International Coffee Council
124th Session
25 – 29 March 2019
Nairobi, Kenya

1. As identified in the International Coffee Agreement 2007, the Five-Year Action Plan and the Programme of Activities for coffee year 2018/19, the ICO is mandated to carry out an analytical function and to provide Members with research in the form of studies related to the coffee sector.

2. In order to comply with Resolution 465 on Coffee Price Levels, approved by the International Coffee Council during its 122nd Session, held in London in September 2018, with a view to contributing to the understanding of the relation between coffee prices and physical market fundamentals, the Secretariat conducted a study on the role of non-commercial traders in coffee futures markets and their impact on the development of coffee prices

1. The presence of financial investors in commodity markets has increased significantly over the past two decades. Volumes traded on futures markets rose faster than the global production of most commodities, a phenomenon coined as the 'financialization' of commodity markets (Domanski and Heath, 2007).

2. In this time period falls the upheaval in international grain markets, when prices for wheat traded on the US futures market rose by almost 200% in the 12 months to March 2008 and fell by 63% by the end of the same year (Beckmann and Czudaj, 2014). These extreme price swings, with global repercussions on farm income and food security, received considerable attention among sector stakeholders as well as the media, and sparked a debate on the role of non-commercial traders – or speculators – in influencing the behaviour of agricultural commodity prices. In line with the 'financialization' view, the main concern remains that, while non-commercial traders provide needed liquidity in commodity exchanges, excessive trading activities in futures markets may result in higher and more volatile commodity prices (UNCTAD, 2012; Chari and Christiano, 2017).

3. Within the group of agricultural commodities, coffee is subject to significant price volatility. Gilbert and Morgan (2010) showed that variation in prices for coffee was higher than across grains and tropical commodities, such as cocoa, but lower than sugar or tea. Over the past two decades the ICO Composite Indicator went through several cycles of high and low prices, ranging from 41 US cents/lb to 231 US cents/lb (Figure 1). Since 2016, coffee prices have experienced a downturn, with the ICO Composite Indicator falling below 100 US cents/lb in August 2018 and remaining at around this level henceforth.

January 1994 – December 2018

Source: ICO

4. Volatile and low coffee prices have severe impacts on the coffee sector, putting the incomes and livelihoods of an estimated 25 million coffee farmers worldwide at risk, and resulting also in under-investment posing a threat to future supply, especially in view of the impact of climate change on productivity, and rising global demand.

5. Coffee prices are determined by market fundamentals (e.g. demand trends, supply shocks). Other factors, such as speculation, may exacerbate price movements. This study contributes to the debate on price behaviour by analysing:

(i) trading activity in Arabica and Robusta futures markets over time, and
(ii) the potential causal link between speculative activity in the futures market and the behaviour of spot market prices for coffee.

6. The study takes also into account previous research carried out by the ICO on the relationship between coffee prices in physical and futures markets (ICO, 2011). The report used the ICO indicator prices of the four groups (Colombian Milds, Other Milds, Brazilian Naturals and Robusta) as spot prices, and the average of the 2nd and 3rd positions of each of the main futures markets (New York and London) as proxy for futures contract prices. The relationship between physical and futures prices and its development over the period from 1990 to 2011 was established through

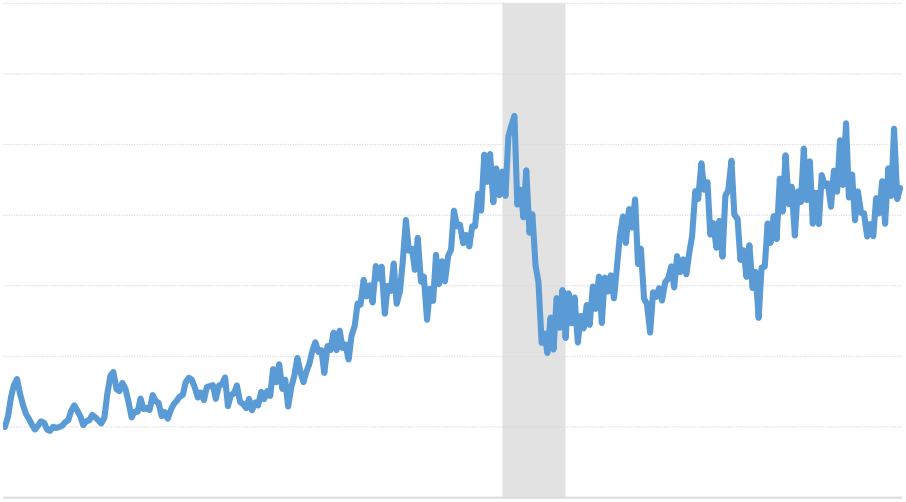
implemented by the International Food Policy Research Institute for wheat, maize, rice and soybeans during the 2008 food price crisis (Robles *et al.* 2009). The analysis focuses on the two international futures markets for coffee: the Intercontinental Exchange (ICE) in New York, with its 'C' Contract for Arabica, and the ICE Futures Europe for the Robusta contract traded in London.

