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Futures markets: the role of non-commercial traders

Background

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. This study uses a widely-recognized econometric model that relates spot market prices for Arabica and Robusta with six indicators of speculation.

3. The main findings of the study show that the volume of futures contracts traded almost tripled in the Robusta futures market and increased five-fold for Arabica from 1994 to 2018. Over the same time period, output of Arabica grew by 64%, while Robusta production rose by 144%. This suggests that the coffee market has been subject to a significant process of "financialization" over the past two decades. Furthermore, the results of the analysis indicate that speculative activity can impact the behaviour of coffee prices in the short-term, while fundamentals, such as demand trends and supply shocks, prevail as determinants of price developments in the long run. The study also describes regulatory interventions that aim to limit the impact of speculation in financial markets, as examples of measures that could be considered for the coffee futures market.

Action

4. The Council is requested to take note of this document.

FUTURES MARKETS: THE ROLE OF NON-COMMERCIAL TRADERS
(February 2019)

I. INTRODUCTION

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.

Figure 1: ICO composite indicator (US cents/lb)
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 statistical tests. A regression analysis revealed a very strong relationship between futures contract and spot prices for all groups of coffee, indicating that futures prices are very closely related to physical market prices and vice versa. The two markets seem to exert mutual influence on price movement. Further research to assess the price discovery role of futures markets was recently conducted by the ICO in collaboration with the Georg-August University of Gőttingen, Germany (ICO, 2018). The econometric analysis of the price data confirmed the existence of a stable long-run relationship between futures and producer prices, indicating that both series react to the same set of external information on the market. The analysis of the role of the futures market as a price discovery mechanism provided mixed results. In Brazil, Colombia, and the Dominican Republic, local producer prices appear to incorporate new information faster than the futures market. In Guatemala and Honduras, however, the New York futures market indeed dominates price discovery, suggesting that producers in these two countries may benefit from making their decisions based on futures contracts price information. In addition, the ICO has undertaken a number of initiatives, including a study on the feasibility of intermediating price risk management to coffee farmers and coffee cooperatives in Africa[1], as well as the possibility of setting up commodity exchanges[2].

7. The present study uses a different methodology to assess speculative activity on the futures market. The empirical analysis is based on an econometric approach that was

[1] *Coffee price risk in East Africa: the feasibility of intermediating price risk management to coffee farmers and coffee cooperatives in Ethiopia, Kenya, Uganda, Tanzania and Zimbabwe. 2004.*
[2] *Study of the potential for commodity exchanges and other forms of market places in COMESA countries, 2003.*

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.

II. DEFINING AND MEASURING SPECULATIVE ACTIVITY IN FUTURES MARKETS FOR COFFEE

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 commodity (short position) may hedge against future fluctuations in the price of the commodity by selling now in a futures markets for future delivery at a currently determined price (WB, 2015)[3]. On the other hand, market participants such as processors that intend to purchase a commodity for future use (long position) may hedge by buying now for future delivery at the agreed price (Robles *et al.*, 2009).

10. In the context of futures markets for agricultural commodities, speculation involves the buying, holding, selling, and short-selling of commodities with the objective of benefiting from price fluctuations instead of buying for use. Speculators are participants that may hold long and/or short positions on any transaction. Cumulatively, all positions held by speculators offset the net imbalances between the long and short positions held by market participants (ibid).

11. Traders at futures markets can be grouped into those with and those without commercial interest. According to the definition by US Commodities Futures Trading Commission (CFTC), speculators are non-commercial traders, that is, traders with no commercial interest in the futures positions held.

Speculation indicators

12. To gauge the level of speculation on each of the futures markets, this study uses measures of speculative activity following the approach of Robles *et al.* (2009). This set of

[3] *Case study 4: implementing price risk management in the Rwandese marketplace.*

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 long/short positions held by non-commercial traders to total reportable positions, and (vi) the index traders' net positions (long-short)[4].

13. The data on (i) volumes and (ii) open interest of coffee futures contracts, for the period January 1994 to December 2018, were retrieved from daily records of the ICO database and from the Intercontinental Exchange (ICE). Other data on (iv,v) non-commercial and total traders' positions and (vi) the index traders, for Arabica, were obtained from the Commitments of Traders and supplemental reports of the CFTC, and, for Robusta, from the historical data of ICE and the London International Financial Futures and Options Exchange (LIFFE). Traders' positions data cover a shorter period of time, from June 2006 to December 2018 for Arabica and from May 2012 to December 2018 for Robusta. This time series data for the indicators enable us to analyse how speculative activity developed over time, both in the Arabica and Robusta markets.

(i) *Monthly volume of futures contracts*

14. Volume is the total number of contracts that trade in the coffee futures market. Volume is aggregated for contracts of all maturities traded in the futures market. An increase in participation of short-term speculative activities raises the volume of futures contracts trading, because speculators open and close positions in a relatively short period of time (Robles *et al.*, 2009; Kalkuhl *et al.*, 2016). However, this is a relatively weak measure of speculation because it does not effectively identify trends and changes in speculative activity from regular activity in the market.

