Price Asymmetry of Coffee Beans: Evidence from Vietnam

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Abstract: The research evaluates the price transmission between export and farmgate prices for Vietnam's Robusta coffee. Our findings suggest that minor asymmetry price transmission exists for export prices in the long-run and for farm prices in the short-run when thresholds are considered. Besides, the daily speed of adjustment is so high as to lead one to conclude that the price transmission is symmetric. Some possible explanations include the low concentration of local exporters, Robusta's low quality, and coffee oversupply. Given the recent downward trend in global coffee bean prices, this result also implies that liberalisation current policies are inadequate to ensuring coffee farmers' welfare.

Keywords: Asymmetric price transmission, Robusta coffee, Vietnam

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1. Introduction

Coffee is one of the major cash crops in developing economies as it makes significant contribution to the government's tax revenue and to agricultural households' income (Worako et al., 2013). Unsurprisingly, it is an important crop for the agricultural economy of Vietnam. The country is the largest producer of Robusta coffee with a total production of about 1.66 million tons in 2014 (International Coffee Organization (ICO), 2016). The total area of coffee production saw an upward trend over the last five years and reached around 642,000 hectares in 2014 (General Statistics Office (GSO), 2016). The export value was nearly US$3.6 billion, about 22% of the total export value of agricultural commodities in the same year (Ministry of Agriculture and Rural Development (MARD), 2016b). In addition, the domestic coffee sector employed nearly 2.6 million workers in 2014 (Summers, 2014), which constituted approximately 4.8% of the total workforce at that time (World Bank, 2016).

During the last three decades, as the nation transitioned from a planned to a market economy, Vietnam has become more integrated into the regional and global market (SEARCA, 2014). In the coffee sector the government has introduced various policies to promote export activities since 2000, including restructuring state-owned enterprises, providing favourable credit for private businesses, and permitting foreign-owned companies (AgroInfo, 2012). However, with this move domestic coffee prices have become more exposed to the volatility of world coffee prices (González, 2007), so that the extent of any benefit from these policies depends on the nature of the price transmission between the two markets. If asymmetric price transmission (APT) occurs, the welfare gains for farmers may not be as great as expected from such economic reforms in Vietnam. Alternatively, if the price transmission is symmetric, these liberalisation policies may be a change for the worse in times of downward prices.

Despite the significance of the price transmission to coffee farmers' well-being, few attempts have been made in Vietnam's coffee sector. To the best of our knowledge, there is only one study investigating the price transmission of Vietnam's green coffee to date (Li & Saghaian, 2013). The authors, using monthly prices from 1990 to 2011, indicate that about 44% of a deviation from the long-run equilibrium value was corrected in farm prices in one month while world prices do not respond to the disequilibrium. However, their analysis had some methodological weaknesses. Firstly, it did not demonstrate different responses to rising and falling prices in the short-run (SR) and long-run (LR). Secondly, it did not take into account the non-linear adjustment process probably caused by transaction costs and other price frictions.

This research aims to address the limitations of Li and Saghaian's (2013) study and to analyse the price transmission between farm and export prices of Vietnam's Robusta coffee beans. It employs daily prices which are of higher frequency and are better at capturing the price dynamics. In addition, the price data used in this study is for a more recent time period, from mid-2011 until the end of 2015. The rest of the paper is organised as follows. Section 2 briefly summarises the current literature. In section 3 econometric models are described. The next section presents data description and empirical results. The fifth and last section closes the paper with some concluding remarks and limitations.

2. Literature Review

2.1. Introduction to asymmetric price transmission

Price transmission is a branch of studies of price linkages along the price chain (Assefa, Meuwissen, & Oude Lansink, 2015). Price transmission denotes the way that a price change at one stage (referred to as input price) is passed on to the price at another stage (referred to as output price) in the marketing chain (Goodwin, 2006). Asymmetric price transmission (APT) can be simply defined as the different response, regarding magnitude, speed, and direction, of output prices to the increase or decrease in input prices (Assefa, Kuiper, & Meuwissen, 2014; Meyer & von Cramon-Taubadel, 2004). In our study, the focus is on APT in speed which assumes a price relationship at the long-run equilibrium. It should also be noted that output prices refer to farmgate prices whereas input prices are export prices in the context of our research.

The investigation of APT's existence across separate markets and throughout supply chains has been of significance in agricultural economics. Firstly, while APT is considered an anomaly in economic theory, many empirical studies have shown APT to be prevalent (see for instance Aguiar & Santana, 2002; Goodwin & Harper, 2000; Peltzman, 2000). Secondly, APT may lead to different impacts from agricultural policies, which are often formulated under the assumption of price transmission symmetry (Mofya-Mukuka & Abdulai, 2013). Thirdly, APT may theoretically imply the exercise of market power, resulting in market inefficiencies (Capps & Sherwell, 2007) and welfare losses to society as a whole (Bonnet & Villas-Boas, 2016; McLaren, 2015). Lastly, since prices also serve as an instrument for conveying information among different layers of the marketing chain, APT may exaggerate the problem of asymmetric information (Falkowski, 2010), and the consequence of which on consumption and production decisions may be less desirable.