8. Previous studies have investigated the relationship between spot prices and speculative activity across different commodities. For the coffee sector, the most relevant study is Kim (2015), who conducted a cross-sectional test to assess the relationship of futures speculation with large price movements for a set of 11 energy and agricultural commodities. The study does not find evidence that speculators destabilize the commodity spot market. On the contrary, speculators might contribute to lower price volatility and provide greater liquidity in the commodity markets.

What is speculation in futures markets?

9. Futures markets for coffee are important mechanisms for price discovery and hedging against risks among stakeholders (ICO, 2018). On the one hand, relatively risk-averse participants holding or anticipating to hold a-4 ((t m Tw (t)-4 (s)2 (4 (4J0.018.6c 0.039 s2 72 4 c)-2 c -0.02

indicators comprises: (i) monthly volume of futures contracts, (ii) monthly open interest in futures contracts, (iii) the ratio of volume to open interest, (iv/v) ratio of



Note: The volume index is a 3-month moving average.
Source: ICO and ICE. Own calculations

(ii) *Open interest in futures contracts*

17. Open interest (OI) is the total number of open and not yet closed, long and short, positions in futures contracts. OI increases when money flows into the market, indicating the entry of medium- and long-term speculators who have confidence in the market direction (Robles *et al.*, 2009). Decreasing open interest might indicate that the market is entering a period of less active trading because market participants are not taking new positions and are closing out existing ones.

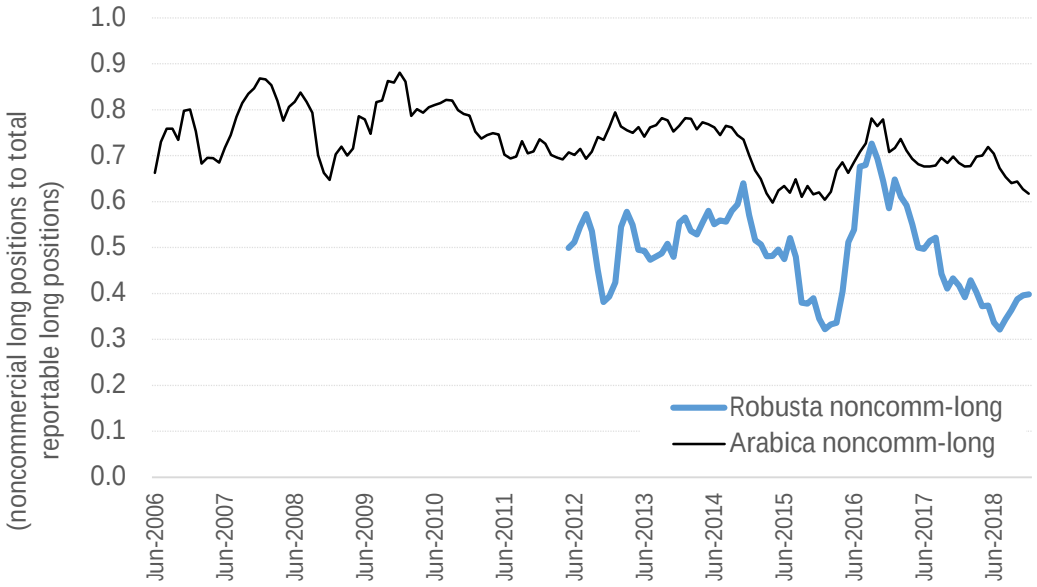
18. OI has been steadily growing for Arabica since 2000. It sharply increased for Robusta until 2005, decreasing afterwards and remained relatively stable during the last five years (Figure 3). Between January 2000 and March 2017, OI increased 150% for Robusta and 286% for Arabica. Since then, OI has shown a sharper increase in the Arabica market, possibly due to more liquidity attracting more investors to this market compared to the Robusta market, as indicated by the trend of the volume of contracts traded.