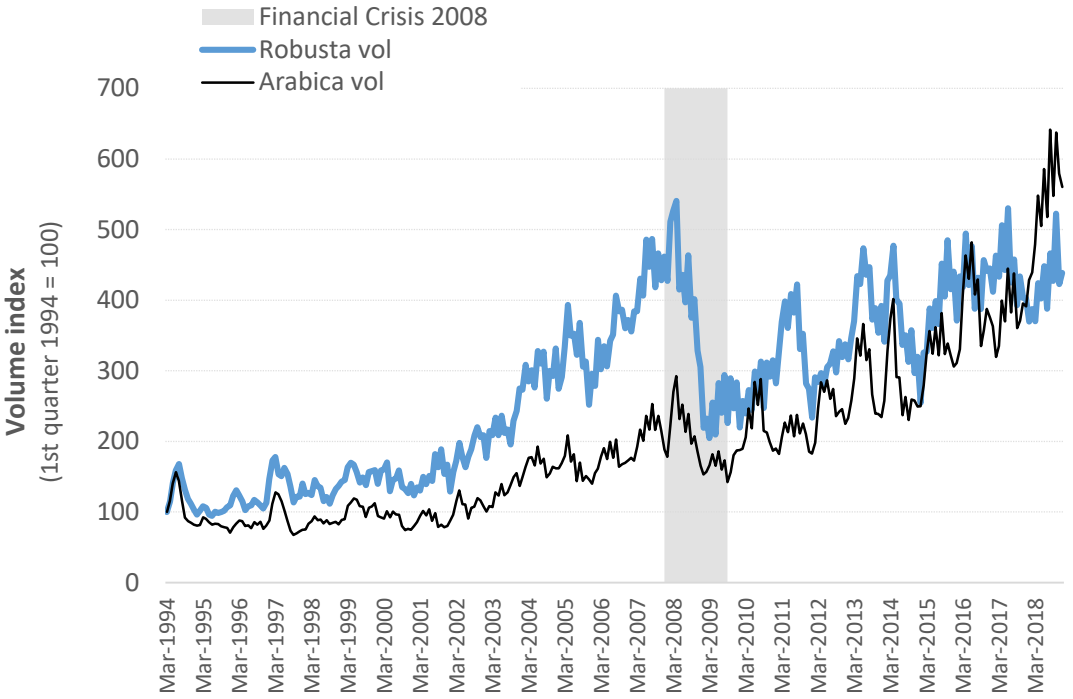
15. Between 1994 and 2000 the monthly volume of coffee futures contracts traded remained relatively stable. Subsequently, the average volume of futures contracts traded rose sharply, with the index for Robusta and Arabica increasing 4-fold and 3-fold, respectively, by April 2008. During the financial crisis of 2008, volumes traded fell to levels observed in the early 2000s. In February 2009, the unit of weight of the Robusta coffee contract increased from 5 MT to 10 MT. Volumes traded of Robusta futures contracts entered a period of stabilization after this unit change until the end of the financial crises. Since then, volumes traded have recovered to pre-crisis levels (Robusta) or exceeded these (Arabica). The upward trend in volumes after the crisis has been particularly strong for Arabica futures (Figure 2).

16. The rise in volume traded over the period 1994-2018 is significantly higher than the expansion of global production. Output of Arabica grew by only 64% from 62 to 101 million 60-kg bags, while Robusta production rose by 144%, from 26 to 64 million bags[5]. This supports the hypothesis that over the past two decades the coffee market was subject to a process of financialization, that accelerated since 2000.

[4] *Available for the Arabica market only.*

[5] *Figures correspond to coffee years 1994/1995 and 2017/2018.*

Figure 2: Monthly volume of coffee future contracts traded



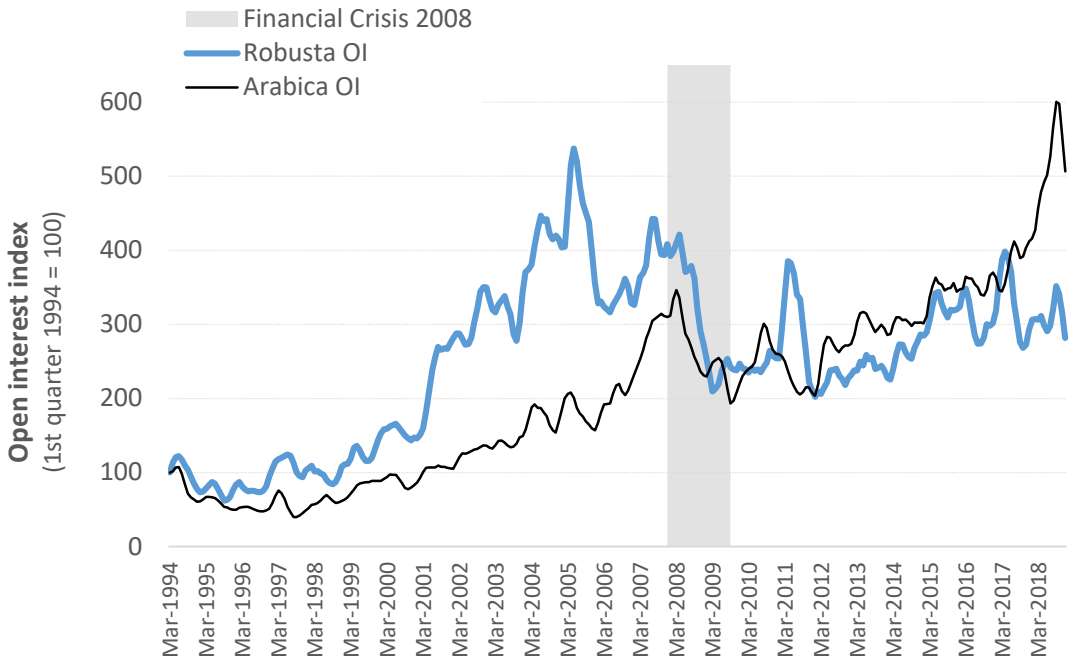
Note: The volume index is a 3-month moving average.
Source: ICO and ICE. Own calculations

(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). OI for Arabica has shown a steep increase since March 2017. 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.