2.2. Types of APT

APT can be categorised according to several criteria. One of the most common is between SR and LR asymmetries (Frey & Manera, 2007). SR asymmetry refers to the degree of variation in output prices (p^{out}) in response to changes in input prices (p^{in}) in several lagged points in time. From a LR viewpoint, the adjustment towards a LR equilibrium level is dissimilar for positive and negative shocks to p^{in}. Another criterion is related to the magnitude and speed with which price shocks are transmitted from p^{in} to p^{out} (Serra & Goodwin, 2003). The third prevailing criterion is the positive or negative APT proposed by Peltzman (2000) and then generalised by Meyer and von Cramon-Taubadel (2004). Positive APT takes place if p^{in} changes that contract margins are transmitted faster and/or more complete to p^{out} than p^{in} changes improving margins. If the reverse is true, APT is negative.

2.3. Reasons for APT

Numerous reasons for APT have been suggested in the current literature (Meyer & von Cramon-Taubadel, 2004). One of the main causes is market power in downstream industries (Bunte & Peerlings, 2003; McLaren, 2015; Weldegebriel, 2004; Xia, 2009). For instance, processors and retailers in the food chain can capitalise on the imperfectly competitive market to transmit increases in input prices received by farmers to output prices paid by consumers, more rapidly and fully than corresponding decreases (positive APT). Another important explanation is different adjustment costs (Peltzman, 2000). These may result from a firm's production costs (McCorriston, Morgan, & Rayner, 2001), menu costs (Azzam, 1999), search costs (as cited in Vavra & Goodwin, 2005), product perishability (Ward, 1982), and inventory management practices (Abbassi, Tamini, & Gervais, 2012; Reagan & Weitzman, 1982). In addition, APT can also be attributed to government interventions (Balcombe, Bailey, & Brooks, 2007; Drabik, Ciaian, & Pokrivčák, 2016; Myers & Jayne, 2012; Serra & Goodwin, 2003), imperfect information dissemination (Abdulai, 2000; Bailey & Brorsen, 1989), and the emergence of temporary traders during price hikes (Fafchamps & Hill, 2008).

2.4. Empirical results of APT studies

In agricultural economics, a considerable amount of literature has been published on price transmission. The findings of APT studies have been mixed and dependent on the study's context (Meyer & von Cramon-Taubadel, 2004). For instance, APT was present for pork, lamb, and fish in European countries (Abdulai, 2002; Gonzales, Guillotreau, Grel, & Simioni, 2003; Jaffry, 2004; Serra, Gil, & Goodwin, 2006), beef and lamb in Australia (Griffith & Piggott, 1994), and dairy products, such as milk, cheese, and butter, in the US (Awokuse & Wang, 2009; Kinnucan & Forker, 1987; Lass, 2005; Lass, Adanu, & Allen, 2001; Stewart & Blayney, 2011). In contrast, little evidence of APT was found in US pork and beef markets (Goodwin & Harper, 2000; Goodwin & Holt, 1999), in the Australian pork market (Griffith & Piggott, 1994), and in the Spanish dairy market (Serra & Goodwin, 2003). These pork, beef, lamb, fish, and dairy sectors have all undergone several structural changes over time, the most obvious being the increasing consolidation of processors and retailers. In the first set of studies, this trend can explain asymmetry due to market power in the downstream industries. In the other studies for which there is little evidence of APT, it seems that some complex changes have exerted more significant impacts on the price transmission rather than the high level of concentration of middlemen in the supply chain. The mixed findings of APT emphasised that the analysis of price transmission requires the understanding of market structure in each case so as to better interpret the results.

In the coffee sector, empirical evidence of APT is more salient between farmers, wholesalers/exporters, and retailers. For example, in some coffee-growing countries like Kenya, Madagascar, Cameroon, Angola, Central African Republic, Ethiopia, and Uganda, price decreases were passed on faster from world markets to domestic markets than were passed on for price increases (Fafchamps & Hill, 2008; González, 2007; Worako et al., 2008). The Brazilian coffee sector demonstrated an opposing characteristic, namely negative APT from world prices to farm prices. Moreover, APT was present between international prices of coffee beans and retail prices of roasted coffee in France, Germany, and the US which have a high level of coffee consumption (Bonnet & Villas-Boas, 2016; Gomez & Koerner, 2009). A similar result was also evident for soluble coffee in Brazil, which is also a major consumer of coffee (Aguiar & Santana, 2002).

