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The New Price Makers: An investigation into the impact of financial investment on coffee price behaviour

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ABSTRACT

The collapse of the international commodity agreements in the 1980s, together with the liberalisation of marketing systems in commodity exporting developing countries under structural adjustment programs have removed the role of the state in the pricing of commodities. The logic of liberalisation was to remove impediments to the efficient market discovery of commodities prices where state intervention was seen as the main culprit. Mainstream economics has also promoted the role of derivatives exchanges in efficient price discovery on physical markets in international commodity markets with globally fragmented production. By rapidly exploiting opportunities to profit from price deviations between futures and spot markets, rational and informed speculators are seen to drive any price deviations in the market quickly to the equilibrium price that reflect international supply and demand realities.

Such a view, however, fails to consider the role of differentiated market participants on international exchanges in driving commodity prices, by assuming that all trading activities are efficiency enhancing irrespective of the motives behind them. There has been much media interest in the role of speculation on commodity prices, in particular food commodities, over the recent months. There has, however, been very little systematic evidence gathered on the extent to which speculative activities affect prices of exchange traded commodities.

Using the example of international prices for coffee, this paper shows that increases in trading activities by non-physical market actors for the purposes of financial investment have led to a dislocation between prices on international exchanges and supply and demand realities. With increasing participation by various institutional investors such as hedge and pension funds, prices have become increasingly driven by trading that arises owing to changes in the financial investment environment more generally, such as the dot-com crash of the late 1990s and the recent credit crunch.

KEY WORDS

Commodity prices, futures markets

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1. Introduction

This paper explores the extent to which financial investment on futures markets affect price outcomes such that futures prices deviate from that which is warranted by the supply and demand conditions in the market for physical commodities.

With the collapse of various multilateral price and income stabilisation schemes, as well as the dismantling of public marketing systems in commodity producing developing countries, various private price risk management (PRM) strategies became the only option for market actors engaged in international commodity systems. Of the available PRM- strategies, futures contracts have been promoted as the key hedging instrument.¹ Theoretical justifications for the wholesale use of future contracts rely upon the assertions that: first - given their widespread availability –futures markets provided effective hedging instruments for cash market actors; second, futures markets are efficient in the sense that they incorporate all knowable market information in price outcomes and therefore enable efficient price discovery (Fama 1970); and third, by facilitating speculation, futures markets are beneficent in that they bring about a better allocation of supplies over time and reduces fluctuations in price (Goss and Yamey 1978). To the extent that these assertions hold, uninhibited futures markets therefore have two important functions in income stabilisation for individuals engaged in the trading of physical commodities, first by providing effective hedging instruments and second by stabilising prices (McKinnon 1967).

Recent economic literature on futures and/or commodities trading, while emphasising the importance of futures markets for price and income stabilisation, have not examined the functioning of these markets in terms of the above assertions together. The financial literature on futures trading has been preoccupied with applying empirical tests for the efficient market hypothesis (Fama 1998). On the other hand, recent literature on the behaviour of cash prices of commodities have examined the relationship between futures and cash prices solely in terms of the co-movement of the two price series, or the enhancement to the accuracy of cash price forecasts with the incorporation of futures price information (refs.) with the implicit assumption that efficient price discovery takes place on futures markets. Neither strands of literature engages in dialogue with the other and the relationship between futures and cash markets tend to be assumed rather than studied.

This paper argues that once we take into account the nature of trading activities of various market participants, distinguished according to the motivations behind their engagement in futures markets, the classical assertions that imply efficient price discovery and price stabilization on futures markets do not necessarily hold. Commodity futures have become increasingly attractive to financial investors

¹ Other private PRM-strategies include the use of forward contracts and income diversification.

who are looking to diversify their portfolios, particularly in times of high inflation and falling equity prices associated with economic downturns (Gorton and Rouwenhorst 2004). The last 20 years have seen a large number of new institutional investors entering commodity markets, including hedge and pension funds (Domanski and Heath 2007).

Section 2 begins by outlining the classical theory of speculation and the implied relationship between futures and physical markets for commodities, it continues with a critique of the classical theory from the perspectives of Post-Keynesian economics as well as the theory of performative economics (McKenzie, date). Section 3 presents two quantitative studies into the extent of financial investment on the coffee exchange of the New York Board of Trade (NYBOT) and its impact on, firstly the relationship between prices and supply and demand, and second the impact of financial activities on price volatility. Evidence is found for a loosening in the relationship between annual prices and changes in supply and demand conditions associated with a once and for all increase in financial investment on commodity markets at the time of the dot-com crash in 2000. In addition, we find that, in some cases, financial activities on coffee markets can lead to increased price volatility.

2. Re-examining the relationship between futures and physicals markets for commodities

Futures contracts were developed in the context of trade in agricultural commodities as an exchange traded risk management instrument for physical market traders. As an agreement between two parties to buy or sell an asset (in this case some quantity of the commodity) at a certain time in the future at a certain price. This allows the buyer and seller to lock in a price and thus hedge against risks associated with adverse movements in price that might take place between harvest and delivery.

The trading of futures contracts can be traced back to Japan in the 18th Century for rice and silk, and the Netherlands for tulip bulbs. The modern form of commodities exchanges appeared in the American Midwest with the establishment of the Chicago Board of Trade (CBOT) in 1848. The commodities exchanges brought together farmers and merchants. Initially, the main task of the exchange was to standardise the quantities and qualities of grains that were traded, but within a few years, futures like contracts were being traded on the exchange. (Hull 2003) Soon after the introduction of futures contracts, speculators entered the market, trading in futures contracts in order to profit from price changes without the need to hold the physical commodity.

Futures and many other derivative instruments have subsequently been developed for a wide range of agricultural and non-agricultural commodities, and financial assets. These are traded on derivatives exchanges across the world.²

1.1. 2.1 Stabilising Speculation

Modern textbooks on futures trading tell us that there are three distinct types of actors in futures market, namely hedgers, speculators and arbitrageurs (Geman 2006). Hedgers are those that are also trading in the physical commodity and engage in futures trading in order to cover themselves against price changes prior to the delivery of the stored, or yet to be produced/harvested, commodity³. Speculators take a position in the market, exposing them to the risk of adverse price movements in order to gain rewards. Speculators, although not necessarily operating outside of physical markets, are often assumed to have no desire to trade in the physical commodity rather they are financial investors that view commodities as an alternative asset class from equities and currencies. The Arbitrageur, unlike the speculator, is said to enter into several transactions in two or more markets in order to gain a *riskless* profit. In exploiting arbitrage opportunities, arbitrageurs quickly eliminate such price discrepancies across different markets.⁴ In the text book case, hedgers do not speculate and speculators do not hedge.

The classical view of speculation sees speculators as playing an important market making role. By providing the market with liquidity, speculation is seen to be beneficent in that it both enhances the allocative efficiency of the economy and reduces fluctuations in price.⁵ Marshall reinforces the

² Currently, the major futures exchanges are the CBOT, the Chicago Mercantile Exchange, the New York Mercantile Exchange, the New York Board of Trade, the International Petroleum Exchange, the London Metal Exchange and Le Marché à Terme International de France.

³ In the language of Holbroke Working (1962) hedgers engage in routine hedging and have no expectations how prices will behave in the future.

⁴ Even in the mainstream financial literature it has been debated whether the pure arbitrageur exists in reality. This together with the result from the EMH of no arbitrage opportunities, models of derivatives pricing are generally based on the assumption of no-arbitrage opportunities and thus no arbitrageurs (Geman, 2006).

⁵ [Speculative activities] "which enable a deficiency in one place to be supplied from the surplus of another, at a moderate or even small advance on the ordinary price, render the fluctuations of prices much less extreme than formerly. This effect is much promoted by the existence of large capitals, belonging to what are called speculative merchants whose business it is to buy goods in order to resell them at a profit. These dealers naturally buying things when they are cheapest, and storing them up to be brought again into the market when the price has become unusually high; the tendency of their operations is to equalize price, or at least to moderate its inequalities. The prices of things are neither so much depressed at one time, nor so much raised at another, as they would be if speculative dealers did not exist.

