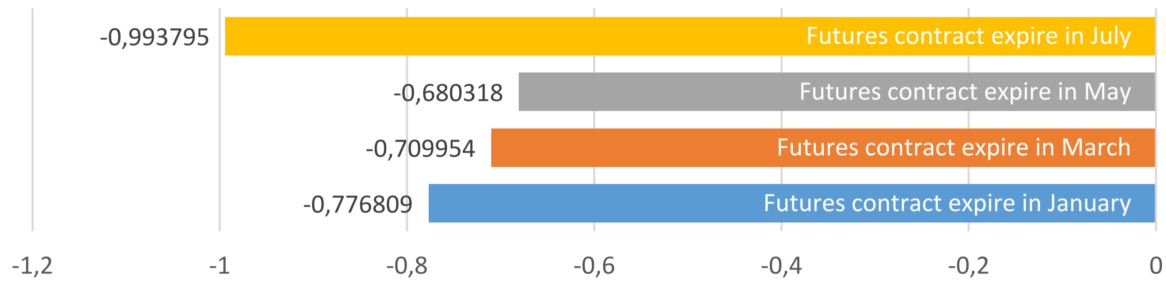


**Figure 3.** ETC $(\omega)$ coefficient of Robusta futures contracts

## 3.3. The optimal hedge ratio and the optimal number of contracts

The study estimated the correlation coefficient by processing on EViews 10 software between the spot prices and futures prices of Robusta, which expire in January, March, May, and July (Appendix 8). Using the formula proposed by Hull (2015), optimal hedge ratios are calculated as follows:

- Robusta futures with the expiration date of January:

$$h_1^* = \rho \frac{\sigma_S}{\sigma_F} = 0.756477 \cdot \frac{71.88}{159.2934} = 0.3414;$$

- Robusta futures with the expiration date of March:

$$h_3^* = \rho \frac{\sigma_S}{\sigma_F} = 0.689969 \cdot \frac{71.88}{144.8018} = 0.3425;$$

- Robusta futures with the expiration date of May:

$$h_5^* = \rho \frac{\sigma_S}{\sigma_F} = 0.670835 \cdot \frac{71.88}{143.4575} = 0.3361;$$

- Robusta futures with the expiration date of July:

$$h_7^* = \rho \frac{\sigma_S}{\sigma_F} = 0.415726 \cdot \frac{71.88}{112.0909} = 0.2666.$$

With $h^*$ and $Q_F$ already calculated for each contract, the optimal number of contracts, which depends on the contract size of the position being hedge $(Q_A)$, is calculated as follows:

- the optimal number of Robusta futures, which expire in January:

$$N_1^* = h_1^* \frac{Q_A}{Q_F} = 0.03414 Q_A;$$

- the optimal number of Robusta futures, which expire in March:

$$N_3^* = h_3^* \frac{Q_A}{Q_F} = 0.03425 Q_A;$$

- the optimal number of Robusta futures, which expire in May:

$$N_5^* = h_5^* \frac{Q_A}{Q_F} = 0.03361 Q_A;$$

- the optimal number of Robusta futures, which expire in July:

$$N_7^* = h_7^* \frac{Q_A}{Q_F} = 0.02666 Q_A.$$

## 3.4. The feasibility of introducing coffee futures exchange into the domestic exchange market

In-depth interviews show that Vietnamese experts highlight the extremely crucial role of liquidity for the success of futures on the domestic commodity exchange. Following this factor, there are spot price volatility and objective factors. A significant change in spot prices strongly encourages coffee producers and traders to seek efficient tools to hedge their price risks. Moreover, the role of Government is essential in the context of developing countries like Vietnam.

Based on 4 criteria such as volatility in spot prices, liquidity, homogeneity, and objective factors, experts evaluate coffee futures feasibility on domestic commodity exchange in Vietnam. It can be seen that Vietnamese coffee experiences high volatility in both spot and futures prices (with

Source: Authors' calculation.