Furthermore, a number of studies have focused on impacts of liberalisation policies on price transmission in the coffee sector. The policy developments can be divided into two main groups: the end of the International Coffee Agreement in 1990 on the global scale, and market reforms during late 1980s and early 1990s at the national level. Their impacts are somewhat intertwined due to their coincident occurrence. After the implementation of these policies, the price transmission seems to improve between the producers and the international markets, and between international and importing markets (Gomez & Koerner, 2009; Lee & Gomez, 2013; Mehta & Chavas, 2008; Mofya-Mukuka & Abdulai, 2013; Musumba & Gupta, 2013; Worako et al., 2008). The improvements in speed of price transmission among these markets are more noticeable and significant in the group of countries such as Brazil, Mexico, and India, which had the highest degree of market liberalisation (González, 2007). The González (2007) study also indicates that the transmission remains largely asymmetric between producer and world prices.

3. Methods

Of two main approaches to APT investigations (Meyer & von Cramon-Taubadel, 2004), the cointegration-based one is more dominant in the existing literature (Hahn, Stewart, Blayney, & Davis, 2016). It adequately handles the problem of nonstationary data (von Cramon-Taubadel, 1998), while the Wolffram-based specifications (Houck, 1977; Ward, 1982; Wolffram, 1971) do not and could produce spurious regressions. Consequently, this research uses vector error correction models (VECM)[1], which are consistent with the cointegration that assumes the tendency to return to the LR equilibrium of time series after a shock.

Given that the price transmission is assumed to be linear, standard VECMs are applied. Prior to their estimations, it is important to test for integration and cointegration of data. First of all, the augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979, 1981) and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) (Kwiatkowski, Phillips, Schmidt, & Shin, 1992) are common tests for stationarity. After that, the Engle-Granger two-step method (Engle & Granger, 1987) and Johansen test (Johansen, 1988, 1992a, 1992b; Johansen & Juselius, 1990) are applied to ascertain whether two I(1) price series are co-integrated.

Once the cointegration of time series is confirmed, standard VECMs are estimated. The appropriate lag length is determined according to the Schwartz Bayesian Criteria (SBC) (Lee & Gomez, 2011). Error correction terms (ECT) and differences of FP_t and EP_t are split into positive and negative values. Since the error terms in the system of equations (2) are not independent, the Seemingly Unrelated Regression (SUR) (Zellner, 1962) is employed instead of the ordinary least squares (OLS) method.

Subsequently, two sets of tests are carried out. The first one is for equal coefficients of ECTs and differences of the price series as explanatory variables. This would verify the LR and SR asymmetries. The second test is for weak exogeneity of the cointegrating equation. If only one price series is not weakly exogenous, the adjustment toward the LR equilibrium will occur in only one direction. If the two prices series are not characterised by weak exogeneity, there will exist feedback relationships between them (Gomez & Koerner, 2009).

The LR relationship is the regression of FP_t on EP_t because coffee-producing countries usually act as price takers (as cited in González, 2007). The equation is:

$$FP_t = \beta_0 + \beta_1 EP_t + e_t \qquad (1)$$

where t = 1, 2, ..., T;

e_t is a residual from OLS regression, a.k.a ECT_t;

EP_t and FP_t are export and farm prices.

[1] All models were computed using the R language and statistical computing environment (R Development Core Team, 2015; https://cran.r-project.org/).

The system of standard VECMs is expressed as follows:

$$\Delta EP_t = \alpha_y + \sum_{j=1}^{P} \beta_{jy}^{+} D_{1t}^{+} \Delta FP_{t-j+1} + \sum_{j=1}^{P} \beta_{jy}^{-} D_{1t}^{-} \Delta FP_{t-j+1} + \delta_y^{+} ECT_{t-1}^{+} + \delta_y^{-} ECT_{t-1}^{-} + \sum_{j=1}^{Ly} \gamma_{jy} \Delta EP_{t-j} + \omega_{ty}$$

$$\Delta FP_t = \alpha_x + \sum_{j=1}^{N} \beta_{jx}^{+} D_{2t}^{+} \Delta EP_{t-j+1} + \sum_{j=1}^{N} \beta_{jx}^{-} D_{2t}^{-} \Delta EP_{t-j+1} + \delta_x^{+} ECT_{t-1}^{+} + \delta_x^{-} ECT_{t-1}^{-} + \sum_{j=1}^{Lx} \gamma_{jx} \Delta FP_{t-j} + \omega_{tx} \tag{2}$$

where $\Delta EP_t = EP_t - EP_{t-1}$;

$D_{1t}^{+} = 1$ if $\Delta FP_{t-j+1} > 0$; otherwise $D_{1t}^{+} = 0$;

$D_{1t}^{-} = 1$ if $\Delta FP_{t-j+1} < 0$; otherwise $D_{1t}^{-} = 0$;

$\Delta FP_t = FP_t - FP_{t-1}$;

$D_{2t}^{+} = 1$ if $\Delta EP_{t-j+1} > 0$; otherwise $D_{2t}^{+} = 0$;

$D_{2t}^{-} = 1$ if $\Delta EP_{t-j+1} < 0$; otherwise $D_{2t}^{-} = 0$;

$ECT_{t-1}^{+} = ECT_{t-1}$ if $ECT_{t-1} > 0$; otherwise $ECT_{t-1}^{+} = 0$;

$ECT_{t-1}^{-} = ECT_{t-1}$ if $ECT_{t-1} < 0$; otherwise $ECT_{t-1}^{-} = 0$;

P, *N*, *Lx*, and *Ly* are the numbers of lags.