Speculators, therefore, have a highly useful office in the economy of society; and (contrary to common opinion) the most useful portion of the class are those who speculate in commodities affected by the vicissitudes of seasons. If there were no corn-dealers, not only would the price of corn be liable to variations much more extreme than at present, but in a deficient season the necessary supply might not be forthcoming at all. Unless there were speculators in corn, or unless, in default dealers, the farmers became speculators, the price in a season of abundance would fall without any limit check, except the wasteful consumption that would invariably follow. That any part of the surplus in one year remains to supply a

classical view by posing the theory of constructive speculation whereby, the actions of speculators in aggregate will tend to stabilise prices even if individual speculators trade in an inefficient⁶ way because it is in the interests of speculators to gather market information and use it in the best way possible since the wrong trading decisions lead to losses. Inefficient speculators, those that tend to make the wrong forecasts, lose money and are thus eliminated from the market (Marshall 1932).

The neoclassical approach focuses on the Knightian definition of risk⁷. In this sense, every decision is risky, and economic actors can assign probabilities to all economic decisions to the limit of available information. While on average knowable, economic actors are operating in a stochastic world and thus all decisions to buy and sell are in this sense speculative, but rational (Samuelson 1952). Mainstream theory of derivatives markets would imply that the introduction of futures markets would reduce cash price volatility owing to the price discovery properties of liquid futures markets. Movements in prices on futures markets are seen to embody the rapid and unbiased incorporation of all available information in the supply and demand on cash markets. By rapidly exploiting arbitrage opportunities that appear on the market, rational and informed speculators are seen to drive any price deviations in the market quickly to the equilibrium price. If markets are efficient, futures prices are unbiased predictions of subsequent spot prices. (Mandelbrot 1966; Samuelson 1965) Futures markets can thus perform their second role in terms of cash price stabilisation and risk reduction through hedging. By enhancing the price discovery mechanism, all trading activities, regardless of the motivation of the trader (be it to derive income from price movements, or to hedge against the price risk associated with holding the physical commodity) are expected to be stabilising. (Working 1962) Speculative activities can act to drive price volatility and amplify price swings on commodity exchanges, only where rational market actors are performing in the context of distorted or incomplete information (Grossman and Stiglitz 1980; Stein 1987).

As a consequence of the classical view of stabilising speculation, much of the empirical work conducted around the operation of futures markets has been in the context of testing the Efficient Market Hypothesis (EMH). The general definition of an efficient market is one in which price always “fully reflect” available information (Fama 1970, p383). The liquidity provided by speculators on futures markets, according to classical theories of speculation greatly enhances the efficiency of these

deficiency of another is owing to farmers who withhold corn from the market, or to dealers who buy it when at the cheapest and lay it up in store.” (Mill 1848, bk 4 ch.2 section 4)

⁶ Such that they trade at prices that deviate wildly from those warranted by market conditions

⁷ For Knight (1933), risk referred to situations where outcomes are randomly generated by stochastic processes that are on average knowable. In this way, probability distributions can be assigned to risky situations. Uncertainty, on the other hand, cannot be anticipated in terms of mathematical probabilities. Subsequent schools of thought in economics have tended to align themselves through emphasising one, or the other conceptions of risk and uncertainty.

markets. Rather than a theory proper, the EMH consists of a number of testable hypotheses (Fama 1970;1998). What is implicit is a theory of price determination⁸ as well as the assumption that derivatives markets function to complete markets in the Arrow-Debreu sense (Arrow and Debreu 1954). In this way, the relationship between futures and physical markets are assumed away as if there is a seamless interface between the two.

2.2 Destabilising speculation

While speculative activities are not conditional on the existence of futures markets⁹, their development has facilitated an enormous growth in speculative activities on commodity markets by making it possible for speculation without the speculator having to deal in the physical commodity. It may be expected, owing to the ease of futures trading, that waves of speculative activity can influence the price levels and price movements of commodities. Whether or not speculative trading on futures markets can influence price such that they deviate from market fundamentals (supply and demand) for any length of time has been the subject of much debate (refs.).

One of the earliest theoretical challenges against the classical theory of speculation came from Irwin (1937), who argued that, contrary to the classical proposition, speculators can in fact gain from trading activities that drive prices away from that which is warranted by physical markets conditions. With the simplest example of the movement or noise trader, profits need not be made by making the *correct* predictions of the market as determined by market fundamentals but “the inertia or momentum in the price movements which arises mainly from the large number of traders operating in these markets” (Irwin 1937, p.270 as quoted in Goss and Yamey 1978, p.35). Speculators can, therefore, profit by riding out price trends, the skill being in getting off before the market turns, rather than the correct price predictions made on the basis of physical market conditions.

⁸ Mainstream commodity market theory refers to the “theory of intertemporal price formation on speculative markets” Ghosh, S, C.L Gilbert, and A.J Hughes Hallet. 1987. *Stabilizing Speculative Commodity Markets*: Oxford University Press..⁸ The theory focuses on the intertemporal relationships between quantity, and consequently price. As well as the relationships between market demand (for consumption) and supply, stock may be demanded for transactions; precautionary or speculative purposes. Taken together, these relationships define an intertemporal stock equilibrium. Movements in stockholding imply movements in prices. Prices are however, ultimately determined through the mechanisms of supply and demand. Market structure is understood as the relationship between the forces of supply and demand. On these basic tenets, econometric models of commodity markets are generally constructed to consist of a “demand block”, a “supply block”, together with an equation relating stocks and prices over time (Labys 1978; Akiyama & Duncan 1982; Adams & Klein 1982)

⁹ Outside of futures markets, speculation in commodities can take the form of stockholding or forward sales in the face of future price uncertainty

Post Keynesians have criticised the focus of neoclassical economics on risk and argue that uncertainty is most relevant when considering economic decision making. (Davidson 1991; Shackle 1979) In the context of a fundamentally uncertain world, Keynes argued that, “the market will be subject to waves of optimistic and pessimistic sentiment, which are unreasoning and yet in a sense legitimate” (Keynes 1997, p154). In this way, speculative activities have potentially destabilising affects on the economy.

As in the case of different types of hedging, there is no reason to assume that all speculators behave in the same way on futures markets. It has also been argued that particular techniques employed by the speculator in his trading activities can have destabilising affects. As early as 1937, Irwin argued that “much of the trading activity of *professional* speculators on commodity and stock exchanges did not correspond with the activities subsumed in the classical theory; and that this type of trading, called movement trading, was destabilizing” (Goss and Yamey 1978, p.34). More recently, MacKenzie (2005) takes this argument further by stressing that derivatives markets themselves are social constructs, and as such will embody, and display the vested interest of their participants, who are far from uniform in terms of their motivations, market power and behaviour. Moreover, the widespread adoption of particular technical apparatus in the formation of price expectations that inform trading decisions can in turn determine market outcomes. In illustrating the performativity of economics in the context of options pricing, MacKenzie shows how socio-historical factors led to the adoption of Black’s Sheets by options traders, that embodied the predictions of the Black-Scholes-Merton (BSM) theory of options pricing, resulted in price behaviour on options markets that became more closely related to the predictions of the BSM model (Black and Scholes 1972; Merton 1973)

1.2. 2.3 Implications of destabilising speculation

The brief discussion above on the potential destabilising affects of speculative trading suggests that empirical research on the implications of financial investment on international commodity exchanges on price behaviour should not be limited to whether or not the EMH holds in the context of futures markets. First, the discussion suggests a need to examine more closely the relationship between futures prices and, so called fundamental market conditions rather than assume that the relationship is given by the co-movement of prices on futures and physicals markets. If futures markets indeed facilitate price discovery, then these efficient prices should reflect changes in the supply and demand of the physical commodity as implied by a theory of price determination. Second, given that speculators can profit from different types of trading, there is no reason to assume that all speculators behave in the same way given that the motivations behind their engagement on futures

markets can differ considerably. There may be periods where the dominant form of speculative activities act to drive prices away from that warranted by supply and demand conditions over long-periods of time (such as in the case of the long bull run in coffee prices that has occurred from 2002 until 2007). There may also occur, situations where a large and sudden influx of financial funds act to destabilise prices to the benefit of short-term financial interests that are trading on price volatility.