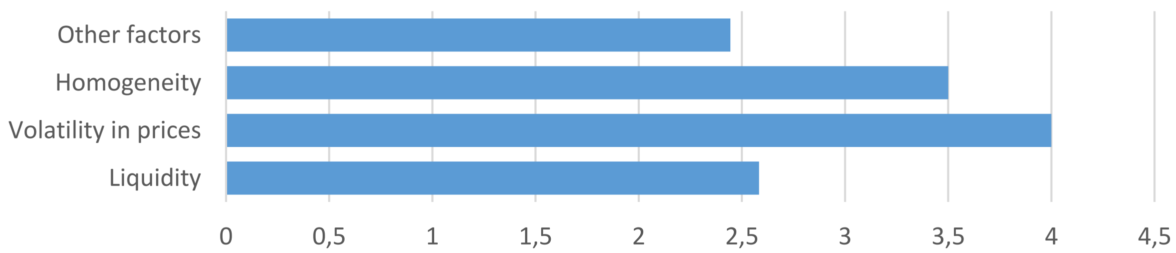


**Figure 4.** Experts' evaluations on the feasibility of introducing coffee futures into the domestic commodity exchange


http://dx.doi.org/10.21511/imfi.17(4).2020.06

4 points), which means a high need for hedging risks from Vietnamese coffee producers. The homogeneity factor is quite good, with 3.5 points. However, liquidity only obtains 2.5 points even though this is the most essential and decisive factor for the success of a futures contract (Figure 4). In other words, according to Vietnamese experts, launching coffee futures on domestic commodity exchange is not feasible in Vietnam.

## 4. DISCUSSION

Firstly, by using the VECM, the study figures that Robusta futures with expiration dates of January, March, May, and July witness their important role of risk management tool, while those of September and November do not. There is no evidence of the relationship between a domestic spot in Vietnam and futures prices on ICE US in terms of Arabica. In other words, both Robusta and Arabica futures on ICE EU and ICE US could not hedge fluctuations in coffee prices on Vietnam's domestic market. This empirical evidence supports the research results of Hudson et al. (1996), Wang and Chidmi (2011), Nicolau and Palomba (2005). However, this finding is not consistent with theories about the role of derivative instruments generally and the hedging role of futures in particular, as well as some studies such as Janet (1995), Yang and Allen (2005), Kumar, Singh, and Pandey (2008), Choudhry (2009), Wibowo (2017), Arfaoui (2018), etc. This can be explained by the fact that the interaction between spot prices and futures prices strongly depends on commodities' physical characteristics (Nicolau & Palomba, 2015).

Secondly, the January contract is the best in terms of hedging tools. For futures which have no cointegration with spot prices like contracts for September and November, the research continues to test the Granger causality at a significance level of 5% and figures that these futures experience a short-term causal impact on spot prices, but the opposite was not true. This means that Vietnamese Robusta does not have enough power to affect international markets' coffee prices at the end of the year.

These findings are appropriate to Vietnam production situations, where production values always peak at the beginning of the years. Some provinces in the Central Highlands, such as Gia Lai, KonTum, Dak Lak, Dak Nong, are the main areas where Robusta grows up and develops. The harvest season usually takes place from October to December or one month later. At that point, the domestic market supply is abundant and frequently reaches a peak in January. While a few big producers wait for higher prices by temporarily stockpiling, most farmers are obliged to immediately sell coffee since they have to pay to banks due to their loans or agents which supply fertilizers and pesticides. Therefore, the first months of the years always experience very high export values of coffee in Vietnam (Figure 5).

In terms of Arabica, this kind of coffee grown up at an altitude of 1,000 m above sea level, in which the most delicious product requires an altitude of 1,500 m. Being quite sensitive to the climate, this kind of coffee strictly requires temperature and average annual rainfall, and high cultivation and harvest techniques, while most Vietnamese farmers struggle to have money to invest in Arabica. Therefore, only some Vietnamese producers are interested in this kind of coffee, which leads to the fact that Arabica's

Source: General Statistics Office of Vietnam (2018).