In reality, the price transmission tends to be non-linear due to transaction costs and other price frictions (Meyer, 2004; Vavra & Goodwin, 2005). In order to handle this issue, the research uses threshold VECMs (TVECM) (one equation in system (3)). The ADF, KPSS, Engle-Granger, and Johansen tests for linear integration and cointegration remain reasonably proper in the case of non-linear adjustment (Balke & Fomby, 1997). The procedure begins with Tsay's (1989) test to examine whether threshold effects are present. The lower and upper thresholds are then determined by the two-dimensional grid search based on the minimum sum of squared residual criterion (Goodwin & Harper, 2000; Goodwin & Piggott, 2001). The two thresholds split the standard VECMs into three regimes whose adjustment processes are assumed to be dissimilar. In the next step, the significance of differences of coefficients across three regimes is validated by Hansen's (1997) approach. After the threshold model is proven, the system of TVECMs, expressed in (3), is re-computed, using the SUR method (Zellner, 1962). The test for equal coefficients is also applied to verify the SR asymmetries.

$$\Delta EP_t = \begin{cases} \alpha_{1y} + \sum_{j=1}^{P} \beta_{1jy}^{+} D_{1t}^{+} \Delta FP_{t-j+1} + \sum_{j=1}^{P} \beta_{1jy}^{-} D_{1t}^{-} \Delta FP_{t-j+1} + \delta_{1y} ECT_{t-1} + \sum_{j=1}^{Ly} \gamma_{1jy} \Delta EP_{t-j} + \omega_{ty} \; if \; ECT_{t-1} < \theta_1 \\ \alpha_{2y} + \sum_{j=1}^{P} \beta_{2jy}^{+} D_{1t}^{+} \Delta FP_{t-j+1} + \sum_{j=1}^{P} \beta_{2jy}^{-} D_{1t}^{-} \Delta FP_{t-j+1} + \delta_{2y} ECT_{t-1} + \sum_{j=1}^{Ly} \gamma_{2jy} \Delta EP_{t-j} + \omega_{ty} \; if \; \theta_1 \leq ECT_{t-1} \leq \theta_2 \\ \alpha_{3y} + \sum_{j=1}^{P} \beta_{3jy}^{+} D_{1t}^{+} \Delta FP_{t-j+1} + \sum_{j=1}^{P} \beta_{3jy}^{-} D_{1t}^{-} \Delta FP_{t-j+1} + \delta_{3y} ECT_{t-1} + \sum_{j=1}^{Ly} \gamma_{3jy} \Delta EP_{t-j} + \omega_{ty} \; if \; ECT_{t-1} > \theta_2 \end{cases} \quad (3)$$

$$\Delta FP_t = \begin{cases} \alpha_{1x} + \sum_{j=1}^{N} \beta_{1jx}^{+} D_{2t}^{+} \Delta EP_{t-j+1} + \sum_{j=1}^{N} \beta_{1jx}^{-} D_{2t}^{-} \Delta EP_{t-j+1} + \delta_{1x} ECT_{t-1} + \sum_{j=1}^{Lx} \gamma_{1jx} \Delta FP_{t-j} + \omega_{tx} \; if \; ECT_{t-1} < \theta_1 \\ \alpha_{2x} + \sum_{j=1}^{N} \beta_{2jx}^{+} D_{2t}^{+} \Delta EP_{t-j+1} + \sum_{j=1}^{N} \beta_{2jx}^{-} D_{2t}^{-} \Delta EP_{t-j+1} + \delta_{2x} ECT_{t-1} + \sum_{j=1}^{Lx} \gamma_{2jx} \Delta FP_{t-j} + \omega_{tx} \; if \; \theta_1 \leq ECT_{t-1} \leq \theta_2 \\ \alpha_{3x} + \sum_{j=1}^{N} \beta_{3jx}^{+} D_{2t}^{+} \Delta EP_{t-j+1} + \sum_{j=1}^{N} \beta_{3jx}^{-} D_{2t}^{-} \Delta EP_{t-j+1} + \delta_{3x} ECT_{t-1} + \sum_{j=1}^{Lx} \gamma_{3jx} \Delta FP_{t-j} + \omega_{tx} \; if \; ECT_{t-1} > \theta_2 \end{cases}$$

where θ_1 and θ_2 are lower and upper thresholds.