3. An investigation into the impact of financial investment on coffee exchange of the NYBOT and coffee price behavior

The structure of the international coffee system¹⁰ has evolved over the past two decades, together with the structure of trading activities on international commodity exchanges. Whilst futures markets were initially developed predominantly to allow the effective management of risks faced by physical traders, they have evolved to increasingly reflect the needs of financial investors operating entirely outside of the markets for physical commodities.

The share of derivatives trading taken up by financial investors has increased throughout the period after the end of the Bretton Woods system. Since 2000, there has been a further explosion in trading activities on commodities exchanges that was initially triggered by the Dot com crisis which saw a shift of funds from equities to commodities.¹¹ The value of outstanding OTC commodity derivatives in June 2007 was over 7.5 trillion US dollars, compared with 0.77 trillion in 2002 and 0.44 trillion in 1998. (Bank for International Settlements 2007) The growth in commodities has been sustained as new investors enter the markets, these include various institutional investors such as hedge funds and to lesser extent pension funds.¹²(Doyle, Hill, and Jack 2007) Unlike hedge funds, pension funds have relatively long investment periods, 30 years for example, and can help sustain the level of investment in these markets over time. There has also been a growth in investment on commodity markets that has resulted from the lowering of entry barriers for smaller hedge funds with the transition from open outcry to electronic trading platforms that have taken place in many of the major commodities exchanges. Retail investment is also set to rise with an increase in the number

¹⁰ The international coffee system describes the economic, political and institutional structures under which the activities between production and consumption of coffee take place. For a more detailed description of the structural changes that have taken place in the coffee system over the past three decades see (Ponte 2001; Daviron & Ponte 2006; Newman 2008).

¹¹ Commodities represent an attractive asset class for investors since commodity prices move in line with inflation, commodities act as an inflation hedge. More importantly, commodity prices display a negative correlation with the price of other financial instruments such as bonds and equities and therefore constitute a good asset class in terms of diversifying portfolios and risk reduction. It is therefore not surprising that commodity markets see increasing investment during periods of economic downturns.

¹² In their 2007 FSA study, Doyle, Hill and Jack, found that 75-80% of funds invested in the Goldman Sachs Commodity Index (GSCI) are from pension funds.

of tradable products, such as Exchange Traded Funds (ETFs), Exchange Traded notes (ETNs) and Exchange Traded Commodities (ETCs). (Doyle, Hill, and Jack 2007)

The coffee exchange of the NYBOT has not escaped the rise of financial investment. It is possible to track this increase in futures trading attributed to market participants who are not involved in the handling of physical coffee since the NYBOT divides all trading members into two categories, commercial and non-commercial traders. Commercial traders are defined as entities that are trading on the exchange who are also engaged in physical commodity trade, these will include the large international commodity trading houses. All other exchange trading members are classified as non-commercial. In spite of the difficulties in separating speculative and hedging activities based upon the NYBOT categories, we can use this distinction in calculating a lower limit for speculative activity as a ratio of total trading activities using the ratio of NPCT open interest to total open interest. Figure 1. illustrates the evolution of the proportion of total futures trading made up by non-commercial (financial) actors on the coffee exchange of the New York Board of Trade (NYBOT) between 1986 and 2007. For coffee futures, the proportion of total trading activities made up by non-commercial actors has been both volatile and increasing on average from between 10 and 30% of total open interest on the NY exchange in the 1980s to a ratio that varies between 40 and 70% in the 2000s.

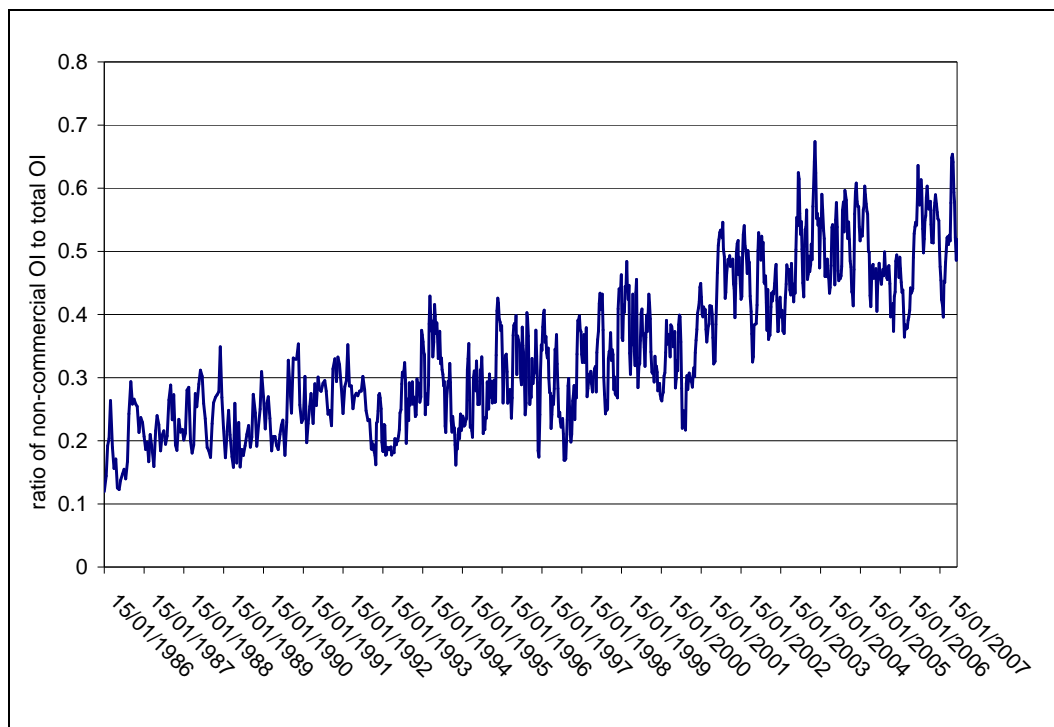


Figure 1. Ratio of non-commercial open interest to total open interest in coffee C contracts on the New York Coffee Exchange.

At the same time as these dramatic increases in the proportion of financial activities on the futures market, the liberalisation of producer country marketing systems has resulted in New York coffee futures price gaining considerably in its importance in terms of informing the pricing decision of market actors engaged in the exchange of Arabica coffee. Of the various market actors in the physical market system, it is the international coffee traders and roasters that make up the vast majority of hedgers on the futures market. Results from interviews of stakeholders in coffee chains, conducted throughout 2007, indicate that for international coffee traders, the New York futures price is the single most important piece of price information used in pricing decisions for the bulk of coffee trade in arabicas, whilst the London futures price is relied upon for trade in robustas. The wide use of “price to be fixed contracts” by international traders and roasters has cemented the relationship between futures prices and the price at which physical coffee is exchanged at the international trader level.¹³ Given the structure of the international coffee system, which is highly concentrated at the international trader level¹⁴, prices on physical markets have become increasingly tied to those which occur on the futures exchange (Newman 2008).

In the remainder of this section, we present the results of two quantitative investigations into the role of financial investment in driving price movements on the coffee exchange of the NYBOT.

3.1 Supply and Demand vs. Trader Composition

In this section, we examine whether increases in the volume of financial flows onto the New York coffee exchange has led to a loosening of the relationship between on-exchange prices and actual physical supply and demand for Arabica coffee. Structural break tests are applied to series that describe:

- i) the evolution of the total annual volume of trade in futures contracts on the New York Coffee exchange to identify sudden increases in the volume of futures trading;
- ii) the fraction of non-commercial futures open interest to total open interest for each year to see whether jumps in the volume of futures trading can be attributed to market participants who are not hedging against physical trades; and
- iii) the relationship between coffee prices and world supply & demand

¹³ A price to be fixed contract refers to a contractual arrangement whereby the volume, delivery date and differential price are specified but the final price at which the commodity is exchanged will depend upon the futures price on the date at which the price is fixed, up to the delivery date.

¹⁴ In 2006, the top 5 trading companies accounted for a market share of over 55%. (Newman 2008).