Note: The open interest index is a 3-month moving average
Source: ICO and ICE. Own calculations

(iii) *Ratio of volume to open interest*

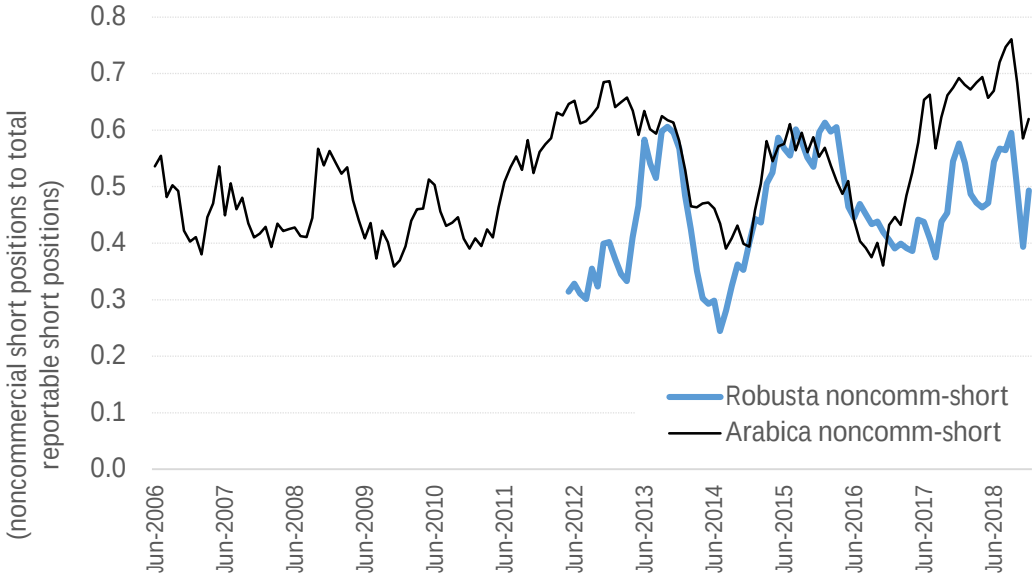
19. This ratio captures speculative market activity under the assumption that the majority of speculators prefer to get in and out of the market in a short period of time (Robles *et al.*, 2009). Therefore, a speculator taking opposite positions (buying and selling contracts) in the market within days or weeks will generate an increase in monthly registered volumes but little change in monthly open interest. ConsequentlyuTc 0.009 Tw 0.24 10 (y)8[((e)-1 (k)6 (s)2 (w)6 .240(i)14 (1

22. The development of the ratio of non-commercial to total reportable long positions is depicted in Figure 5. In the Arabica market, this ratio has shown a slight downward trend moving from averages of 70% before the end of 2014 to averages of 60% in the last three years. For the Robusta market, the share of non-commercial long positons has shown higher variability. After declining since 2014 the ratio experienced a strong increase in 2016 and decreased in the past two years. This graphical analysis might indicate that speculative activity has decreased in recent years on the buying side of the coffee futures markets for Arabica and Robusta.



Note: data for the Robusta market is available from 2012
Source: CFTC and ICE. Own calculations

23. Analogous to the ratio of long positions, Figure 6 shows the development of the share of non-commercial short positions on total reportable short positions over time. In contrast to long positions, the ratio of short positions shows an upper trend for both Arabica and Robusta, especially from 2017. Historically, short positions ratio fluctuated around an average of 50% in the Arabica market, but since January 2017, this average has increased to 63%. For Robusta, the long-term mean has been 45.6%, with increasing slightly to 47.2% in the last two years. This might indicate a higher level of speculative activity on the selling side of the coffee futures markets.



Note: data for the Robusta market is available from 2012
Source: CFTC and ICE. Own calculations

(iv) Index traders' net positions

24. Index traders are a relatively new category of investors in commodity markets that has gained importance since the early 2000s (Tang and Xiong, 2012). These traders mostly hold long positions in a mix of commodity markets that are rolled forward from futures contract to futures contract using a defined methodology. It should be noted that this category of traders includes both commercial and non-commercial traders, e.g. pension funds. However, following Robles *et al.* (2009), it is assumed that if these economic agents enter agricultural commodity markets for purposes other than hedging against commodity-specific risks, their trading positions can be regarded as speculative activity.