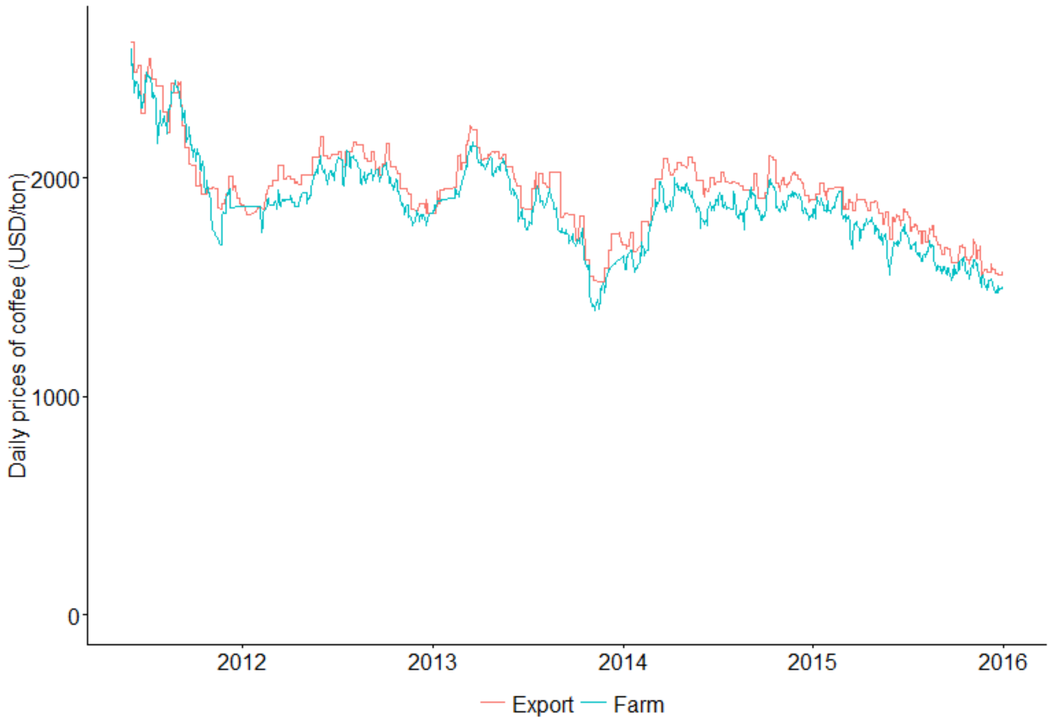
4. Data and Empirical Results

4.1. Data description

The data is the export and farm prices of coffee beans on a daily basis from June 1st, 2011 to December 31st, 2015, obtained from the Ministry of Agriculture and Rural Development (2016a). Export prices are denominated in US dollars (USD) and quoted on a FOB basis in Ho Chi Minh city, the domestic hub of trade activities. Farm prices are expressed in Vietnam dong (VND) and collected in Dak Lak, the largest coffee-producing province in Vietnam. Farm prices are converted into USD by using the average daily exchange rate from Bloomberg (2016). The two prices are transformed into natural logarithms, which is usual practice to alleviate fluctuations in the price series. It is also important to note that missing values have been replaced by either averages of the two adjacent values or forecasts from AR(2) models (Wooldridge, 2009).

As shown in Figure 1, it would appear that daily export and farm prices fluctuate together as they follow a downward trend over the period. Export prices were generally higher than farm prices except in the early period. The two price series decreased sharply from over 2,500 USD/ton to below 2,000 USD/ton in the second half of 2011, then steadily recovered, but by the end of 2012 they had once again headed back to their previous low. They rose gradually over the next months, but plunged to around 1,500 USD/ton in November, 2013. Early 2014 saw a rise in two prices while both series were on the decline for the remaining period.

Figure 1: Daily prices of Robusta coffee at two levels from 06/2011 to 12/2015



Source: MARD (2016a)

4.2. Estimation results

Prior to applying VECMs to determine the existence of any APT in the SR or the LR, the data are tested for integration and cointegration. The results of these tests are presented in the subsection which follows.

4.2.1. Integration and cointegration tests

The results from the ADF and KPSS tests for export and farm prices are presented in Table 1. As for the ADF test, the null hypothesis of non-stationarity is not rejected for farm prices in two cases. Export prices exhibit non-stationarity without a constant and stationarity with a constant. The KPSS test indicates that there is enough evidence to reject the null hypothesis of stationarity of both price series. The contradictory results from these two tests for export prices are not entirely unexpected. This quandary frequently occurs in series whose roots are close to unity (in absolute terms) (Enders, 2015). In this situation, the KPSS test tends to be more powerful than the ADF test. For this reason, it would be more appropriate to confirm the non-stationarity of both farm and export prices.