In this paper we use the Bai-Perron (2003) method to test for multiple structural breaks in a linear model estimated by least-squares. Bai and Perron (1998b) present a number of alternative tests to determine the break dates: “a sup-Wald type tests for the null hypothesis of no change versus an alternative hypothesis containing an arbitrary number of changes and a procedure that allows one to test the null hypothesis of, say, ℓ changes, versus the alternative of $\ell + 1$ changes.¹⁵ The latter is particularly useful in that it allows a specific to general modelling strategy to consistently determine the appropriate number of changes present.” (Bai and Perron 1998a) The Bai and Perron method can be applied to pure and partial structural change models. The data and errors can be allowed to have different distributions across segments, alternatively a common structure can be imposed across the data over the entire time period in testing for a partial structural change. In order to estimate the number of breaks present in the data, Bai and Perron discuss methods based on information criteria as well as a method based on a sequential testing procedure.¹⁶ Here Bayesian Information Criterion (BIC) are used to determine the number of breaks contained in the data.¹⁷

Structural break tests on the volume of trading in coffee C contract on the New York Coffee Exchange (1973-2006).

Before testing for a structural break in the evolution of the annual data on the total volume of trading for coffee C contracts (ATV), the time series properties of the series must first be analysed in order to establish how best to model the series. The graph in figure 2 clearly shows that the series is not stationary. From first inspection, the series appears to be increasing at an accelerating rate over time, suggesting that the underlying data generation process is an autoregressive process of order one (eq. 1)

$$ATV_t = \beta ATV_{t-1} + \rho_t \quad (1)$$

where ρ is a white noise error term.

In reality, there may be both a deterministic and a stochastic time trend. Harvey (1997) argues that models with deterministic trends are a limiting case with stochastic trends where the hyper-parameters (which allow for the level and slope of the trend to change) are equal to zero and therefore suggests that time series are best modelled as autoregressive processes. There is, however, an

¹⁵ The test procedures are (i) a sup F type test of no structural break versus the alternative hypothesis that there are a fixed number of breaks, (ii) a double maximum test, two tests of the null hypothesis of no structural break against an unknown number of breaks given by some upper bound, (iii) A test of ℓ versus $\ell + 1$ breaks. This method amounts to the application of $\ell + 1$ tests of the null hypothesis of no structural change versus the alternative of a single change ($\text{Sup } F_T(\ell + 1|\ell)$)

¹⁶ The method is based on the sequential application of the $\text{Sup } F_T(\ell + 1|\ell)$.

¹⁷ The test procedures have been implemented using the RATS code MULTIPLEBREAKS.SRC written by Tom Doan (2005) that is available on the Estima website (<http://www.estima.com/Stability.shtml>). The RATS procedure does not give the F-test results and BIC are used to estimate the number of structural breaks.

argument for using the model specifications with a deterministic trend since a “non-linear curve can be seen as a number of straight lines, with varying slopes, if there are stochastic trends, that would be reflected in a large number of structural breaks in a linear trend” (Rao and Rao 2007, p6). We, therefore, test for structural breaks on the basis of the AR(1) specification shown in eq 1 as well as a more general model that includes a time trend (eq. 2)

$$ATV_t = \alpha_0 + \alpha_1 ATV_{t-1} + \gamma + \delta_t \quad (2)$$

where δ_t is a white noise error term.

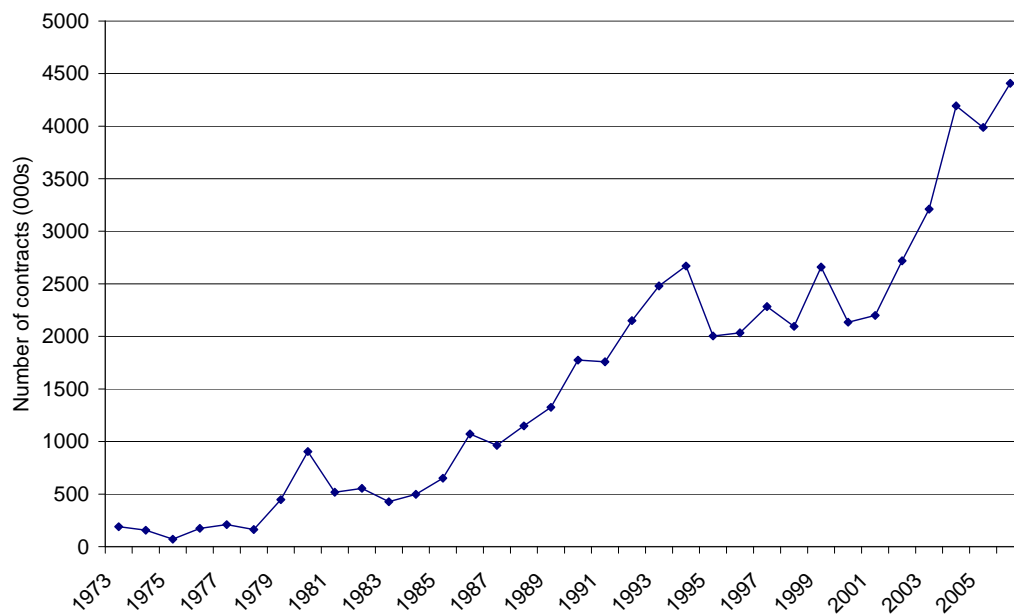


Figure 2. Total traded volumes of coffee C contracts on NYBOT per year (Data Source: NYBOT 2007)

Variable	Estimated coefficient	p-value
Constant	81945.998636	0.40912633
ATV_{t-1}	1.030368	0.00000000

R-squared = 0.974264

R bar-squared = 0.924633

Table 1. Estimation results for $ATV_t = \beta ATV_{t-1} + \rho_t$ (1973-2006)

<i>Variable</i>	<i>Estimated coefficient</i>	<i>p-value</i>
Constant	-163955.7050	0.24219607
ATV _{t-1}	0.7049	0.00003242
T	40963.0360	0.02319624

R-squared = 0.978388

R bar-squared = 0.934600

Table 2. Estimation results for $ATV_t = \alpha_0 + \alpha_1 ATV_{t-1} + \gamma + \delta_t$ (1973-2006)

Tables 1 and 2 show the results from Bai Perron tests for multiple structural breaks applied to the AR(1) and AR(1) with a time trend specifications of ATV. The maximum number of allowed breaks was set to three to allow for sufficient observations between regime changes. In both specifications, the Bayesian Information Criteria select a single break, with a break date of 2001 for the AR(1) model and 1999 for the model including a time trend. These break points coincide with an influx of funds on commodity markets associated with the dot-com bubble burst at the end of the 1990s when investors suffered poor returns from both equity and bond markets (Doyle, Hill, and Jack 2007).¹⁸ The break identified at the date 1994 for both of the model specifications does not coincide with dramatic events in the physical coffee market but are coincidental with shifts in the volume of financial activities on commodities exchanges. In 1993-4 hedge funds allocated a small portion of their funds to commodities which, owing to the large size of hedge funds, amounted to a sizeable influx of money for the commodity markets (World Bank 1997). From his study of cocoa markets, Gilbert(1994) concludes that the rise in cocoa prices during 1993-94 was due to fund investment. The recent great Bull Run on commodities markets began in 2002 and has been sustained into 2008. This has seen growth in existing commodity index funds as well as the launch of a number of large index funds in 2003, including the Deutsche Bank Liquid Commodity Index.

For the AR(1) model including a time trend, an additional break date, which is absent from the AR(1) model, at 1980 is found. The year 1980 precedes a period of high coffee prices that resulted from a severe frost in Brazil in July 1981.

One of the reasons why the breaks identified in the data differ between the two specifications is due to the difference in the specifications of the trend term. While the AR(1) specification shows up breaks in a stochastic trend, a deterministic trend is included in the second specification. It may be that once and for all changes in the behaviour of physical commodity traders on derivatives markets are affected by changes in physical market conditions such as a supply shock, while changes that

¹⁸ "In part investors were searching for yield, in part they were seeking an inflation hedge, but mainly they were looking to diversify equity- and bond-heavy portfolios" (Doyle, Hill !& Jack 2007, p16)

affect the behaviour of financial investors will reinforce stochastic trends since future behaviour depends more on the trader behaviour in past periods than on physical supply and demand.

	$ATV_t = ATV_{t-1} + v_t$	$ATV_t = \alpha_0 + \alpha_1 ATV_{t-1} + \gamma + \delta_t$
Best 3 break dates identified by Bai-Perron method	2001, 2004, 1994	1980, 1994, 2000
Number of breaks selected by BIC	1	1
Break Date	2001	1999

Table 3. Results from structural break tests on annual total trading volume on the coffee futures exchange of the NYBOT (unrestricted – both intercept and trend were allowed to vary)

Structural break tests on the annual ratio of non-commercial to total open interest for coffee C contracts (1986-2006).