25. Since 2006, the CFTC has collected data on futures and options traded by this category of traders and provides it as index traders' long and short positions. Their long positions account for 23% of total open interest. This is in line with the findings of Robles *et al*. (2009) for maize and soybeans (25%) but significantly lower than for wheat (40%). Figure 7 shows the evolution of monthly net-positions (long minus short positions) held by index traders in the Arabica futures market between January 2006 and December 2018. Over this period, net positions of index traders show a slight downward trend, due to a sharp drop experienced in early 2015. However, since March 2015 net positions have steadily increased reaching a maximum of 46,500 in October 2018, which corresponds to the average level of net positions recorded between 2006 and 2014.

Note: Robusta data not available
Source: CFTC. Own calculations

26. This section contains an analysis to establish if there is a causal link between speculation activity and movements in spot market prices. In principle, causality can run in both directions, with speculation affecting spot prices and vice versa. This study uses the Granger causality test, an econometric technique that tests whether the past behaviour of each of the six measures of speculation described above caused changes in the spot market prices observed. We use time series of daaboveF .26 0 Td[(d)-6 ((W)-t (T)]TJ0.001 Tc -07001 Tw 9.26 0 Td (m

thetiapeertioios 6 s t-7iodih 8e dnees

8edn1os

for shorter periods, tests were conducted by taking 50-month periods and rolling the test one month at a time. For example, for the speculation indicator volume traded, the first test was conducted for the initial 50-month period (January 1994-February 1998), for each of the four group indicator prices. Subsequently a further 250 tests were carried out until the last 50-month period (November 2014-December 2018). This procedure was repeated for all other indicators of speculation depending on data availability (please see the Technical Annex for further information on rolling regressions).

29. Granger causality test results provide a value (*F-statistic*) that should be compared to a reference value (*F-critical value*) given by the *F-distribution* at the 95% statistical confidence level. If the F-statistic is greater than the F-critical value (that is their difference is greater than zero), there is evidence of causality or predictive power of speculation on coffee prices at a 95% statistical confidence level. Values larger than zero suggest a higher statistical confidence level (e.g. 99%), but they should not be interpreted as stronger influence of speculative activity on spot prices behaviour.

30. In the case of coffee futures market, causality test results indicate that there is evidence of speculative activity predicting price movements for the 50-month periods ending in the dates listed in Table 1. Figures A1, A2, A3 and A4 in the Annex summarize the results graphically for each of the ICO indicator groups. Figures A1 to A4 plot the difference between *F-statistic* and *F-critical value* for each of the 50-month or 30-month periods tested. Positive values, that is above the zero line, indicate evidence of predictive power of speculation on prices at least at 95% statistical confidence level. Only those indicators are included in the figures that were found significant in explaining coffee price behaviour at any point in the whole period.

31. Table 1 and Figure A1 show that open interest, the Vol/OI ratio and the share of long non-commercial positions in total reportable positions did not have any predictive power for Brazilian Naturals price movements. However, evidence of predictive power was found for other speculation indicators in the short-term.

32. For Colombian Milds (Figure A2) and Other Milds (Figure A3) more indicators of speculation were found significant to predict price movements, with some period variation in

sppvdvr2 (pe)4Tab(o)-2 (us-3.9 a10 (r)4 (ei)4 (c)8 (e)13 (b30.1 (o (ns)16)3 (po)12)3 (r)4 (cs)6 (ts in)6 (s)16)3 (

