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# Developed Speculation and Under Developed Markets – The Role of Futures Trading on Export Prices in Less Developed Countries

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# Developed Speculation and Under Developed Markets – The Role of Futures Trading on Export Prices in Less Developed Countries

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## Abstract

*This paper examines the relationship between New York coffee futures and cash export prices in Guatemala and Honduras. Cointegration tests suggest that the futures market is serving its price discovery function, and provides a vehicle by which to manage the domestic price risk in export countries. However, further analysis finds that as the percent of speculative open interest increases in the coffee futures market, price volatility increases. This suggests that cash market price risk in exporting countries may actually increase as a result of futures trading activity in developed country futures exchanges.*



## Key Words

Speculation, futures markets, coffee, Less-Developed Countries, hedging


## 1. Introduction

Coffee exporting countries are currently in a state of crisis. In February 2002 world coffee prices were at their lowest levels since the 1930's, matching the great hog price rout of 1998. One difference, however, is that hog prices rebounded quickly, while coffee prices have remained near lows (Figure 1). In addition, price risk for coffee appears greater in the smaller export countries than in the overall sector (Figure 2).

Historically low coffee prices coupled with substantial price volatility puts less developed countries (LDCs) relying on coffee exports at risk. The potential effects of not developing an effective price risk management program can be devastating. However, selecting among various risk management strategies can be challenging. The impacts of alternative risk management strategies have been debated for decades, and conclusions have often turned on researchers' initial assumptions as to the primary objective of in-country LDC policy makers. Until the mid 1980's the focus tended to be on various supply management schemes for addressing price risk issues for LDCs. Measures of producer and consumer welfare effects from these programs varied depending on overall policy objectives. For example, in 1969 Massell assumed that the policy objective of LDCs was to completely stabilize prices, and that this could be achieved through the public management of stocks. He concluded that a complete price stabilization policy would result in a gain to producers, but a loss to consumers.

In 1981 Newberry and Stiglitz argued that complete stabilization was not feasible, and examined the impacts of reducing, but not eliminating, price volatility for export commodities. They concluded that reducing price volatility also reduces producer incomes, while leaving consumers relatively unaffected. The policy makers' challenge was to determine whether lower producer incomes justified the overall reduction in price risk. In other words, did the benefits of reduced price dispersion more than offset the costs of lower producer incomes?

By the mid 1980's, attention began to focus on alternative ways to manage export price risk. In 1985 Gemmill compared the relative costs and benefits of managing buffer stocks with the direct use of forward contract arrangements by individual producers. Gemmill's work is of particular interest because it looked at individual contract arrangements as an alternative to more common supply management schemes, and because coffee was one of the commodities studied. He estimated both country-by-country and total world costs and benefits associated with managing international buffer stocks. Based on earlier work by Nguyen (1980), Gemmill estimated baseline costs associated with maintaining a buffer stocks program. He then compared the results to the individual country and total market costs and benefits associated with individual producer forward pricing. The forward pricing "rule" (i.e., the amount of production priced in the forward market) was estimated in a mean/variance type model where an individual country's export income variance was minimized given target levels of income.

The research results varied across both commodities and countries. In the case of coffee, Gemmill found that at the world level the total costs of maintaining a buffer stocks program was significantly higher than the benefits accrued. Thus, he found forward trading to be a more cost-effective risk management strategy. However, for three of the six coffee exporting countries examined forward contracting by domestic producers did not achieve as high a benefit-risk ratio as could be achieved with a local buffer stocks program. He found forward contracting was more cost effective, but also resulted in less total risk reduction.

Over the past several years LDCs appear to be moving away from supply management schemes and in the direction of market based solutions for managing price risk. Morgan, Rayner, and Vaillant (1999) note that LDCs have enacted policy reforms that increase the attractiveness of forward contracts as a risk management strategy. Recent international agreements liberalizing trade make supply control policies unacceptable mechanisms, and market based strategies for risk reduction, including forward contracting and hedging in futures markets, are being increasingly considered as alternatives.