Since this paper argues that it is a change in the type of trading activities on international commodity exchanges, as well as the over all volume that has led to changes in the behaviour of commodity prices it is necessary to examine the nature of the evolution of the composition of trading activities on these markets. This is done by studying the time series properties of the ratio of non-commercial to total open interest, aggregated over the period of one year (ANCOIR), data for which is available in the Commitment of Traders reports published by the U.S Commodity Futures Trading Commission (CFTC).¹⁹

As in the case for total annual traded volume, the series ANCOIR is modelled by an AR(1) and an AR(1) model including a time trend (see table 4. and table 5.).

¹⁹ All traders identified by the U.S CFTC is classified as either “commercial” or “non-commercial” or “non-commercial.” All of a trader’s reported futures positions in a commodity are classified as commercial if the trader uses futures contracts in that particular commodity for hedging as defined in [CFTC Regulation 1.3\(z\)](#), 17 CFR 1.3(z). A trading entity generally gets classified as a “commercial” trader by filing a statement with the Commission, on [CFTC Form 40](#): Statement of Reporting Trader, that it is commercially “...engaged in business activities hedged by the use of the futures or option markets.” (CFTC 2007)

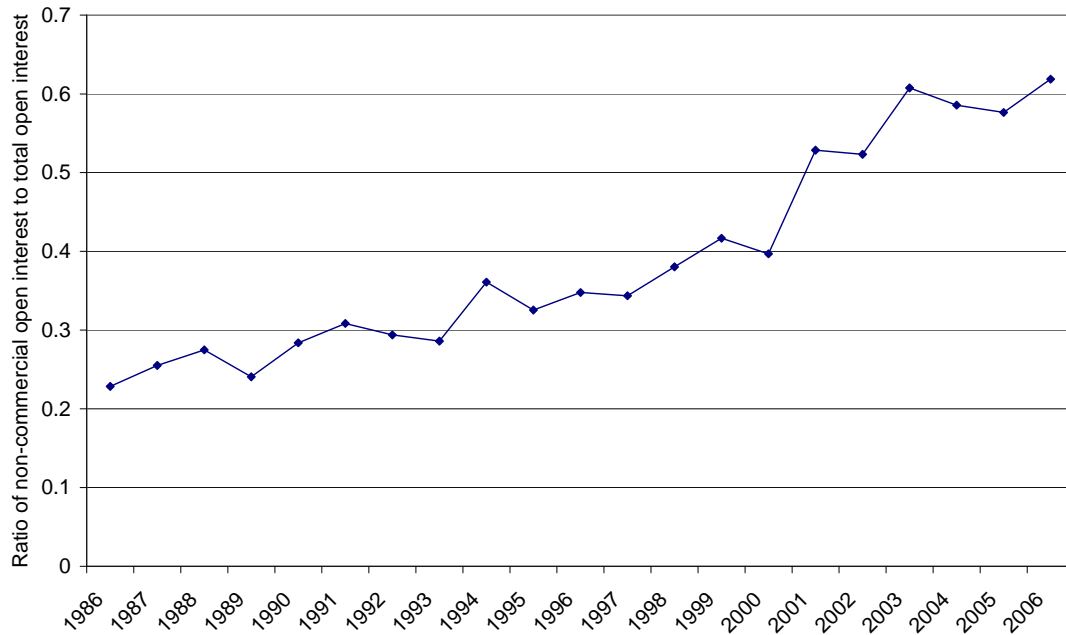


Figure 3. Ratio of non-commercial to total open interest for coffee C contracts 1986-2006 (Data Source: CFTC 2007)

<i>Variable</i>	<i>Estimated coefficient</i>	<i>p-value</i>
Constant	0.0241249612	0.47052084
ANCOIR _{t-1}	0.9878033977	0.00000000

R-squared = 0.990033

R bar-squared = 0.882110

Table 4. Estimation results for $ANCTOIR_t = \delta ANCTOIR_{t-1} + \sigma_t$

<i>Variable</i>	<i>Estimated coefficient</i>	<i>p-value</i>
Constant	0.0857198814	0.03667971
ANCOIR _{t-1}	0.4970132484	0.02906118
T	0.0107845222	0.02244070

R-squared = 0.992729

R bar-squared = 0.908944

Table 5. Estimation results for $ANCTOIR_t = \lambda_0 + \lambda_1 ANCTOIR_{t-1} + \eta t + \omega_t$

	$ANCOIR_t = \delta ANCOIR_{t-1} + \sigma_t$	$ANCOIR_t = \lambda_0 + \lambda_1 ANCOIR_{t-1} + \eta t + \omega_t$
Best 3 break dates identified by Bai-Perron method	2001, 1993, 2003	1984, 1987, 1990
Number if breaks selected by BIC	1	1
Break Date	2001	1990

Table 6. Results from structural break tests on the ratio of the annual non-commercial to total open interest on the coffee futures exchange of the NYBOT (unrestricted – both intercept and trend were allowed to vary)

Results from the structural break tests applied to the AR(1) and AR(1) with trend specifications for the series ANCOIR are shown in table 6.

A single break is selected by BIC for the case of the pure AR(1) model at 2001. The best three break points are in line with those identified by the Bai-Perron method for the AR(1) specification of ATV above. The break points found for the two models estimated for the series ANCOIR differ considerably. By contrast, the best break point identified in the AR(1) model with trend is at 1990, soon after the collapse of the International Coffee Agreement in 1989. Once again, the differences in the results from the two models can be attributed to the identification of breaks in a stochastic trend and a deterministic trend respectively. Comparing results from the AR(1) models for ANCOIR and ATV suggests that shifts in the volume of futures trading on the coffee exchange of the NYBOT can be attributed to financial investors such as hedge funds wishing to diversify from bonds and equities and commodity index funds.

Structural break tests on the relationship between coffee prices and world supply and demand (1978-2006)

Here, the Bai-Perron multiple structural break method is applied a model of coffee prices that depends upon physical supply and demand. The annual average ICO composite indicator price for green coffee is used as a measure for the world price for green coffee. Coffee prices (P) are modelled as a function of the stock level (TST), disappearance in member countries (MC), and consumption in producing countries (PC).^{20,21}

$$P = f\left(\frac{TST}{[MC + PC]}\right) \quad (3)$$

Following the coffee price model of Maizels, Bacon and Mavrotas (1997) the price model is specified in log linear form. Through successive estimation the functional form shown in eq. 4 was found to best fit the data.²²

$$LP = \alpha_0 + \alpha_1 LSTRT + \alpha_2 LP_{t-1} + \varepsilon \quad (4)$$

Where, LP is the log of world coffee price and $LSTRT$ is the log of ratio of producer stocks to world coffee production.²³ The results from the estimation of the price model in eq (4) over the entire time period and structural break analyses are shown in table 7 and table 8 respectively.

²⁰ Member countries refer to coffee producing and consuming countries that are members of the International Coffee Organisation (ICO). In 2006, the top 10 coffee consuming countries made up over 70% of the total market value. Of the top 10, only Russia (ranked 8th with 2.61% of total market value in 2006) is not a member of the ICO. Owing to the availability of data, only ICO member countries within the top 10 consuming countries are included in the model. Consumption from non-member countries is taken as exogenous.

²¹ Disappearance is used as a measure of consumption owing to the difficulties of measuring consumption directly. Disappearance is measured by deducting re-exports from imports and adjusting the resulting figure changes in visible inventories. (ICO 2003)

²² Only the central price equation of the Maizels, Bacon and Mavrotas model features in this paper. The entire coffee price model consists of over 50 separately estimated equations for supply in individual producing member countries, demand equations for individual consuming member countries as well as 3 separate price equations to link i) the retail price to world price (relating the nominal retail price to the world coffee price, the exchange rate against the dollar, and time trend); ii) the world price to producer price (relating the nominal retail price to world coffee price, the exchange rate and a time trend); and the world price to stock level (relating stock ratios on the supply side to stock levels on the demand side via the world price. Details on the estimation of this system of equations making up the coffee price model between 1982 and 2006 are available on request from the author.