Figure 3: Monthly open interest in coffee future contracts



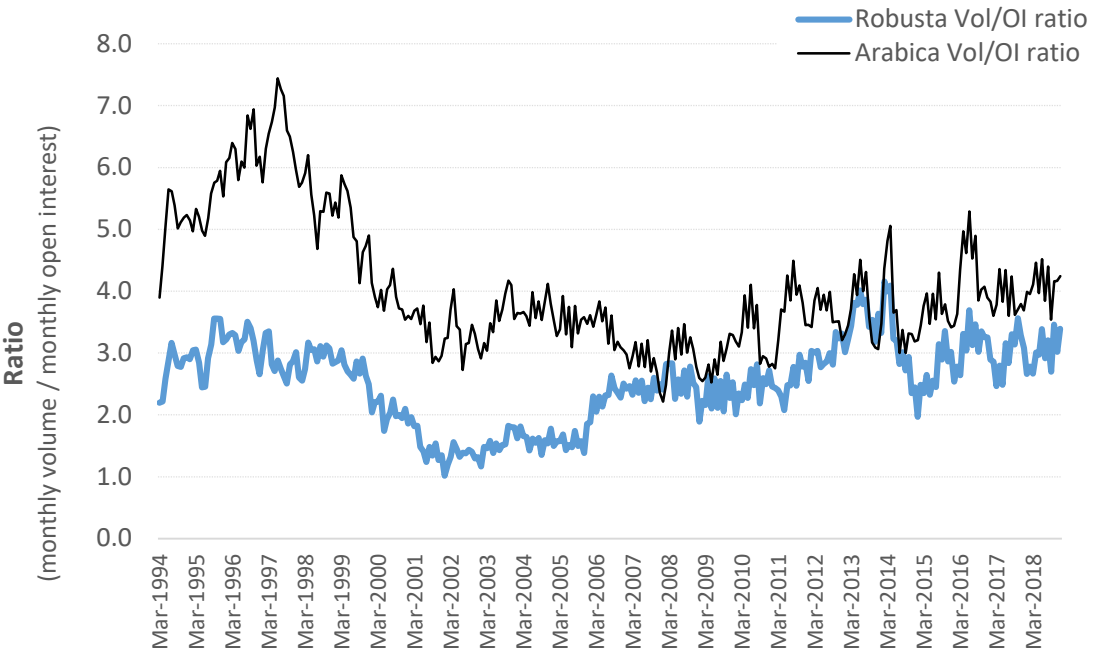
Note: The open interest index is a 3-month moving average
Source: ICO and ICE. Own calculations

(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. Consequently, the more short-term speculation the higher the ratio of volume to open interest.

20. Figure 4 depicts the evolution of the ratio of volume to open interest (Vol/OI) from 1994 for both coffee futures markets. For Arabica, the Vol/OI ratio decreased until 2007, showing a slight upward trend, but without reaching previous high levels experienced in 1997. For Robusta, the Vol/OI ratio also decreased until 2002, remaining at a stable level until 2006 to then steadily increase to current levels.

Figure 4: Ratio of volume to open interest in coffee futures contracts



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

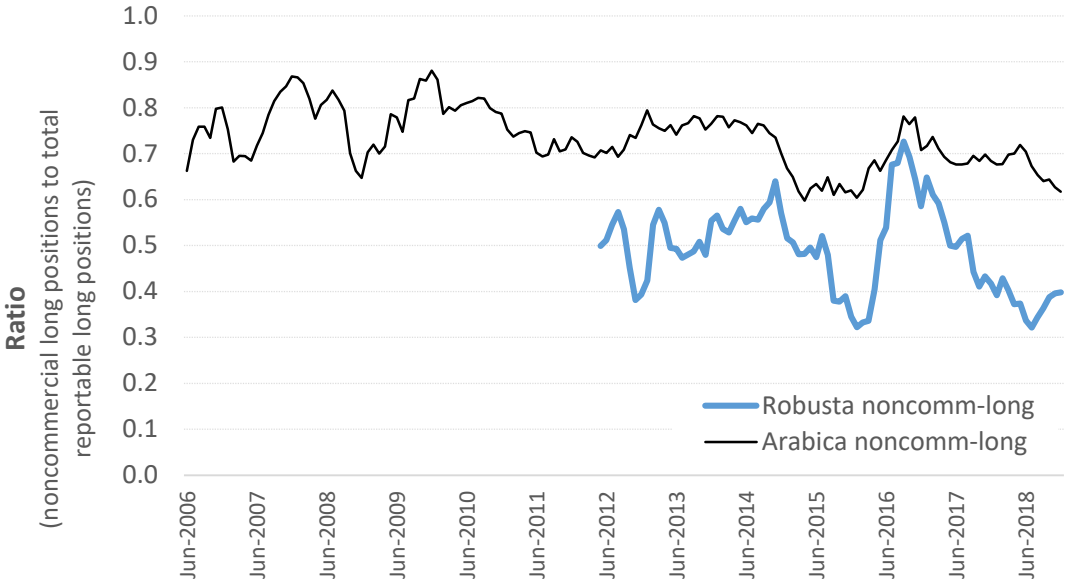
(iv, v) *Ratio of non-commercial positions to total reportable positions in futures contracts, short and long*

21. The Commodity Futures Trading Commission (CFTC) publishes a weekly report called the Commitment of Traders (CoT). This report breaks down open interest by different classes of market participants and outlines whether they are holding long or short positions. The CoT report the positions held by reportable traders in four categories: producers, merchants, processors and users (commercial traders), swap dealers, money managers and other reportable positions (non-commercial traders)[6]. Commercial traders are those who use futures contracts for hedging purposes as defined by CFTC. Therefore, non-commercial positions (short or long) in futures contracts mainly represent speculative activity in pursuit of financial profits (Robles *et al.*, 2009). A higher share of short or long positions in futures contracts by non-commercial traders reflects increased speculation.

[6] *The CFTC included swap dealers in the commercial category before splitting it up in 2009 (Nijs, 2014). There has been considerable debate whether swap dealers are commercial or non-commercial traders (CFTC, 2016). The general consensus is that this category includes both commercial and non-commercial traders (Nijs, 2014). Robles et al. (2009) and Kim (2015) consider swap dealers as commercial traders in their research models. In this study, we take a more conservative approach by including swap dealers in the non-commercial traders category. We conducted a sensitivity analysis to evaluate the implications of reclassifying swap dealers into the commercial category, please see the box: "Role of swap dealers" below.*

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.