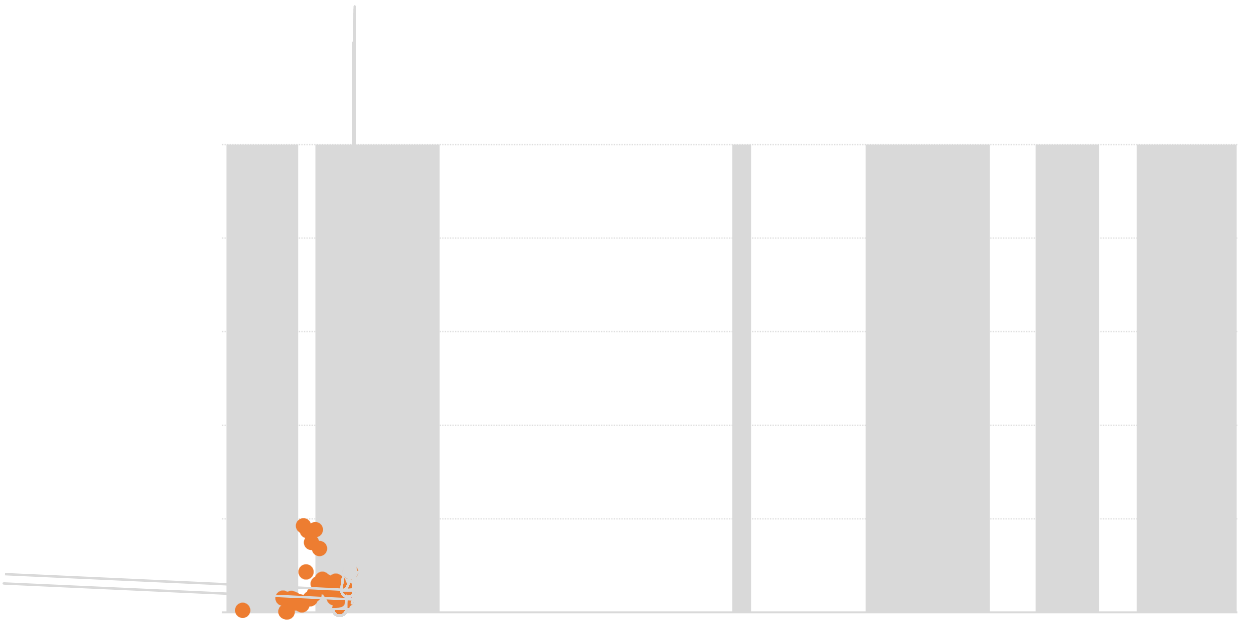
	1. Monthly volume of futures contracts	Apr2001-Sep2004, Jun-Aug2006, Feb-Mar2007, Sep2009, and, Sep-Dec2018	May1999-Apr2002, Nov2002-Mar2005, Jun-Aug2006, Feb-Mar2007, Jan-Feb2009, Aug-Sep2009, Aug-Sep2010, May-Jun2011, Mar2012, and, Sep-Oct2018	Jul 1998, May1999-Jan2002, Sep2002-Jul2003, Mar-Jul2004, Aug-Nov2010, Aug-Oct2013, and, May-Jun2018	
(Coffee C - ICE Futures U.S.)	6				

Evidence of speculation during periods of rising and falling prices

34.

predictive power on the behaviour of Colombian Milds and Other Milds prices. No other indicator of speculation exerts an influence on Arabica group prices after 2014. Results of the influence of volume of contracts traded on prices need to be interpreted with caution, as this is a weak indicator of speculative activity compared to others such as the Vol/OI ratio and non-commercial to total positions, which better reflect speculative activities in the short term.

37. For the case of Robusta (Figure 10), the only indicators of speculation that exert influence on the direction of the market are volume traded and open interest. The Vol/OI ratio, a stronger measure of short-term speculation, was found relevant for determining Robusta prices, but only early in the period of analysis, before October 1998. In December 2018, the ratio of non-commercial long positions to total long positions showed some predictive power in the Robusta market, indicating that non-commercial traders had some influence on the price trend in that month.



-

Note: Dates indicate last month of a 50-month period
Source: ICO

44. Building on these findings, more analysis is required to attribute a relative importance to factors determining spot prices. While the analysis presented here allows to answer the question if and when speculation did impact spot prices in the coffee market, it does not attribute the relative weight of speculation in driving prices compared to other factors, including fundamentals of demand and supply or market interventions.

45. An additional extension of this analysis is using daily and weekly data that allow the econometric models and tests to be conducted for shorter periods of time and capture more variation in the behaviour of the coffee futures market, both for prices and speculative activity.

Avelino, Jacques, *et al*. "The coffee rust crises in Colombia and Central America (2008–2013): impacts, plausible causes and proposed solutions." *Food Security* 7.2 (2015): 303-321.

Beckmann, Joscha, and Robert Czudaj. "Volatility transmission in agricultural futures markets." *Economic Modelling* 36 (2014): 541-546.

CFTC. "Swap dealer de *minimis* exception final staff report". (2016)

Chari, Varadarajan V., and Lawrence Christiano. "Financialization in commodity markets." No. w23766. *National Bureau of Economic Research*, (2017).

Cooke, Bryce, and Miguel Robles. "Recent Food Prices Movements. A Time Series Analysis." *IFPRI Discussion Paper No. 00942*, (2009).