²³ Testing for a structural break in this equation is equivalent to testing for a structural break in an equation for price determination that links the world price to the ratio of disappearance to consumer stocks.

<i>Variable</i>	<i>Estimated coefficient</i>	<i>p-value</i>
Constant	1.2716433856	0.00154120
LSTRT _t	0.9138159603	0.01662796
LP _{t-1}	0.5950293368	0.00001777

R-squared = 0.997879

R bar-squared = 0.690437

Table7. Estimation results for the coffee price model: $LP = \alpha_0 + \alpha_1 LSTRT + \alpha_2 LP_{t-1} + \varepsilon$

	$LP = \alpha_0 + \alpha_1 LSTRT + \alpha_2 LP_{t-1} + \varepsilon$
Best 3 break dates identified by Bai-Perron method	1994, 2000, 2004
Number if breaks selected by BIC	1
Break Date	1994
Intercepts	1.4332727529 (p-value 0.00163319) 1.5442321270 (p-value 0.03369707)
Coefficient on LSTRT	1.6469755916 (p-value 0.00248171) 1.3112557084* (p-value 0.10207228)
Coefficient on LP _{t-1}	0.6761458959 (p-value 0.00002563) 0.5857708346 (p-value 0.01673472)

* not significant at the 5% level

Table 8.

The best three break dates identified by the Bai-Perron method are close to those identified for the series ATV and ANCOIR, modelled as AR(1) processes, albeit in a different order of significance. Bayesian Information Criteria select a single break in the relationship between coffee prices, stocks and prices in the previous period in 1994. Estimates for the coefficients of the price model in the sub-periods 1978-1994 and 1994-2006 indicate a loosening in the relationship between price and stocks. In the earlier sub-period, the regression results suggest that, *ceteris paribus*, a 1.65% increase in the ratio of producer stocks to world coffee production is associated with a 1% increase in the world price

compared with a 1.31% increase in the ratio of producer stocks to world coffee production being associated with a 1% increase in the world price. The coefficient on LSTRT is less significant in the period 1994-2006 (p-value = 0.102) compared with the period 1978-1994 (p-value 0.002).

The structural break analysis presented in this section provides evidence for a break in, as well as a loosening of the relationship between coffee prices and physical supply & demand that coincides with a break in the data for futures trading volumes on NYBOT. Increased trading volumes for the coffee C contract can be attributed to increased participation by non-commercial traders such as hedge funds and commodity index funds.

3.2 Financial investment and short-term price movements

Following the method set out by Laby and Thomas (1975) we examine the simple correlation between financial investment in coffee futures and a computed instability index, or volatility index for the futures price. A monthly volatility index is calculated as the normalised standard deviation of daily closing futures prices within a trading month (equation 5)

$$VI = \left(\frac{100}{\bar{P}} \right) \sqrt{\left(\frac{\sum (P_t - \bar{P})^2}{n} \right)} \quad (5)$$

Where P_t is daily closing Coffee C futures price on NYBOT, and \bar{P} is the monthly average closing Coffee C futures price on NYBOT. Figure 4 shows the monthly volatility index from 1972 to 2006.

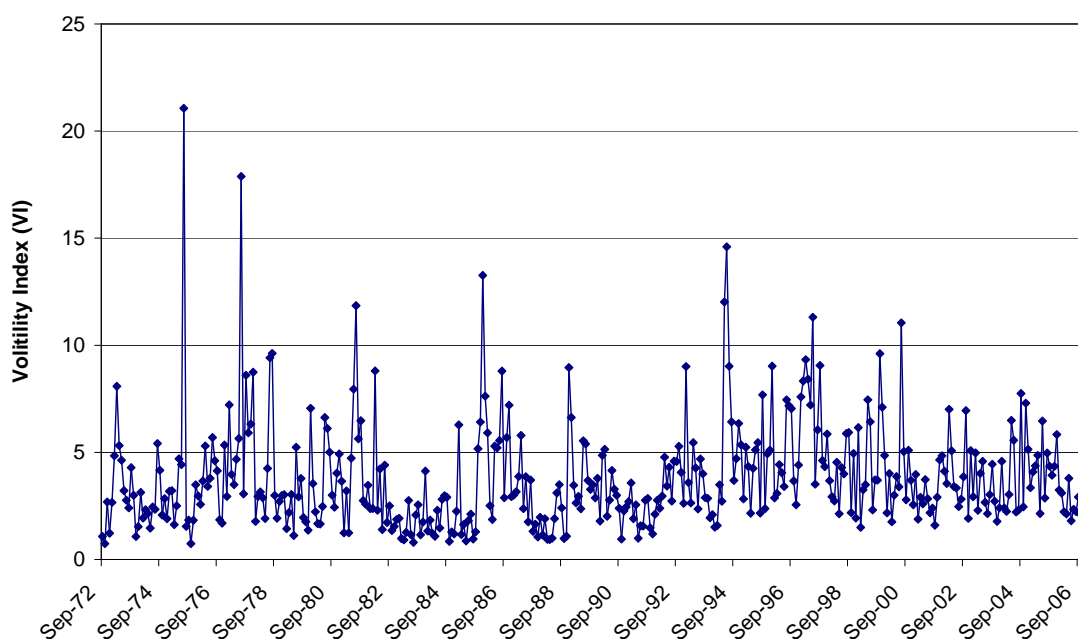


Figure 4.

As a measure of futures trading that is not for the purposes of hedging we construct a financial investment index (SPEC) as the natural logarithm of the ratio of the volume equivalent of coffee-C contracts traded and total exports of green coffee from ICO member countries.²⁴ The monthly Financial Investment Index for the period 1972-2006 is shown in figure 5.

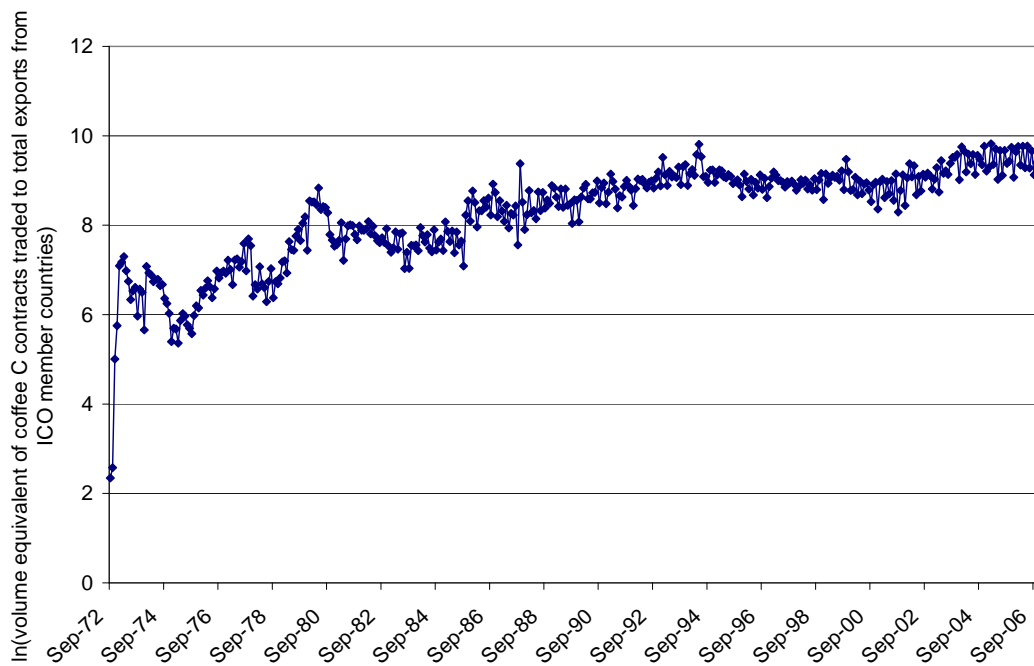


Figure 5. Natural logarithm of the ratio of monthly coffee volume equivalent of futures contracts traded on NYBOT to total exports from ICO member countries 1972-2006 (SPEC)
(Data Source: CFTC 2007; ICO 2007)

Equation 6 gives the linear specification for the relationship between the volatility index and the index of financial investment that is estimated by OLS.

$$VI_t = \beta_1 + \beta_2 SPEC_t + u_t \quad (6)$$

OLS estimation of the relationship between volatility and financial investment result in a positive and significant slope coefficient on the index of financial investment is significant (see table 9). This is

²⁴ Laby and Thomas (1975) discuss a number of possible quantitative measurements for speculative activities including a measure based upon the ratio of long and short positions in the market according to the specification by Working (1962) that the actual nature of market commitment is that hedging is normally net short and that speculation is net long. Another possible measure of speculative activities on futures markets can be constructed is the ratio of the volume of physical trade to the volume equivalent of futures contracts traded in a particular period.

indication of a positive statistical relationship between financial investment activities and price volatility on the New York coffee exchange.