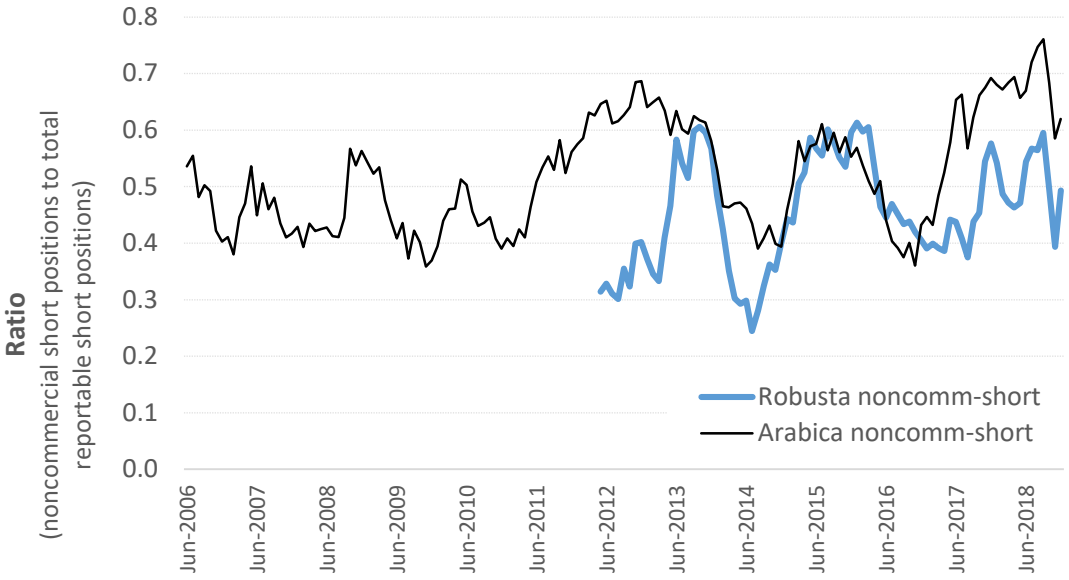
Figure 5: Ratio of non-commercial long positions to total reportable long positions



Note: Robusta data is available from 2014
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.

Figure 6: Ratio of non-commercial short positions to total reportable short positions



Note: Robusta data is available from 2014
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.

Figure 7: Index traders' net positions in futures and options - Arabica

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

III. ANALYSING THE CAUSAL EFFECT OF SPECULATION ON COFFEE SPOT PRICE MOVEMENTS

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 daily spot market prices collected by the ICO covering the time period from January 1994 to December 2018, calculating monthly averages for each of the four ICO groups: Colombian Milds, Other Milds, Brazilian Naturals and Robusta. For details on the methodology employed, please refer to the Technical Annex.

27. The first test of causality was performed for the entire period available for each combination of coffee prices and speculation indicators, that is, a total of 23 Granger causality tests were conducted[7]. These tests of long-run causality did not find evidence that speculative activity has predictive power for Arabica prices (Colombian Milds, Other Milds and Brazilian Naturals). In the case of Robusta, causality was found only for volume traded and open interest. Therefore, only two tests out of 23 indicated weak evidence of a potential long-term causality between speculative activity in futures markets and coffee prices.

28. Although long-run causality does not seem to be present for the majority of coffee price indicators, there can be short-term causality, due to speculative activity behaving differently in response to short-run external information or shocks. In order to assess causality

[7] *Three Arabica price indicators with six speculation measures, and Robustas price indicator with five speculation measures.*

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 which speculation-price causality was found.

33. In the case of Robusta (Figure A4), the main speculation indicator with power to predict Robusta price movements over the entire time period is open interest, while volume traded and Vol/OI ratio was indicative at the beginning of the period studied (1998-2000).

Table 1: Evidence of speculation activity affecting commodity prices

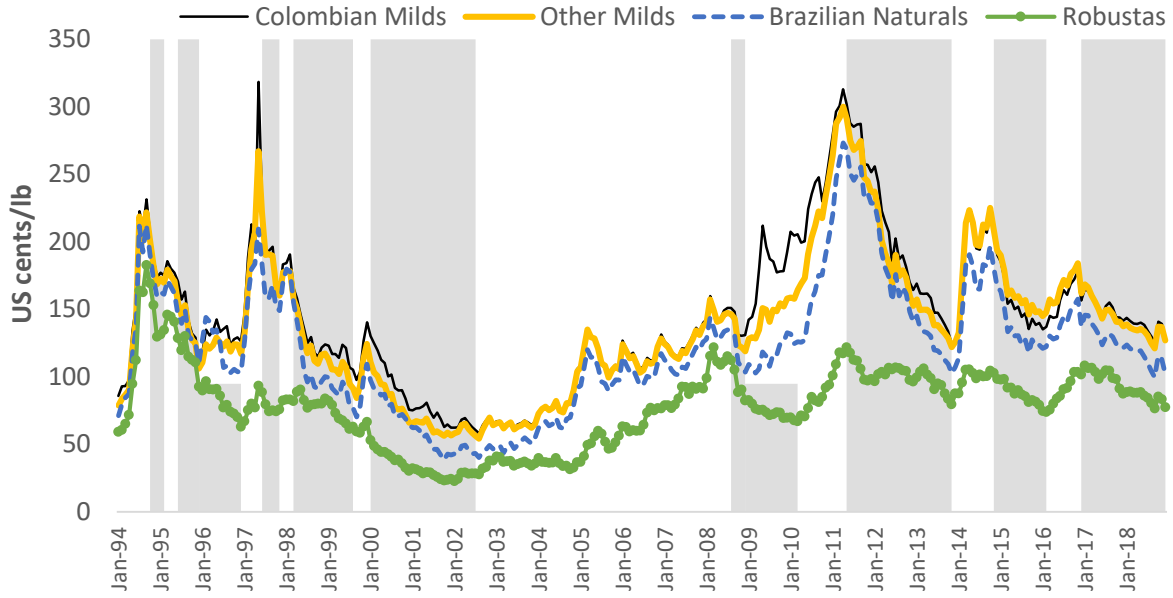
Market	Indicator of speculation activity	Colombian Milds	Other Milds	Brazilian Naturals	Robustas
Arabica (Coffee C - ICE Futures U.S.)	1. Monthly volume of futures contracts	Apr2001-Sep2004, Jun-Aug2006, Feb-Mar2007, Sep2009, and, Sep-Dec2018	May1999-Apr2002, Nov2002-Mar2005, Jun-Aug2006, Feb-Mar2007, 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	
	2. Monthly open interest of futures contracts	Feb-Dec2002, Apr-Dec2003, and, Apr-May2004	Jul-Oct2002, and, Jun2003		
	3. Ratio of volume to open interest (1)/(2) (futures contracts)		Aug-Oct2009		
	4. Ratio of non-commercial positions to total reportable positions (long)	Jul2013-Feb2014	Jul2013-Jan2014		
	5. Ratio of non-commercial positions to total reportable positions (short)	Jul2010-Jul 2011, and, Jul2013-Feb2014	Jul2010-Mar2011, and, Dec2012-Jan2014	Jul-Sep2010, Dec2012-Jan2014	
	6. Index traders' net positions (long - short positions)	Jul2013	Jul2013-Sep2014	Feb-Jun2010, Oct-Dec 2013, and, Jan-Jul 2014	
Robusta (ICE Futures Europe)	1. Monthly volume of futures contracts				Feb1998-Feb2000
	2. Monthly open interest of futures contracts				Mar2004-Oct2006, and, Apr2012-Nov2015
	3. Ratio of volume to open interest (1)/(2) (futures contracts)				Feb1998-Oct1998
	4. Ratio of non-commercial positions to total reportable positions (long)				Dec2018
	5. Ratio of non-commercial positions to total reportable positions (short)				