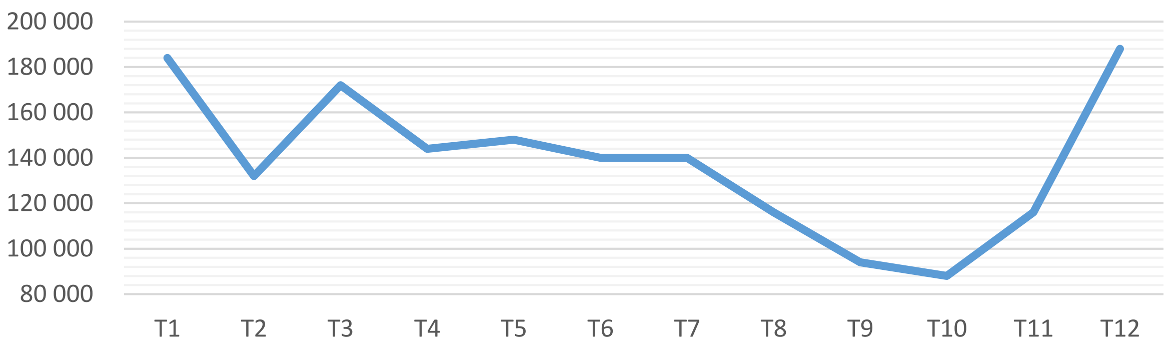


**Figure 5.** Coffee production in Vietnam in 2019 (tons)

production values are very low in Vietnam, and then Arabica is not the main product for exportation in Vietnam. That is why the research does not find any relationship between Arabica spot prices and futures prices on ICE US.

Thirdly, the optimal hedging ratios are approximately 34% for Robusta futures with expiration dates of January, March, and May, which are much less than the results computed by previous research (Table 7). This lower optimal hedging ratios result from a loose relationship between Robusta spot prices and futures prices, which means Vietnamese coffee producers have not shown their power in forwarding transactions yet. Only a few Vietnamese participants join this kind of market, which results from several reasons, such as not enough knowledge about derivatives and weak performance on implementing risk management strategies, as well as trading on international commodity exchanges, inappropriate size of futures on international commodity exchanges, and issues related to exchange rates (Nguyễn Hoàng Mỹ Phương, 2013).

Last not but least, the feasibility of introducing coffee futures on domestic commodity exchange is considered when the research results show that futures do not hedge Vietnamese coffee on ICE US and ICE EU, and the optimal hedging ratios are quite low, compared to China, Indonesia, Australia, and the United States. According to Nguyễn Thị Nhung (2017), domestic commodity exchanges can bring some significant benefits, including limiting basis risks, eliminating exchange rate risks, designing futures appropriate to domestic production and demands, etc. However, it is not easy to form a domestic commodity exchange because it requires strict price volatility, information transparency, infrastructure, and technologies.

In-depth interviews indicate that it is not feasible to launch coffee futures in Vietnam in the short term. The forward transaction through commercial banks has been known since 2004 and officially realized through the Vietnam Commodity Exchange (VNX) in 2010 and the Buon Ma Thuot Coffee Exchange Center in 2011. However, the trading volume and value were still very small. Nguyễn Thị Nhung (2017) has pointed out four main root causes of this situation, including (1) there were some inadequacies in Vietnamese regulations about forwarding transactions; (2) trading on VNX and BCEC did not bring benefits or investment opportunities to participants; (3) financial institutions have not shown an active role in the capital market by building a reliable clearing system on BCEC and VNX; (4) Vietnam's infrastructure is not good enough. This can be considered a bad impression, making participants not trust domestic commodity exchanges, leading to very low liquidity while this is the most important factor ensuring the success of futures. Besides, the current legal framework and warehouse conditions for coffee storage have been not good enough. That is why the Government decided to close the two domestic exchanges/centers, and in the meantime, the Ministry of Industry and Trade issued License No. 486/GP-BCT, which started allowing Mercantile Exchange of Vietnam to operate. This is the only nationally centralized com-

**Table 7.** Comparison of optimal hedging ratios in various researches

Source: Authors' summary.

| No. | Authors | Models | Countries | Hedge ratio |
|---|---|---|---|---|
| 1 | Janet (1995) | Mean-variance framework | US | More than 50% |
| 2 | Yang and Allen (2005) | OLS, VAR, VECM, GARCH | Australia | Around 70% |
| 3 | Kumar et al. (2008) | OLS, VAR, VECM | India | More than 90% |
| 4 | Wang and Chidmi (2011) | OLS | United States, Australia, China | US: 58% |
| | | | | Australia: 73% |
| | | | | China: 42% |
| | | VAR | | US: 60% |
| | | | | Australia: 83% |
| | | | | China: 48% |
| | | VECM | | US: 67% |
| | | | | Australia: 52% |
| | | | | China: 97% |
| 5 | Wibowo (2017) | OLS, VECM, TARCH | Indonesia | More than 70% |