<i>Variable</i>	<i>Estimated Coefficient</i>	<i>p-value</i>
Constant	-6.105975118	0.00035828
<i>SPEC</i>	1.134782785	0.00000001

R-squared = 0.759739

R bar-squared = 0.092990

Table 9. Estimation results for $VI_t = \beta_1 + \beta_2 SPEC_t + u_t$ for the period 1980:01 to 2006:12

To test for breaks in the relationship between the volatility and speculation indices, the Bai-Perron method, described in section 3.1, is applied. Table 10. summarises the results from the Bai-Perron tests. Bayesian Information Criteria select 1 structural break in October 2000. This coincides with the structural breaks identified in the data for futures trading activity and financial trading activities, attributed to the inflow of financial funds into commodity markets as a result of the Dot-com crash of 2000 in section five.

The correlation coefficient (ρ) between the volatility and financial investment indices are calculated and the simple linear regression model shown in eq. 6 are estimated for four different sub periods. The four sub periods are based upon the best two structural breaks identified, these are: 1980:01 to 1994:04, 1994:04 to 2000:10, 2000:10 to 2006:12 and 1994:04 to 2006:12. 1994:04 is included as a break date since it coincides with the entry by hedge funds onto commodity markets. The correlation coefficients differ for all four sub-periods and is at its highest, 0.46 (2dp), between 1994:04 and 2000:10. The estimated slope coefficients for regression model for each sub-period also differ. In the period 1980:01 to 1994:04, the slope coefficient is highly significant and suggests that an increase in the index of financial investment of one unit results in an increase in the volatility index of 0.84 units (2dp). By contrast, the slope coefficient estimated for the period 1994:4 to 2000:10 is 5.66 (2dp), with a p-value lower than that calculated for the estimated coefficient for the previous period. This result supports the argument that increasing financial activities on commodity exchanges associated with the massive inflow of funds from hedge funds in 1993/4 has lead to heightened price volatility on the coffee exchange of the NYBOT.

The estimated slope coefficient between 2000:10 and 2006:12 was found to be lower than the previous periods, 0.73 (2dp), and not statistically significant at the 10% level. This is somewhat of a surprise given that the year 2000 saw a sudden increase in financial investment on commodities

associated with the dot-com crisis, and has continued to increase over the remainder of the period. This apparent contradiction in the relationship between financial investment on commodity exchanges and volatility can be explained if we consider the type of participants in the market, their motivations for trading and consequently, the nature of the trading activities.

The structural break in the relationship between price volatility and financial investment on the NYBOT coffee exchange in 1994 is explained by the inflow of funds associated with the inclusion of commodities by a number of large hedge funds. While the term 'hedge fund' covers a diverse group of institutional investors, a distinguishing feature of hedge funds operating on commodities markets is in their ability to sell short that is to bet on falls in the market and profit from them. (Doyle, Hill, and Jack 2007) Hedge funds can thus profit from price volatility on commodities markets in a way that other financial investors cannot and provide commodity markets with a large proportion of the liquidity in them. An estimated 80% of funds in commodity markets are looking for higher-than-market-following returns (alpha) (Doyle, Hill, and Jack 2007). This alpha money is short-term and moves quickly into and out of the market. The volatility of fund in- and out-flows has implications on short-term price movements on commodity exchanges where large flows can rapidly drive prices away from the price warranted by world supply and demand.

The motivations of financial investors entering commodities markets in 2000 were very different from the inflows of money due to hedge funds in the 1990s. The burst of the dot-com bubble saw a dramatic fall in the returns from both equity and bond markets. In addition, commodities had been in a bear market for around 25 years preceding the dot-com crash, with prices at their all time low. Falling returns on equity and bond markets, together with the anticipation of inflation led investors to seek out alternative investment vehicles. The character of commodity markets (with prices that move in the opposite direction to equities and bonds and in line with inflation) led to an inflow of funds seeking an inflation hedge and looking to diversify their bond and equity heavy portfolios. The period since 2000 has thus been accompanied by greater variety in the types of financial investors and investment strategies in commodity markets (Domanski and Heath 2007). In particular, passively managed investment and portfolio products have been growing. These investments often pursue a fully collateralised long futures strategy which is attractive to institutional investors with a longer-term horizon such as pension funds. (Domanski and Heath 2007) Rather than trading on volatility, this group of investors profit from long-run price increases. It is therefore, not surprising that the slope coefficient for the regression equation (6) estimated for the period 2001:10 to 2006:12 is insignificant and smaller than that estimated for previous periods. Rather than enhanced price volatility, the period between 2001 and 2006 has seen an upturn in commodity prices that has been largely driven by financial investors with longer-term horizons as described in the previous section.

	$VI_t = \beta_1 + \beta_2 SPEC_t + u_t$ (1980:01 to 2006:12)	BIC
Best 5 break dates identified by Bai-Perron method	1981:03, 1981:09, 1987:06, 1994:04, 2000:10	1.33945
Best 4 break dates identified by Bai-Perron method	1980:05, 1986:11, 1994:04, 2000:10	1.37260
Best 3 break dates identified by Bai-Perron method	1987:06, 1994:04, 2000:10	1.38572
Best 2 break dates identified by Bai-Perron method	1994:04, 2000:10	1.44880
Best break date identified by Bai-Perron method	2000:10	1.53878
Number if breaks selected by BIC	1	
Break Date	2000:10	

Table 10. Summary of results from Bai-Perron tests of multiple breaks in the relationship between financial investment and price volatility

Variable	Estimated coefficient	p-value
1980:01 to 1994:04, R-squared = 0.718231, R bar-squared = 0.048808, $\rho = 0.233176$		
Constant	-3.773838265	0.09257627
SPEC	0.836345100	0.00208172
1994:04 to 2000:10, R-squared = 0.839774, R bar-squared = 0.203926, $\rho = 0.462745$		
Constant	-45.75715604	0.00009639
SPEC	5.66135965	0.00001756
2000:10 to 2006:12, R-squared = 0.861727, R bar-squared = 0.019330, $\rho = 0.163134$		
Constant	-3.171043700	0.46426916
SPEC	0.731497994	0.12120941
1994:04 to 2006:12, R-squared = 0.790368, R bar-squared = 0.007724, $\rho = 0.180504$		
Constant	-3.407337938	0.51972349
SPEC	0.855760676	0.14160197

Table 11. Estimation results for $VI_t = \beta_1 + \beta_2 SPEC_t + u_t$ for the 4 sub-periods between 1980:01 to 2006:12