Source: ICO

Evidence of speculation during periods of rising and falling prices

34. Table 1 lists the periods for which evidence was found that speculative activity had certain influence on the direction of the market at that moment. Figure 8 shows the periods in which coffee prices were experiencing upward trends (white areas) and downward trends (shaded areas) for the four groups.

Figure 8: ICO indicator prices of coffee (US cents/lb)



Note: shaded areas are periods of downward trend in coffee prices
Source: ICO

35. Figures 9 and 10 below combine the results of the causality tests with the direction of the market for Arabica and Robustas prices, respectively. The graphs show that speculation activity (as measured by the indicators) played a role in price behaviour during periods of both rising and falling prices.

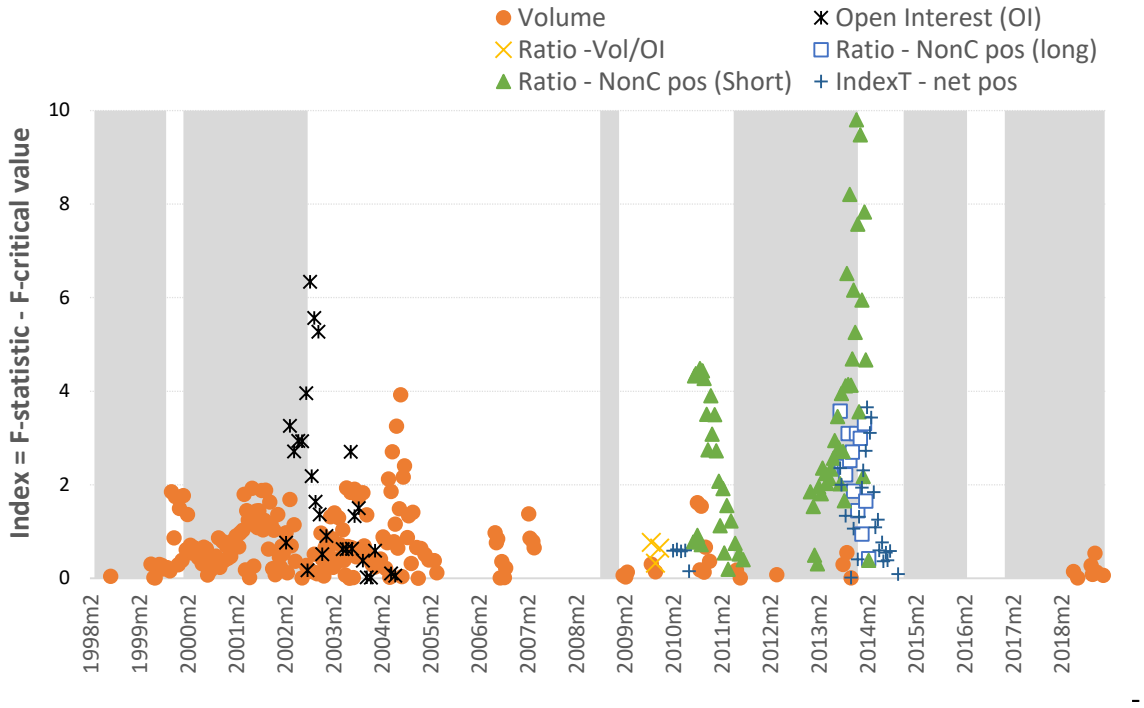
36. For the case of Arabica (Figure 9), the first period for which influence of speculation was found to be significant was before March 2005 when prices were fluctuating. The next periods in which speculation might have exacerbated the movement of the market were from February 2010 to July 2011 and from December 2012 to September 2014, when prices were mostly increasing. In this latter period, the market reacted to the 2012-2013 Coffee Leaf Rust crisis in Central America and Mexico. The impact of this event lasted at least three years (Avelino *et al.*, 2015). Since December 2016, when the current period of low coffee prices started, the first evidence of speculative activity influencing prices related to Brazilian Naturals in May and June 2018,[8]. This influence is not present in the following months until September, October and December 2018, when volume traded might also have had some

[8] *From volume of contracts traded, a relatively weak indicator.*

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.