Domanski, Dietrich, and Alexandra Heath. "Financial investors and commodity markets." *BIS Quarterly*, March, (2007).

Gilbert, Christopher L., and C. Wyn Morgan. "Food price volatility." *Philosophical Transactions of the Royal Society B: Biological Sciences* 365.1554 (2010): 3023-3034.

Hull, John. Options, futures and other derivatives. *Upper Saddle River, NJ: Prentice Hall,* (2009).

ICO. "Relationship between coffee prices in physical and futures markets". *ICO document ICC 107-4*, September, (2011).

ICO. "The role of the coffee futures market in discovering prices for Latin American producers". *ICO document ICC-122-5*, September. (2018).

Irwin, Scott H., and Dwight R. Sanders. "Index funds, financialization, and commodity futures markets." *Applied Economic Perspectives and Policy* 33.1 (2011): 1-31.

Kim, Abby. "Does futures speculation destabilize commodity markets?." *Journal of Futures Markets* 35.8 (2015): 696-714.

Nijs, Luc. *The handbook of global agricultural markets: The business and finance of land, water, and soft commodities*. Springer, (2014).

Robles, Miguel, Maximo Torero, and Joachim Von Braun. "When speculation matters". *Washington, DC: International Food Policy Research Institute (IFPRI)*, (2009).

Tang, Ke, and Wei Xiong. "Index investment and the financialization of commodities." *Financial Analysts Journal* 68.5 (2012): 54-74.

Turner, Matthew. "The Commitment of Traders Report and its usefulness". The London Bullion Market Association, (2009)

UNCTAD. "Don’t blame the physical markets: financialization is the root cause of oil and commodity price volatility." *Geneva: United Nations Conference on Trade and Development*. (2012).

WB. “Risk and finance in the coffee sector : a compendium of case studies related to improving risk management and access to finance inializ tim.3(e)9f (t)f(.)7ee (t)- (im.t(.)7 (o)-1r) .um

Note: Positive numbers on vertical axis show evidence of influence.
Dates indicate last month of a 50-month period
Source: ICO

Note: Positive numbers on vertical axis show evidence of influence.
Dates indicate last month of a 50-month period
Source: ICO

Note: Positive numbers on vertical axis show evidence of influence.
Dates indicate last month of a 50-month period
Source: ICO

Note: Positive numbers on vertical axis show evidence of influence.
Dates indicate last month of a 50-month period for volume, OI and Ratio - Vol/OI, and a
30-month period for the Ratio of noncommercial long positions to total reportable long

This technical annex details the methodology and steps required to perform Granger causality tests. Granger causality is based on time series analysis within econometrics methods. Coffee prices and the measures of speculation described in section II above can be examined using time series analysis. Time series analysis is used to study the development of an economic indicator based on their past behaviour and predict future values of such indicator based on their previously observed values. Granger causality extends the analysis of time series under the assumption that the historical behaviour of other indicators can also have a predictive power (or causal relationship) for the behaviour of such indicator. The main objectives of this study fit into the scope of time series analysis since they focus on analysing the development of Arabica and Robusta futures markets over time, and, identifying a potential causal or predictive link between speculative activity in the futures market and the behaviour of spot market prices for coffee.

Optimal lag order – individual series

The first step of the methodology is to identify how many periods of past behaviour (lags) are relevant to predict the current behaviour of each variable of coffee price and speculation indicators. This is firstly done by visual inspection, observing the autocorrelation function (ACF) and partial autocorrelation (PACF) plots[9], which provide a guide of the lags that are relevant to explain the current behaviour of a variable. After visual inspection, three information criteria (Akaike (AIC), Hannan–Quinn (HQIC) and Bayesian-Schwarz (SBIC)), are used to corroborate the most appropriate lag structure of the individual series. The results of this process for each of the individual series analysed are presented in Table A1, showing the final optimal lag order selected.

Stationarity – Unit Root tests

After identifying the optimal lag order, the next step is to test whether the series are integrated of order 1 or have a unit root. Series with a unit root are non-stationary, meaning that the variance of the series is not constant in time and, thus, a time-shock on the variable will produce a permanent deviation of the long-run behaviour of the variable. If a unit root is present, the series can be differenced to render it stationary. In order to test for unit root, augmented Dickey-Fuller (ADF) tests are used to analyse each price and speculation variable. Results indicate that the ADF tests fail to reject the null hypothesis of unit root for all coffee price indicators and for volume traded, open interest and Vol/OI ratio (Table A2). Non-

[9] *Available upon request.*

commercial positions ratio, long and short, and the index traders' net positions were found stationary (Table A2). Further ADF tests were conducted for the first difference of the series with unit root and all were found stationary.