Table 1: Results of stationarity tests for export and farm prices

Tests		Critical values	EP_t	FP_t
ADF	with constant	-2.86	-2.96** [1]	-2.80 [1]
	no constant	-1.95	-1.09 [1]	-1.25 [1]
KPSS	no linear trend	0.463	5.39*** [7]	6.49*** [7]

*** and ** denote the 1% and 5% significance level respectively. Critical values are at the 5% significance level. The numbers in square brackets represent the lag length chosen based on the respective criterion for ADF and KPSS tests.

The ADF and KPSS tests are applied to the first differences of export and farm prices. Their results are summarised in Table 2. The first differences are all stationary. Therefore, the two price series are integrated of order one, I(1).

Table 2: Results of stationarity tests for first differences of export and farm prices

Tests		Critical values	ΔEP_t	ΔFP_t
ADF	with constant	-2.86	-25.52*** [1]	-24.22*** [1]
	no constant	-1.95	-25.5*** [1]	-24.19*** [1]
KPSS	no linear trend	0.463	0.077 [7]	0.071 [7]

*** denotes the 1% significance level. Critical values are at the 5% significance level. The numbers in square brackets represent the lag length chosen based on the respective criterion for ADF and KPSS tests.

Regarding the Engle-Granger method for cointegration, the first step is to estimate the cointegrating relationship between two price series (as in equation (1)). The result of ADF test for the residuals from the equation (1) confirms the cointegration of two price series (Table 3).

$$FP_t = -0.295 + 1.034EP_t$$

The Johansen tests substantiate the existence of cointegrating vectors between export and farm prices (Table 3). The test statistic of the trace test with r = 0 is highly significant, which verifies the alternative hypothesis of more than one cointegrating vector. The result of the trace test with r = 1 is not sufficient to reject the null hypothesis of one cointegrating vector. The max tests with r = 0 and r = 1 also lead to the similar result of cointegration of order one between the two price series. In short, these Johansen tests indicate that there is one cointegrating vector between the two price series.

Table 3: Results of cointegration tests

Tests		Critical values	Test statistics
ADF	no constant	-3.35	-10.325*** [1]
Johansen	trace test: r = 0	19.96	126.48***
	max test: r = 0	15.67	117.55***
	trace test: r = 1	9.24	8.93
	max test: r = 1	9.24	8.93

*** denotes the 1% significance level. Critical values are at the 5% significance level. The numbers in square brackets represent the lag length chosen based on SBC.

This sub-section confirms that export and farm prices are integrated of order one and that they are cointegrated. These are necessary conditions to apply VECMs to detect any APT in the price transmission process. The estimations of VECMs are presented in the appendixes. The following sub-sections report the findings of any possible asymmetries in the SR and LR.

4.2.2. Asymmetries in VECMs

Parameter estimates of the system (2) are presented in Appendix 1. The number of lags is one according to the SBC. First of all, the two models explain only 9% and 1.4% of variation of changes in export and farm prices respectively. The very low explanatory power reflects the fact that other factors such as the market structure and the sector's cost function are far more important to determine changes in export and farm prices than the prices at the other market level. The Durbin-Watson test statistics do not provide enough evidence to reject the null hypothesis of no autocorrelation at lag one in the error terms. Furthermore, the inter-relationships between first differences of export and farm prices, and between them and lagged ECTs are highly significant. More than 40% of changes in farm prices will be passed on to the first differences of export prices. Meanwhile, about 30% of export price variations will be transmitted to farm price differentials. Estimates for lagged ECTs are lower, but remain highly significant. Lastly, estimates of coefficients of lagged first differences are extremely low (under 5%) and statistically insignificant having adjusted for other variables.

As shown in Table 4, it can be concluded that the price transmission between farm and export stages is largely symmetric in the SR and LR. Of six tests, only LR asymmetry in the export price equation is significant (test statistic of 11.4). More specifically, about 22% of a negative deviation from the LR equilibrium is corrected per day while the speed of adjustment for a positive deviation is around 9% per day (see Appendix 1). This negative APT seems detrimental to exporters. However, since the daily speed of adjustments are so high that the APT and harmful impact are very short-lived. In this export price equation, the two tests for SR asymmetries are not significant. As for the farm price equation, the symmetric transmission holds in the SR and LR.

Table 4: Tests of SR and LR asymmetries in VECMs

Null hypothesis of equal coefficients		Critical values ($\chi^2(1)$)	Test statistics
Export price equation			
SR	$\Delta FP_t^+ = \Delta FP_t^-$	3.84	1.1612
	$\Delta FP_{t-1}^+ = \Delta FP_{t-1}^-$	3.84	0
LR	$ECT_{t-1}^+ = ECT_{t-1}^-$	3.84	11.405***
Farm price equation			
SR	$\Delta EP_t^+ = \Delta EP_t^-$	3.84	0.2953
	$\Delta EP_{t-1}^+ = \Delta EP_{t-1}^-$	3.84	1.6363
LR	$ECT_{t-1}^+ = ECT_{t-1}^-$	3.84	0.4971

*** denotes the 1% significance level. Critical values are at the 5% significance level.

Table 5 presents the results from tests of weak exogeneity. Both test statistics are highly significant, indicating that the LR coefficients are not weakly exogenous. This means that the feedback relationship is present between export and farm prices. In other words, any deviations from the LR equilibrium will be adjusted in both levels of the marketing chain, implying the close relationship between domestic and international markets.