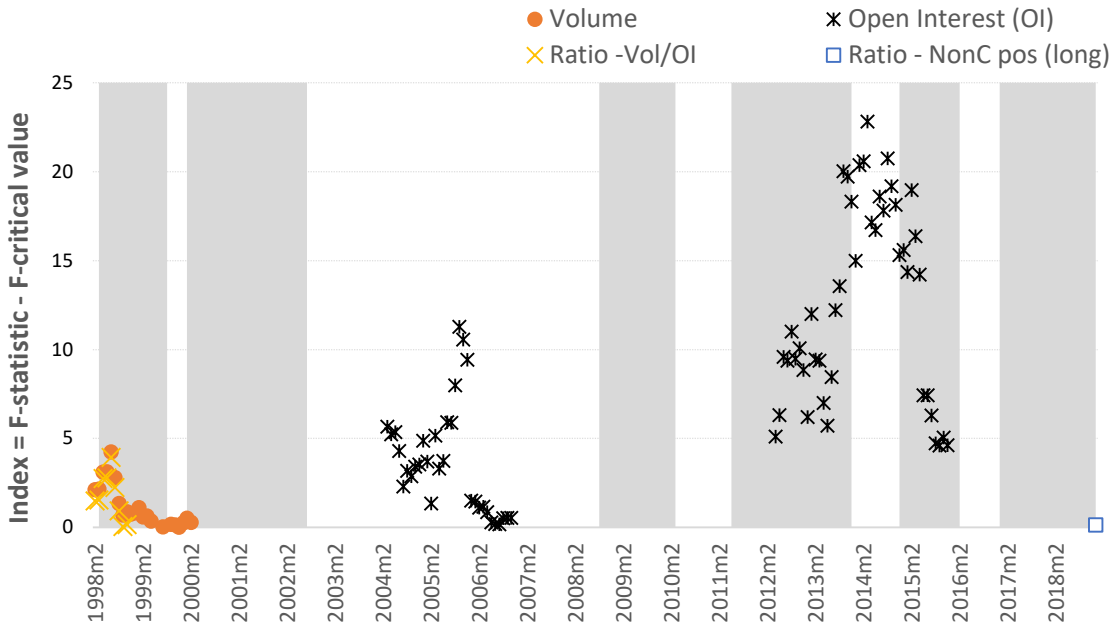
37. For the case of Robusta (Figure 10), the only indicators of speculation that exert influence on the direction of the market are volume traded and open interest. The Vol/OI ratio, a stronger measure of short-term speculation, was found relevant for determining Robusta prices, but only early in the 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.

Figure 9: Low price periods vs evidence of speculation – Arabicas



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

Figure 10: Low price periods vs evidence of speculation – Robustas



Note: 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 positions

Source: ICO

Box: The role of swap dealers

There has been considerable debate whether swap dealers are commercial or non-commercial traders (CFTC, 2016). The general consensus is that they comprise both commercial and non-commercial traders (Nijs, 2014). This study adopted a conservative approach by including swap dealers in the non-commercial traders category. This approach has implications in the definition of two of the six measures of speculation considered: the ratios of long and short non-commercial positions to total reportable positions.

We conducted a sensitivity analysis to examine the effects of excluding swap dealers from the non-commercial category. First, the average ratio of non-commercial long positions to total positions decreases from 73% to 50% for Arabica and from 49% to 42% for Robusta. The average ratio of short non-commercial positions to total positions decreases from 52% to 46% for Arabica and from 46% to 36% for Robusta.

Second, a full set of short-term Granger causality tests were conducted for each combination of these two speculation indicators and coffee price groups. After excluding swap dealers from non-commercial traders, we find no evidence of predictive power of the ratio of non-commercial long positions on spot prices of either Arabica or Robusta. In the case of non-commercial short positions, we find evidence of speculative activity predicting price movements for shorter periods of time for all three Arabica groups. For Robusta, we find evidence that short non-commercial positions exerted some influence in Robustas prices in May 2016. In conclusion, by excluding swap dealers from non-commercial traders we find similar short-term effects of speculative activity, without structural changes in the main results.

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Note: Full results of the sensitivity analysis are available upon request.

IV. CONCLUSION AND NEXT STEPS

38. The financialization of commodity markets over the previous decade has sparked concerns that speculation could impact price behaviour. This study linked data on speculative activity in the futures markets for Arabica and Robusta to data spot market prices for coffee.

39. The main findings are: first, between 1994 and 2018 volumes traded at coffee futures markets increased faster than world production, suggesting that the coffee market has been subject to a significant financialization. The inflow of capital, in relative terms, is comparable to that in the market for grains prior to 2008, when prices sharply increased.

40. Second, the study finds a causal link between speculative activity at the futures markets in New York and London and spot market prices for coffee in specific time periods. However, the analysis does not show a significant impact of speculation during the recent downturn of the coffee market, suggesting that other factors such as the current imbalance between supply and demand, predominate. The findings also depend on the choice of proxy used to capture speculative activity in coffee futures markets.

41. Third, the effect of speculative activity is short term. These findings are in line with the body of literature on the 2008 price crisis in the market for grains (Robles *et al.*, 2009; Kim, 2015). The results suggest that fundamentals, such as of demand trends and supply shocks, prevail in determining price behaviour over the long run.

42. Fourth, speculation was identified as causal for spot price movements during bearish as well as bullish coffee markets. That is speculators enter the coffee futures markets both during periods of rising and falling prices based on fundamentals, exacerbating the underlying price movements. As a result, all market participants are affected by the destabilising effect of speculation. Depending on whether market participants are sellers or buyers of coffee and the direction of the price movement, the effect of speculation can be either positive or negative. Coffee-exporting countries can benefit from speculation resulting in higher price levels while coffee importers are negatively affected, and vice versa.

43. The literature suggests that the impact of speculation on coffee prices can be managed through regulatory interventions. Changes in the framework of futures markets can result in a strict limit on the positions held by non-commercial traders, as in the case of the Dodd–Frank Wall Street Reform and Consumer Protection Act (Irwin and Sanders, 2010). Alternatively, regulation can seek to increase the cost of non-hedging participation in the market. For example, Robles *et al.* (2009) discuss imposing capital requirements for each transaction on the futures market and a compulsory delivery on contracts or positions of contracts.