## 2. LDC use of Futures Markets

According to Morgan et. al, an important decision in LDC use of futures markets is determining whether LDCs should hedge in markets already in existence in developed countries, or develop domestic futures markets. They argue this decision turns on whether it is more cost-effective to use an established market and attempt to manage not only the price risk of the export commodity, but also the exchange rate risk between the developed country and the LDC, or whether the substantial costs associated with developing both the physical infrastructure and the regulatory and trading environment necessary to launch a successful exchange should be incurred in order to develop trade in futures contracts priced in the export country's home currency.[1,2]

Gemmill's 1985 research assumed that forward contracts were available and accessible to LDC producers. To the extent forward contracts are available to LDC producers for the commodities he studied (sugar, coca, and coffee), they likely exist only because futures contracts for those commodities exist. However, the futures contracts trade in developed countries, and are not priced in producers' domestic currencies. If forward contracts are actively offered to LDC producers, the contractor is promising to pay a specific price on a future date in local currency, and likely hedging the associated price risk in another currency.[3] In the case of many coffee-producing markets, the exchange rate risk cannot be hedged directly. Thus, the strategy suggested by Morgan et al. of hedging both the commodity price risk and the exchange rate risk directly is not

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[1] The potential success of a locally developed exchange will also depend on the market's ability to deliver sufficient volume to insure liquidity.

[2] As noted by an anonymous reviewer, some futures exchanges outside the United States (US) trade commodities priced in US dollars, and thus any exchange rate risks faced by traders in these markets is no different than if they traded the same commodity on a US futures exchange. There are also several examples of non-US exchanges pricing futures contracts for various commodities in local currency. Examples include maize traded in South African dollars on the SAFEX, feeder cattle traded in reais on the Brazilian Mercantile and Futures Exchange, canola traded in Canadian dollars on the Winnipeg futures exchange, and soybeans traded in yen on the Tokyo Grain Exchange. The paper by Morgan et. al implicitly assumed that any futures exchanges developed in LDCs would price contracts in local currency.

[3] For a complete discussion of simultaneously hedge commodity price, exchange rate, and export freight rate risk, see Haigh and Holt (2002).

available. This might represent the most appealing case for developing a local futures market. If exchange rate risk cannot be managed using market tools, it is likely that either there will not be a sizeable offering of forward price contracts, or the contract prices will be discounted to compensate for not only the straight basis risk, but also the exchange rate risk.[4] To the extent that that the decision criteria surrounding the development of a local futures market is a comparison of the costs of infrastructure development with the costs of exchange rate risk exposure, it would seem cases where exchange rate risk cannot be directly hedged would represent the most likely scenario favoring local exchange development.[5]

Perhaps, however, reasons exist for LDC exchange development even when the costs of exchange rate risk do not exceed the costs of local futures exchange development. The implicit assumption of both Gemmill and Morgan et. al is that price transmission between the futures contract in a developed country's futures market and cash prices in a LDC market is efficient. Thus, the only reason to develop a domestic futures exchange in a LDC is to eliminate the exchange rate risk between futures and cash markets. Some work, for example Bessler and Covey (1991),[6] have questioned efficient price transmission between futures and cash markets even in developed countries where both markets are traded in the same currency. If cash and futures

[4] By straight basis risk, we mean the possibility that the difference between two prices (say corn at the Chicago Board of Trade and cash corn prices in Iowa) may change in unanticipated ways. This is the usual risk taken on by any hedger in return for eliminating risks associated with changes in general price levels.

[5] Exporters would still be exposed to, and need to deal with exchange rate risk, but a futures contract priced in local currency could provide more useful forward pricing opportunities for producers and smaller intermediate marketers whose cash transactions are in local currency. If forward pricing arrangements are to be used to manage income stability (the objective addressed by Gimmel and Morgan et. al) then market agents must have access to either futures or forward cash markets.