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modities market organizer in Vietnam. On 17th August 2018, MXV officially launched the nationally centralized commodities market. However, it is very necessary to seriously think about hedging for Vietnamese farmers on coffee. Until now, they still struggle to use derivative instruments in both domestic and foreign markets. In the long term, based on convenience and accessibility, Vietnam should build the domestic commodity exchange, like what African and American countries did. Besides, Vietnamese coffee is always ranked at a very high position globally in terms of export value. Thus, developing domestic commodity exchanges will be an indispensable trend in Vietnam when one needs an organization that manages and regulates commodity prices in the market.

## CONCLUSION

The introduction of the Mercantile Exchange of Vietnam (MXV) in August 2018 remarked the appearance of the nationally centralized commodities market in Vietnam. It was a very good sign for a growing maturity in the national financial market. The study provides the first empirical evidence about the hedging role of futures contracts on ICE EU and ICE US for Vietnamese participants from January 2018 to December 2019. Using Vector Error Correction Model (VECM), the research demonstrates that there is only a long-run relationship between spot price in the Vietnamese market and futures prices in January, March, May, and July on ICE Europe for Robusta. Besides, the research contributes to enrich the existing empirical evidence on the hedging role of futures for the agricultural sector. The study results are very significant when futures are still not popular for Vietnamese participants in agriculture.

However, it is seen that the research is executed in a short period from 2018 for only 5 futures contracts and only focus on the most important role of hedging. Therefore, the research results cannot fully reflect the total nature of coffee trading on Vietnam's commodity market. There is a need for further follow-up studies with deep analysis, highly specific recommendations, and a longer (richer) sample of the data about different kinds of coffee futures contracts and especially about the feasibility of developing futures trading for coffee in the domestic market.

## AUTHOR CONTRIBUTIONS

Conceptualization: Nguyen Thi Nhung, Nguyen Nhu Ngan, Tran Thi Hong, Nguyen Dinh Cuong.
Data curation: Nguyen Thi Nhung, Nguyen Nhu Ngan, Tran Thi Hong, Nguyen Dinh Cuong.
Formal analysis: Nguyen Thi Nhung, Nguyen Nhu Ngan, Tran Thi Hong, Nguyen Dinh Cuong.
Investigation: Nguyen Thi Nhung, Nguyen Nhu Ngan, Nguyen Dinh Cuong.
Methodology: Nguyen Thi Nhung, Nguyen Nhu Ngan, Tran Thi Hong, Nguyen Dinh Cuong.
Software: Nguyen Thi Nhung, Nguyen Nhu Ngan.
Supervision: Nguyen Thi Nhung.
Validation: Nguyen Thi Nhung.
Visualization: Nguyen Thi Nhung, Nguyen Nhu Ngan, Tran Thi Hong, Nguyen Dinh Cuong.
Writing – original draft: Nguyen Thi Nhung, Nguyen Nhu Ngan, Tran Thi Hong, Nguyen Dinh Cuong.
Writing – review & editing: Nguyen Thi Nhung.

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# APPENDIX

| No. | Appendix | Link |
|---|---|---|
| 1 | Appendix 1. In-depth survey | https://www.researchgate.net/publication/345139157_Coffee_Hedging-Appendix?_sg=jz9SrOij_PYD8AsFAoKzAANQvFJQntVv-bCH1XWU2vDl5pxG0hlFSddTgfFlOAjR10-7L-Dl8YAIfQ3VU817q7z6GvBDpdlwiwP9JhFU.L7dJkYy4e_FvGt5c7pHOuaH9lpprKhWwuCfatEFmmLGpMS42wqd6PUCf-kFSdTE_PsVdarMKNIVK-nJUZ082Ow |
| 2 | Appendix 2. Stationarity test - Robusta coffee | |
| 3 | Appendix 3. Optimal lag selection – Robusta coffee | |
| 4 | Appendix 4. Cointegration test – Robusta coffee | |
| 5 | Appendix 5. Vector Error Correction Model – Robusta coffee | |
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| 7 | Appendix 7. Granger causality test - Robusta coffee | |
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