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.

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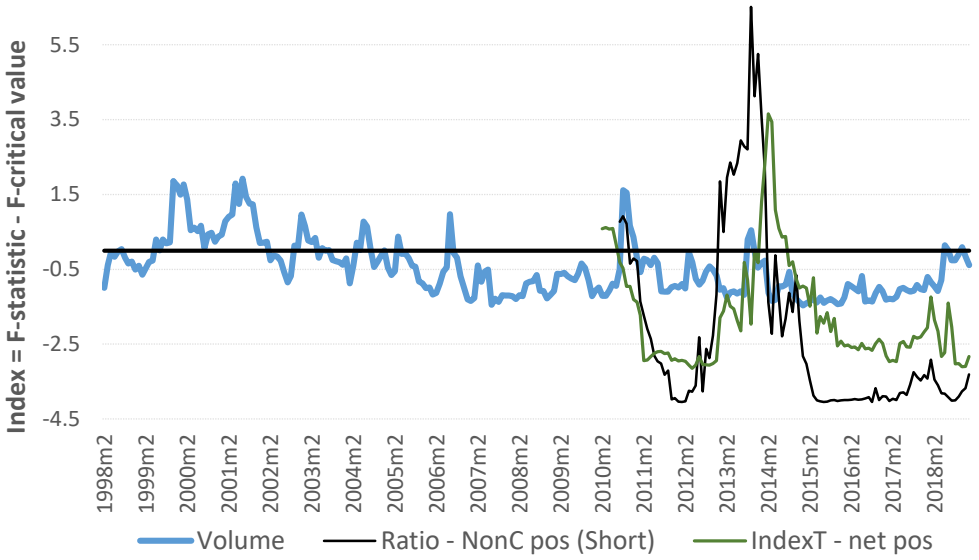
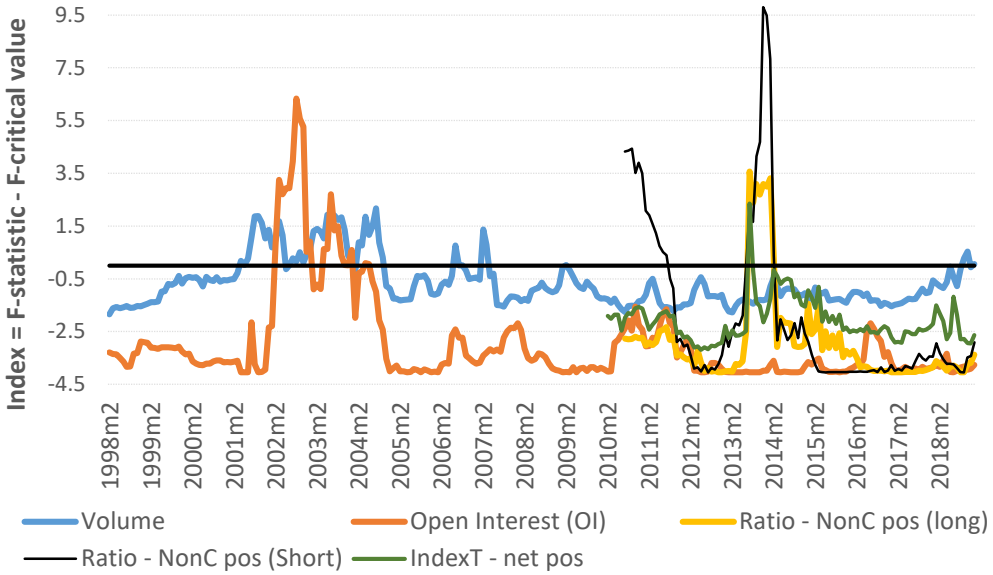
Figure A1: Evidence of speculation influencing price for Brazilian Naturals



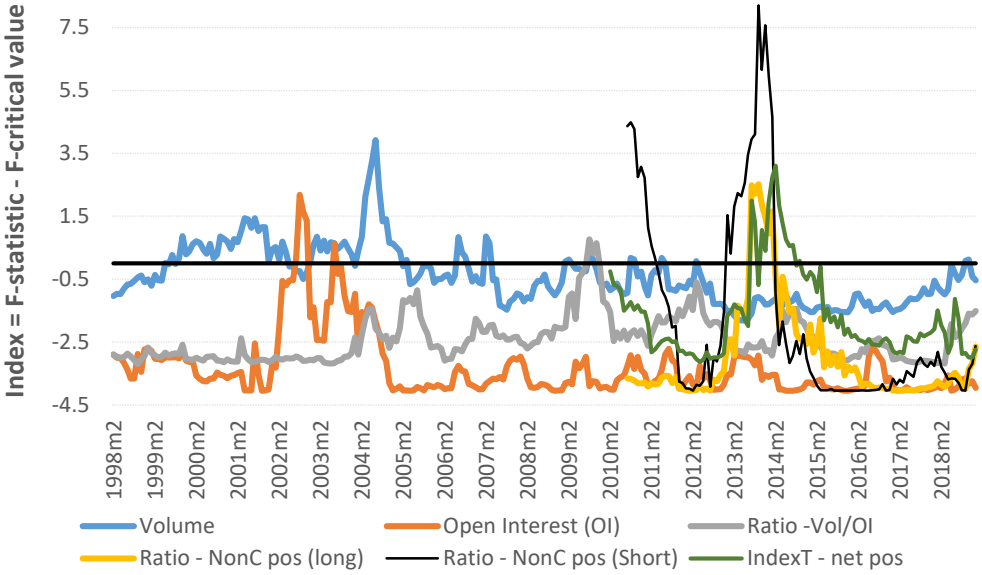
Note: Positive numbers on vertical axis show evidence of influence.
Dates indicate last month of a 50-month period
Source: ICO