Table 5: Tests of weak exogeneity

	Critical values ($\chi^2(2)$)	Test statistics
Export price equation (H_0: $\delta_y^+ = \delta_y^- = 0$)	5.99	225.76***
Farm price equation (H_0: $\delta_x^+ = \delta_x^- = 0$)	5.99	168.05***

*** denotes the 1% significance level. Critical values are at the 5% significance level.

4.2.3. Asymmetries in TVECMs

The Tsay's (1989) test for threshold effects is reported in Table 6. For both the ascending and descending orders of arranged autoregression of ECTs, the test statistics are significant. This confirms the non-linearity in the adjustment process of export and farm prices.

Table 6: Results of Tsay's test

Arranged autoregression	Critical values	Tsay's test statistics
Increasing	3	3.24**
Decreasing	3	4.17**

** denotes the 5% significance level. Critical values are at the 5% significance level.

The estimations from Hansen's (1997) approach to TVECMs are excluded from this paper for brevity. The p-values for Hansen test statistics are computed from the asymptotic distribution of 1000 simulations. Whereas the TVECM for farm prices is insignificant, the TVECM for export prices highly significant. Therefore, the price transmission is different according to the regime in which the ECTs lie. The thresholds in the latter model will be used to re-compute the system of export and farm price equations in the presence of a non-linear adjustment process. The lower and upper thresholds are -0.023 and 0.024 respectively. The number of observations in regime I, II, and III are 238, 742, and 215 respectively.

The estimation of this system (3) is shown in Appendix 4. The adjusted R^2 are 12.9% and 3.2% in two equations, indicating the very low explanatory power of the system to model changes in export and farm prices (as was the case for the VECMs). The Durbin-Watson test also confirms no first order autocorrelation in the error terms of the system. The Breusch-Pagan test demonstrates that the error terms are homoskedastic. Another point to note is that some coefficient estimates are greater than unity. For instance, a unit increase in farm prices will lead to a 128% increase in export prices. This was unexpected as we would have expected a more gradual adjustment. Furthermore, the speed of adjustment for farm prices in the lower regime is higher than that in the upper regime (10% and 5% respectively). This means that farmers are slightly better off when there are shocks to export prices. However, such advantageous condition only lasts a short period of time.

Table 7 summarises the test for SR asymmetries. Of the 12 possible SR asymmetries, three are statistically significant; however, two of these must be disregarded (as the coefficients > 1), leaving one SR asymmetry in the price transmission process ($\Delta EP_t^+ = \Delta EP_t^-$ in regime III). For this one positive SR APT, rising export prices are transmitted more slowly to farm prices than falling export prices (coefficients of 0.33 and 0.64 respectively). This exposes the slightly disadvantaged position of the growers, in relation to the exporters, in the coffee supply chain. Since the variation in export price changes will be reflected in farm prices within several days, it is evident that the APT is minimal in the market for Vietnam's Robusta coffee beans.

Table 7: Tests of SR asymmetries in TVECMs

Null hypothesis	Regime I	Regime II	Regime III
Export price equation – test statistics			
$\Delta FP_t^+ = \Delta FP_t^-$	0	0.001	21.366***
$\Delta FP_{t-1}^+ = \Delta FP_{t-1}^-$	0.0782	0.0286	2.6694
Farm price equation – test statistics			
$\Delta EP_t^+ = \Delta EP_t^-$	14.322***	0.1237	**5.9596****
$\Delta EP_{t-1}^+ = \Delta EP_{t-1}^-$	0.0085	1.2094	1.0723

*** and ** denote the 1% and 5% significance level respectively. Critical values are at the 5% significance level.

5. Conclusion

This research built on the work of Li and Saghaian (2013) who found, using monthly price data for Vietnamese Robusta coffee market, that some 44% of a deviation from the LR equilibrium was corrected in farm prices in the next month. The aim of this study was to analyse the transmission between export and farm prices of Vietnam's Robusta coffee using daily price data between mid-2011 and the end of 2015.

Results confirm that the price transmission between farm and export markets is largely symmetric regardless of rising or falling prices at the other market. It also verifies the significance of threshold effects, in part caused by unobservable transaction costs, in the transmission process. A positive asymmetry in the SR is found only in the TVECMs, not in the linear VECMs; however, the APT is minor because the daily speed of adjustment is high. In addition, the results show the two-way directional relationship between farm and export markets. Any divergence from the LR equilibrium will be corrected in both markets, implying their close relationship. These findings contradict those of previous studies in the coffee sector in other countries. In previous studies, the coffee sector was characterised by APT, and market reforms did not eliminate it despite enhancing the speed of price transmission. Furthermore, the price transmission was usually unidirectional from the world to domestic markets due to the dominant market share of local wholesalers/exporters. The different findings seem to result from the distinct characteristics of Vietnam's coffee sector.