[6] Bessler and Covey employed bivariate cointegration models to test for efficiency. A later paper by Zapata and Fortenbery (1996) showed that rejection of bivariate cointegration might not justify a conclusion that two markets are inefficient in their exchange of information.

markets in developed countries are not always efficiently linked, it is not reasonable to assume futures prices in developed countries and cash markets in LDCs always efficiently interact.

Further, even if the futures markets in developed countries and LDC cash markets are linked, it still seems possible that the existence of the developed countries' futures contract may not improve price performance in the LDC. In 1993, Witherspoon suggested that it was possible to have excessive speculation in a futures market, and in such a case the cash market might be destabilized by futures market price action. If this occurs, hedging in the futures market may only reduce the price risk resulting directly from futures market activity, and not reduce the overall price risk inherent in a commodity's cash market fundamentals. If Witherspoon is right, the problem might be greatest in contracts like coffee, cocoa and sugar that tend to be relatively thin, and that have experienced a significant increase in the ratio of speculative to hedging activity in recent years (figure 3).[7]

If futures markets in developed countries and cash markets in LDCs are not efficiently sharing information, or if speculative activity in developed countries' futures markets is increasing overall market price volatility, incentives may exist to develop

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[7] Figure 3 actually understates the percentage of speculative activity. The Commodity Futures Trading Commission divides futures traders into commercial and non-commercial traders. All non-commercial traders are by definition speculators: they have no commercial interest in the cash markets. However, while all commercial traders have commercial interests in cash markets, it is not always the case that their positions are direct hedges of those cash positions. Once designated a commercial trader, all trades are reported as commercial open interest even if a firm engages in a purely speculative trade. The ratio in Figure 3 also only accounts for activity by large, reportable traders. To assume the ratio accurately represents the market as a whole implies assuming the ratio of speculative to hedged positions among the small, non-reporting traders mirrors that among the reporting traders.

domestic futures markets regardless of exchange rate risk levels.[8] A lack of efficient price transmission between the developed market and the LDC market implies the basis risk associated with hedging in a developed country's market could still be unacceptable even if the source of the basis risk is not volatile exchange rates. Further, if the level of speculative activity is increasing overall price volatility in the developed country's futures market, and that volatility is being passed back to the LDC cash market, the LDC may have an incentive to develop a local futures contract for both domestic price discovery and as a vehicle from which to offer local forward cash contracts.[9]

Historically we have not thought much about the impact of speculative behavior on price action. In fact, until a decade or so ago, it was simply assumed that the more traders in the market, the more efficient the market was at discovering price, regardless of the relative composition of speculators to hedgers. However, the coffee market (like cocoa and sugar) is unique in that U.S. commercial traders have become both increasingly concentrated and more vertically integrated, potentially reducing their need for price risk management. This may have resulted in LDCs representing a larger portion of the commercial volume, with total commercial activity falling as a percent of total market activity.

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[8] In the case of Honduras, for example, the standard deviation of the month-to-month rate of change in the exchange rate is 6.24 percent. Note from figure 2 that this represents significantly less than half of the total cash price volatility for coffee. Further, if the exchange rate risk were eliminated from the export coffee price, cash volatility would be about equal to futures price volatility. If futures price volatility is increased as a result of speculative futures activity, the cash price volatility may be as well.

[9] In-country futures markets may increase market access and opportunities for local producers and merchandisers in several ways. One, having contracts designed with delivery specifications more closely linked to the way cash market transactions take place in the local market could increase the value to local producers of forward price information. Second, adjusting contract sizes to accommodate use by producers could increase an individual's ability to control price risk. An example is the feeder cattle contract traded in Brazil. It is priced per animal (as opposed to cwt. in Chicago), and constitutes 33 animals (less than half a Chicago Mercantile feeder cattle contract based on average feeder cattle weights). Further, the price discovery information would be more transparent to producers and farm marketers if prices are in local currently.