Figure A2: Evidence of speculation influencing prices for Colombian Milds



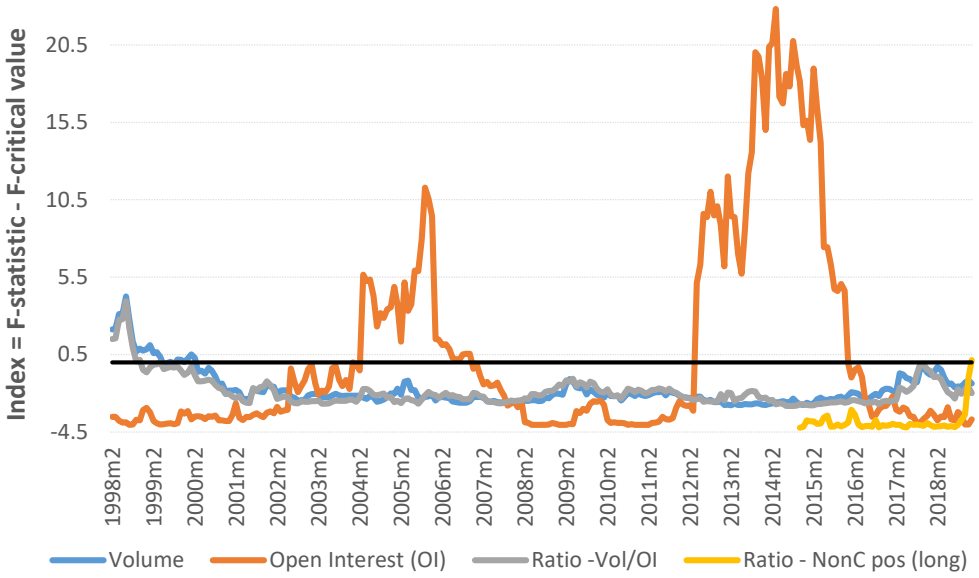
Note: Positive numbers on vertical axis show evidence of influence.
Dates indicate last month of a 50-month period
Source: ICO

Figure A3: Evidence of speculation influencing prices for Other Milds



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

Figure A4: Evidence of speculation influencing prices for Robustas



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 positions
Source: ICO

TECHNICAL ANNEX - ECONOMETRIC METHODOLOGY

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.

I. PROPERTIES OF THE INDIVIDUAL SERIES

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.

Table A1: Selection of optimal lag order for each individual series

	Variable	Optimal lag order
Arabica	L(Colombian Milds price)	1
	L(Other Milds price)	2
	L(Brazilian Naturals price)	2
	L(Volume traded)	13
	L(Open Interest)	2
	Vol/OI ratio	13
	Non-commercial positions ratio - long	1
	Non-commercial positions ratio - short	1
	L(Index traders' net positions)	2
Robusta	L(Robustas price)	2
	L(Volume traded)	4
	L(Open Interest)	1
	Vol/OI ratio	4
	Non-commercial positions ratio - long	1
	Non-commercial positions ratio - short	1

Note: *L(X) = log(X)*

Table A2: Unit root (ADF) test results

	Variable	ADF test statistic
Arabica	L(Colombian Milds price)	-2.120
	L(Other Milds price)	-2.380
	L(Brazilian Naturals price)	-2.274
	L(Volume traded)	0.487
	L(Open Interest)	-0.593
	Vol/OI ratio	-1.487
	Non-commercial positions ratio - long	-2.599**
	Non-commercial positions ratio - short	-2.163*
	L(Index traders' net positions)	-2.838**
Robusta	L(Robustas price)	-1.854
	L(Volume traded)	-1.507
	L(Open Interest)	-1.949
	Vol/OI ratio	-2.226
	Non-commercial positions ratio - long	-2.599**
	Non-commercial positions ratio - short	-2.78**

Note: *L(X) = log(X).* ** non-significant at 1%, * Significant at 5%

II. GRANGER CAUSALITY TESTS

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:

$$D.P_t^c = \propto_0 + \sum_{i=1}^{m} \propto_i D.P_{t-i}^c + \sum_{i=1}^{m} \beta_i S_{t-i}^c + \varepsilon_t$$

in which:

- P_t^c is the log of each coffee price indicator (*c*) at year *t*.
- $D.$ is the first difference of the variable, for example for coffee prices: $D.P_t^c = P_t^c - P_{t-1}^c$ and $D.P_{t-1}^c = P_{t-1}^c - P_{t-2}^c$
- S_{t-i}^c is the lagged speculation measure for each relevant type of coffee (*c* = Arabica/Robusta) at year *t*, in its stationary form. So, S_{t-i}^c will effectively be $D.S_{t-i}^c$ for volume traded, open interest and Vol/OI ratio.
- m is the optimal lag order for the combination price-speculation indicator. The Bayesian-Schwartz criterion was use to define this optimal lag order as shown in table A3.

After the unrestricted model is estimated, its residual sum of squares (ESS_u) is recorded. The second step is estimating the following *restricted* model:

$$D.P_t^c = \propto_0 + \sum_{i=1}^{m} \propto_i D.P_{t-i}^c + \varepsilon_t$$

This model is *restricted*, because the condition of non-causality is imposed as the speculation variable is not present in the model. Therefore, we are *constraining* the model by assuming that speculation does not have any influence in the behaviour of prices. After the restricted model is estimated, its residual sum of squares (ESS_r) is recorded.

The Granger-causality test is now performed by calculating the F-statistic and comparing it to the F-critical value, given by the F-distribution at 95% of significance level. The F statistic is computed as follows:

$$F - statistic = \frac{(ESS_r - ESS_u)/m}{\frac{ESS_u}{n-1-m}}$$

in which:

m is the optimal lag order for the combination price-speculation indicator

n is the number of observations

m and $(n-1-m)$ 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.*

Table A3: Selection of optimal lag order for each price-speculation model

	Price indicator	Speculation measure	Optimal lag order
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: $D.L(X)= log(X)_t - log(X)_{t-1}$; $D.X= X_t - X_{t-1}$; $L(X) = log(X)$.