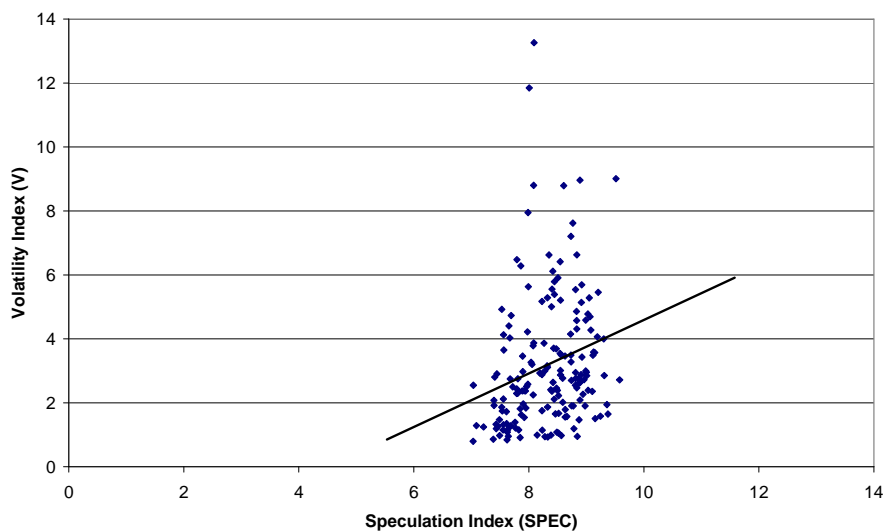


Figure 6. Volatility Index Vs. Index of financial investment 1980:01 to 1994:04

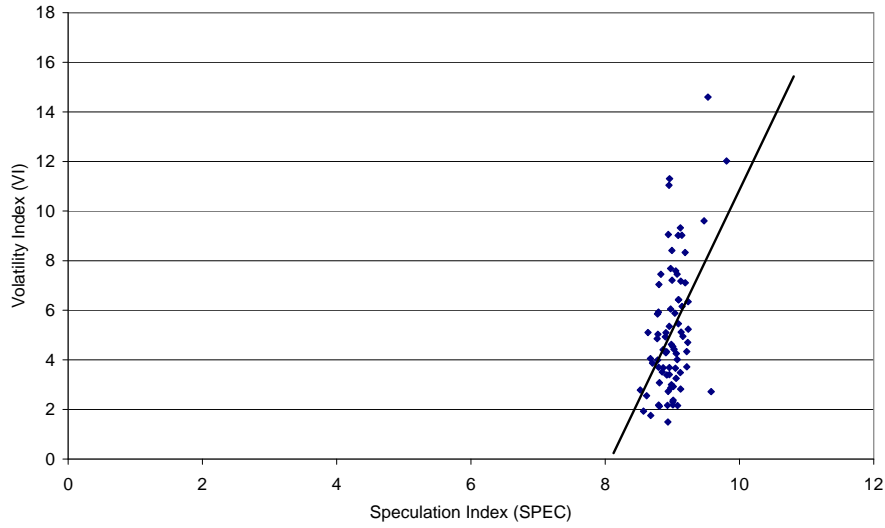


Figure 7. Volatility Index Vs. Index of financial investment 1994:04 to 2000:10

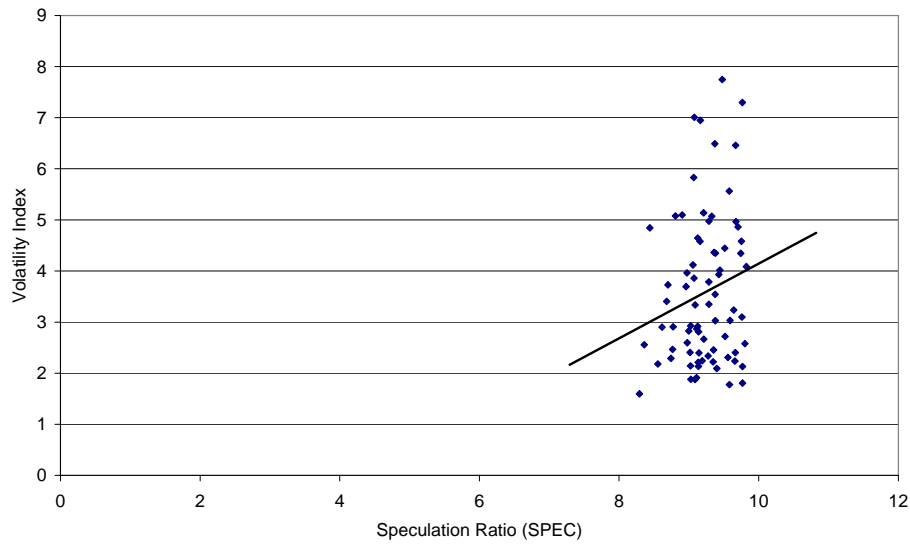


Figure 8. Volatility Index Vs. Index of financial investment 2000:10 to 2006:12

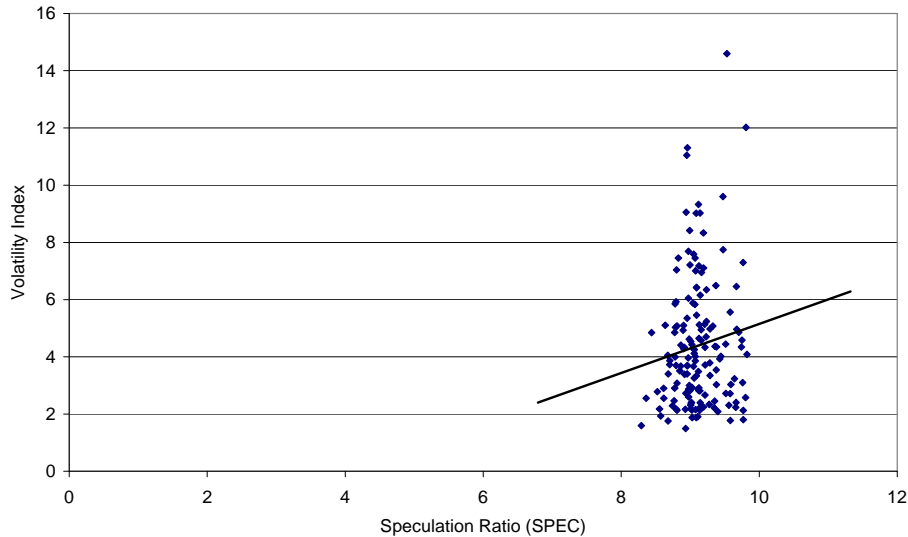


Figure 9. Volatility Index Vs. Index of financial investment 1994:04 to 2006:12

4 Conclusion

The results from the quantitative analysis presented in section 3 suggest that the behaviour of prices for coffee has been affected by the extent, as well as the type, of financial investment that has taken place on the coffee exchange of the NYBOT. Since the 1990s, financial investors have based their trading decisions on coffee futures markets in terms of a diversified portfolio of investments that aim to balance risks against returns, rather than trading on the basis of supply and demand conditions in the physical market. The flow of funds onto the NYBOT has occurred in relation to the wider economic environment, such as the down-turn in the price of equities associated with the dot-com crash in 2000, rather than the market conditions of the commodity in question. A similar inflow of funds onto commodity markets has taken place since the sub-prime crisis and resulting credit crunch that began to emerge in the latter half of 2007. Commodity prices have continued to increase across the board. While in some cases, price increases can be attributed to increasing demand, such as for metals and minerals, or grains, there are a number of commodities (such as coffee) that are likely to be carried along with the current commodity boom owing to financial interests on international exchanges.

Whether or not specific bouts of financial activities on commodity markets can occur to the benefit of physical market actors will depend firstly, on the affect on price outcomes that fund inflows have. It has been suggested in this paper that, depending on the type of financial investment, whether gains are made from longer term price trends or short-run volatility, price outcomes will differ. Second, depending on the type of price outcome, whether or not physical market actors can benefit

will depend upon the structure of the market, and the extent to which different market actors can deal with the risks associated with price volatility. Newman (2008) shows how heterogeneous market actors in Tanzanian and Ugandan coffee chains differ in their ability to harness rewards associated with price volatility. As hedging instruments, futures contracts are inherently biased against producers and local exporters since they are unable to benefit from forms of speculative hedging open to short-hedgers such as international trading companies.

In terms of policy conclusions, this paper suggests that, coffee price stabilization may be desirable in the context where producers and local exporters do not have easy access to hedging instruments. Multilateral price stabilization schemes along the lines of the International Commodity Agreements (ICAs) are neither economically, nor politically feasible today (Gilbert 1996; Newbery and Stiglitz 1981). Moreover, the buffer stock and quota schemes of the ICAs do not address the causes of price volatility that originate outside of the physical markets. In order to anchor prices that evolve on the international commodity exchanges to supply and demand conditions, it may be prudent to fix an upper limit to the proportion of futures trading conducted by non-commercial actors. The suitable size of such a cap will depend upon the market in question and the types of financial activities that take place on it.²⁵

²⁵ For example, it may be expected that cotton prices were less sensitive than coffee to financial investment on the associated cotton exchange of the NYBOT since the cotton price control of the US-Farm Scheme can act as a price anchor. Having said this, cotton prices experienced historical highs in March 2008. The causes of this recent price trend need further investigation.

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