## 3. Objectives

The objective of this paper is to examine the relationships between the New York coffee futures market and cash markets in two Latin American LDCs. In contrast to Morgan et. al, the intent is to determine if incentives might exist for LDC futures market development even when exchange rate risk is not the driving factor. For example, if futures trading on a foreign exchange increases price risk in a LDC cash market (i.e., increases cash market price volatility), LDC policy makers may decide to encourage local exchange development in order to maximize access by domestic producers and merchandisers to futures market forward pricing opportunities as a vehicle for managing domestic income stability. As such, the specific objectives here are to 1) determine whether the New York futures contract for coffee offers hedging opportunities for Latin American coffee market participants, and 2) examine the relationship between futures trade composition in New York and the volatility of coffee prices in Latin American cash markets.

The first objective is addressed using cointegration analysis. The issue is whether there is efficient information flow between the New York futures market and Latin American cash markets for coffee, and whether the basis risk associated with a hedge is less than the cash price risk faced by an un-hedged producer.[10] If the futures and cash markets are not cointegrated, it suggests that basis levels behave in a non-stationary way, and there is no guarantee that basis risk is less than actual cash price risk.

[10] Contrary to some interpretations of cointegration results, we do not view the cointegration results as a test of overall market efficiency. Rather, it is a test of relative price efficiency between the two markets. For our purpose, a rejection of the hypothesis of no cointegration implies that relevant information is getting priced similarly in both markets, suggesting that futures and cash markets are functioning in a manner that allows the futures market to be used as a risk management vehicle for cash market participants.

The second objective is tackled using a combination of a regression model that examines the impact of futures market composition on futures price volatility, and results from evaluating the residual behavior from the cointegration equations. The results allow discussion of the potential impact of speculative market activity on futures volatility, and the extent to which futures market volatility corresponds to volatility in LDC cash markets.

## 4. Data

Data for the cointegration analysis span March 1990 through December 2001. Average monthly New York coffee futures prices and monthly export prices for Honduras and Guatemala were used.[11] Futures prices were collected from Commodity Research Bureau InfoTech data, and cash prices from the International Coffee Organization database. All cash prices are dollar equivalents; in other words cash prices in local currency have been multiplied by the appropriate exchange rates to arrive at a monthly average export price in dollars. The first observation coincides with the month the Honduran Lempira was decoupled from the dollar. Prior to March 1990, the Honduran Lempira did not float. The Guatemalan Quetzal has also floated over the entire sample period.[12] Since cash prices were only available on a monthly basis, the cointegration models utilize monthly data

[11] The New York coffee contract began trading at the Coffee, Sugar, and Cocoa Exchange (now part of the New York Board of Trade) in 1961. The contract is for 37,500 pounds (250 bags) of coffee, and is priced in cents per pound. Specifications call for physical delivery of washed arabica coffee. This type coffee is produced in several Central and South American countries, as well as countries in Asia and Africa. Coffee produced in Guatemala can be delivered against the contract at par, and Honduran coffee can be delivered at a 100 basis point discount. Delivery locations include Exchange licensed warehouses in New York, New Orleans, Hamburg, Antwerp, and Miami. Delivery outside of New York incurs a 1.25-cent per pound discount.

[12] Honduras and Guatemala were chosen because of their relative lack of market share in total coffee trade, but the importance of coffee exports in their overall trade portfolio. Both countries represent very poor

The data used to address objective 2, impact of market composition on price volatility, span January 1992 through December 2001.[13] Price volatility measures are calculated as the standard deviation of period-to-period percentage price changes.[14] These are calculated from the price data described above. Data used to represent market composition come from the Commitment of Futures Traders reports released by the Commodity Futures Trading Commission each week. The reports place traders in several categories, including non-commercial and commercial, long and short, percent of open interest represented by each trader type, and percent of open interest accounted for by the four largest traders who are long and the four largest traders who are short the market.