Arabica	L(Colombian Milds price)	1
	L(Other Milds price)	2
	L(Brazilian Naturals price)	2

After identifying the properties of the individual series (optimal lag structure and stationarity), Granger causality tests can be performed to identify whether speculation indicators have any predictive power that explain coffee price movements. The first step of the test is estimating the following *unrestricted* econometric model:

. = + . + +

in which:

is the log of each coffee price indicator (*c*) at year *t*.

. is the first difference of the variable, for example for coffee prices: . =

and . =

is the lagged speculation measure for each relevant type of coffee (*c* = Arabica/Robusta) at year *t*, in its stationary form. So,

in which:

is the optimal lag order for the combination price-speculation indicator
is the number of observations
and (1) are the degrees of freedom to identify the F-critical value in the F-distribution.

ESS provides an indication of whether the model is a good fit to the data and is considered a criterion for optimal model selection. The Granger causality test compares the ESS of both the restricted and the unrestricted model. The null hypothesis of the test is that speculation does not Granger-cause coffee prices. The null hypothesis can be rejected when the *F statistic* is greater than the *F critical value*, that is, there is evidence of Granger-causality. In this case, the restricted model, which includes speculation measures, is a better fit to the data.

The Granger causality test was performed for each coffee price-speculation model for the whole period of available for each series as described in paragraph 25, page 9, above. Evidence of long-term Granger causality was not found for any of the 18 Arabica-speculation models. For Robusta, Granger causality was found only for volume of contracts traded and open interest.

Rolling regressions

Since evidence of long-term Granger causality was not found for the majority of the 23 tests for each price-speculation combination, using the whole period of time available, Granger causality tests were performed on a rolling basis for shorter periods of time. This procedure was done to identify causality in different periods as the market behaves differently from time to time. Therefore, causality tests were conducted by taking 50-month periods and rolling the test one month at a time. For example, for volume traded, open interest and Vol/OI ratio, the first test is conducted for the 50-month period, January 1994-February 1998. Subsequently a further 250 tests for all four price indicators[10] were carried out until the last 50-month period, November 2014-December 2018. Due to data availability, the first 50-month test period sets in later for the other three indicators of speculation: long and short ratios of non-commercial positions to total reportable positions (June 2006-July 2010) and index traders' net positions (January 2006-February 2010). In the case of Robusta, the period length of non-commercial positions ratios, long and short, is six years shorter compared to Arabica. Therefore 30-month periods were taken for these two variables. For the Robusta market, Index traders data is not available. In total 4,047 tests were conducted by running the models and computing the F-statistic described above. The results are presented in Section III above.

[10] *This implies that a total of 3,012 tests were conducted for the four coffee price indicators, Colombian Milds, Other Milds, Brazilian Naturals and Robustas and three speculation measures, Volume traded, Open Interest and Vol/OI ratio.*

Arabica	D.L(Brazilian Naturals)	D.L(Volume traded)	12
		D.L(Open Interest)	1
		D.Vol/OI ratio	2
		Non-commercial positions ratio - long	1
		Non-commercial positions ratio - short	1
		L(Index traders' net positions)	2
	D.L(Colombian Milds)	D.L(Volume traded)	12
		D.L(Open Interest)	1
		D.Vol/OI ratio	2
		Non-commercial positions ratio - long	1
		Non-commercial positions ratio - short	1
		L(Index traders' net positions)	2
	D.L(Other Milds)	D.L(Volume traded)	12
		D.L(Open Interest)	1
		D.Vol/OI ratio	2
		Non-commercial positions ratio - long	1
		Non-commercial positions ratio - short	1
		L(Index traders' net positions)	2
Robusta	D.L(Robustas)	D.L(Volume traded)	3
		D.L(Open Interest)	1
		D.Vol/OI ratio	3
		Non-commercial positions ratio - long	1
		Non-commercial positions ratio - short	1

Note: $D.L(X) = log(X)_t - log(X)_{t-1}$; $D.X = X_t - X_{t-1}$; $L(X) = log(X)$.