There are several possible reasons for the symmetric price transmission in Vietnam's coffee sector. First of all, market reforms have liberalised the sector to a large extent. The concentration of the eight largest firms remained under 50% in 2014 (Vu, 2015). Meanwhile, in Uganda the proportion of top ten exporters was about 87% in 2000/01 while Ethiopia established a committee to regulate the coffee sector (González, 2007). Vietnamese exporters, therefore, do not have enough market power to maintain a wide price gap between global and domestic markets. Secondly, Robusta coffee is of lower quality than Arabica coffee (Ghoshray, 2010). When there is often a surplus of Arabica coffee, it is not possible for Vietnamese exporters to bargain coffee's export prices to their advantage in the international market. Another cause could be the oversupply of Robusta coffee. Farmers do not have bargaining power over local exporters and tend to accept the prices driven by market forces.

The findings of symmetry of price transmission provide evidence for the success of the government's liberalisation policies in terms of market efficiency and integration in Vietnam's coffee sector. Liberalisation policies have indeed moved the Vietnamese economy into a market economy and as such exposed its farmers to the fluctuations of global prices. This means that when global prices are high and there is very little APT, the farmers' profits are also high. However, as is currently the case, when global coffee prices are subdued, the symmetric price transmission results in lower prices and hence a fall in welfare for those coffee farmers. Is this a reason to interfere with the workings of the market? Whilst tempting, raising and stabilising prices to coffee farmers would create incentive for expansion in coffee production, exaggerating the problem of a coffee glut and dampening future coffee prices. For these unintended consequences, the government should be very cautious if wanting to intervene in the market price in the coffee sector.

The study has some limitations, which could be the subject of further research. The four-and-a-half year time period of daily price data is relatively brief, so later an analysis of a longer time span may provide better evidence of price transmission in Vietnam's Robusta coffee market. Additionally, the study does not model retail prices in the price transmission process. The inclusion of retail prices would offer a more complete understanding the price transmission in the coffee supply chain.

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Appendices

Appendix 1: VECM estimation results, export and farm price equations

Export price equation	Coefficients	Farm price equation	Coefficients
Intercept	0.0009	Intercept	-0.0008
	(0.0007)		(0.0006)
ΔEP_{t-1}	0.0193	ΔFP_{t-1}	0.0705
	(0.0281)		(0.0301)**
ΔFP_t^+	0.4934	ΔEP_t^+	0.3823
	(0.0547)***		(0.0383)***
ΔFP_t^-	0.4029	ΔEP_t^-	0.3537
	(0.0492)***		(0.0346)***
ΔFP_{t-1}^+	-0.0372	ΔEP_{t-1}^+	0.0233
	(0.0553)		(0.0383)
ΔFP_{t-1}^-	-0.0358	ΔEP_{t-1}^-	-0.0431
	(0.0517)		(0.0345)
ECT_{t-1}^+	0.0879	ECT_{t-1}^+	-0.0753
	(0.0222)***		(0.0203)***
ECT_{t-1}^-	0.2220	ECT_{t-1}^-	-0.1009
	(0.0258)***		(0.0240)***
Durbin-Watson statistic[a]	1.9968	Durbin-Watson statistic	1.9599
Adjusted R^2	0.0896	Adjusted R^2	0.0139

** and *** denote 5% and 1% significance level respectively.

[a]: test for autocorrelation.

Appendix 2: TVECM estimation results, export and farm price equations

Variables	Regime I	Regime II	Regime III
Export price equation			
Intercept	-0.0002	0.0002	0.0073
ΔEP_{t-1}	-0.0186	-0.0066	0.1284
ΔFP_t^+	0.4646	0.3325	1.2837
ΔFP_t^-	0.4622	0.3288	0.3613
ΔFP_{t-1}^+	-0.0782	0.0285	-0.2192
ΔFP_{t-1}^-	-0.1366	0.0102	0.1231
ECT_{t-1}	0.2127	0.0986	-0.0391
Durbin-Watson statistic[a]	1.9906		
Adjusted R^2	0.129		
Farm price equation			
Intercept	-0.0009	-0.0007	-0.0012
ΔFP_{t-1}	0.1327	0.0732	-0.007
ΔEP_t^+	2.0335	0.3734	0.3299
ΔEP_t^-	0.3091	0.3386	0.6443
ΔEP_{t-1}^+	0.0829	0.0154	-0.3216
ΔEP_{t-1}^-	0.0704	-0.0582	-0.0239
ECT_{t-1}	-0.1009	-0.0656	-0.0456
Durbin-Watson statistic	1.9525		
Adjusted R^2	0.032		

[a]: test for autocorrelation.