## 5. Cointegration Methodology and Results

Cointegration has become a standard technique for evaluating the relative performance of two related markets (Schroeder and Goodwin (1991), Zapata and Fortenbery (1996), Fortenbery and Zapata (1993, 1997)). One reason for the popularity of cointegration analysis over the last decade is its ability to identify the long run equilibrium relationship between two markets, while allowing for deviations from the equilibrium relationship in the short run.

According to Labys and Granger (1970), most commodity futures prices approximate stochastic processes, but that does not mean they are not pricing new market

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countries in Latin America (and in fact the entire Western Hemisphere), and both rely heavily on agricultural exports for export income. For example, agricultural exports represent 67 percent of total Guatemalan exports, with coffee, sugar and bananas being the primary commodities exported. Honduras also relies primarily on agricultural exports for trade income generation, with coffee representing 45 percent of total agricultural exports (CIA, 2002). As such, both countries seem particularly vulnerable to impacts from trade in coffee futures markets.

[13] We were unable to acquire weekly futures trader data prior to 1992.

[14] To get weekly data, for example, daily percentage price changes were calculated as $(\ln P_t - \ln P_{t-1})*100$, where P is the closing daily price and t is the current day. Volatility in a given week is calculated as the standard deviation of percentage change in daily prices during the week.

information. What it does mean is that it is difficult to anticipate what the new information is going to be, thus its impact on future prices, and that past prices are not good predictors of future prices.

Cointegration does not address whether any individual market is pricing information correctly, but allows one to examine whether two different markets are pricing the same information similarly. In a futures/cash market context, this price difference is called the basis. Cointegration tests between futures and cash markets are measures of the extent to which basis is stationary. If basis is stationary, its mean and variance do not change over time, suggesting information that changes the price in one market also changes the price in the other market, and that there is a stable long-run relationship between those price changes.

Tests for cointegration in coffee prices were conducted via the maximum likelihood approach of Johansen and Juselius (1990). They proposed that tests of cointegration should be based on a fully specified error-correction model (ECM). The error correction model for series integrated of order one takes the form:

1) $\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \ldots + \Gamma_{k-1} \Delta Y_{t-k+1} + \prod Y^*_{t-k} + \varnothing D + e_t$

In this specification, $e_t$ is NID $(0,\Lambda)$, $\Gamma_1,\ldots,\Gamma_{k-1}$, $\prod$, $\varnothing$, $\Lambda$ are parameters to be estimated, $\Delta = 1\text{-}L$ where L is the lag operator, D is a matrix of non-stochastic variables (i.e., dummies, etc.), and $t= 1,2,\ldots,T$.

Cointegration is tested by examining the rank of $\prod$. If the rank of $\prod$ is zero, there is no cointegration, and no long run equilibrium relationship exists between the variables considered. If the rank of $\prod$ is between zero and p, where p is the number of variables in the system, then there is cointegration, with the number of cointegrating relations defined by the rank of $\Pi$. In testing for cointegration the hypothesis of interest is $H_0$: $\Pi = \alpha\beta'$, where $\alpha$ and $\beta$ are p x r matrices, $\beta$ is the cointegrating vector, $\alpha$ is the weight vector that measures the speed of adjustment towards equilibrium, and r is the number of cointegrating relations.

To estimate $\beta$, all terms but $\beta$ are eliminated from the likelihood function (Johansen, 1988):

$$2)\ \ln L = -T/2 \ln |\Omega| - \Sigma_t e'_t \Omega^{-1} e_t$$

This is done by regressing $\Delta Y_t$ and $Y_{t-k}$ on their lagged differences. The $\Gamma$ parameters are eliminated, and the resulting system has a dependent variable $R_{0t}$ (the residuals from a regression of $\Delta Y_t$ on lagged $\Delta Y_t$'s) and independent variable $R_{kt}$ (the residuals from regressing $Y_{t-k}$ on lagged $\Delta Y_t$'s). Next, letting $S_{ij} = T^{-1}\Sigma_t R_{it} R_{jt}$, i,j = 0,1, and assuming $\beta$ known and estimating $\alpha$ by:

$$3)\ \hat{\alpha} = -S_{01}\beta(\beta' S_{11}\beta)^{-1}$$

the likelihood becomes

$$4)\ \ln L = (-T/2) \ln |\Omega(\beta)|$$

with

$$5)\ \hat{\Omega}(\beta) = S_{00} - S_{01}\beta(\beta' S_{11}\beta)^{-1}\beta' S_{10}$$

The likelihood function is maximized by choosing $\beta$ to be the first r eigenvectors of the determinantal equation (4) that correspond to the r largest canonical correlations ($\lambda_i$). The value of the likelihood function is:

$$6)\ \ln \hat{L} = -(T/2)\{\Sigma_I \ln(1-\lambda_I), +\ln|S_{00}|\},\ i=1,2,\ldots,r$$

A likelihood ratio test ( the Trace test) for at most r cointegration vectors takes the form:

7) $-2 \ln Q = -T\Sigma_I \ln(1-\lambda_I)$, $i=r+1,\dots,p$

Johansen and Juselius also recommend using a λMAX statistic to test for cointegration. This is the same as the Trace test except that it evaluates maximum eigen values only. Tabulated critical values for the Trace test and λMAX test are presented in the appendices of Johansen and Juselius.

The dynamics of the coffee market are examined by estimating the cointegration relationships between the New York futures market for coffee and the cash markets in Honduras and Guatemala. The error-correction term in equation 1, $\prod Y^*_{t-k}$, includes a constant so that the partial equilibrium relationship between futures and cash prices is properly modeled, and the critical values of the Trace and λMAX are chosen accordingly. The lag-length of the error-correction model (ECM) is chosen by sequentially testing lags in a VAR in levels (up to maximum of 10 lags) and using a modified likelihood ratio test to select the appropriate lag (Sims, 1980). The ECM is estimated at the optimum lag length and the residuals tested for autocorrelation to assure model adequacy. Impulse response functions (Lukepohl, 1993) are estimated for the ECM with the cointegrating restrictions imposed (Lutkepohl and Reimers, 1992).

Table 1 provides the cointegration results between the export countries considered and the New York futures market. Results are based on the specification outlined in equation 1, with coffee futures prices and export cash prices as $k_1$ and $k_2$. In general, there is a finding of cointegration, suggesting the futures and cash markets do respond to the same information sets, and basis is indeed stationary. Note, however, the relatively long lags between price changes in the futures market and associated changes in the cash markets. Perhaps even more surprising is the difference in response time across the two cash markets. In Guatemala futures price changes are completely reflected in the cash export price within two months. While this is much timelier than Honduras, it is still quite slow relative to information transmission in most measures of cointegration between domestic U.S. cash and futures markets. For example, in their study of U.S. corn and soybean markets, Fortenbery and Zapata (1973) found that futures price changes were completely reflected in cash prices within in 1 to 3 days.[15] The Honduran coffee market takes up to six months to completely respond to coffee price changes in the New York futures market.

Figures 5 and 6 illustrate the impulse response functions from the two different models (one with Honduras cash prices and one with Guatemalan cash prices). The top panel in figure 5 shows the response of New York futures prices and Honduran export prices to a one-time shock in futures prices. Both series reveal a positive and immediate impact. They rise during the first few months, and then settle at a new equilibrium 7-8 months later. The initial response in Honduran export prices is steeper than that for futures prices. In contrast, shocking the Honduran export price (bottom panel of figure 5) results in a totally different price response. Honduran export prices initially respond positively to a shock in their own price but quickly decline to an equilibrium level that coincides with the equilibrium level for the New York futures price. Futures prices reveal only a minor response to a shock in Honduran export prices.

In the case of Guatemala, the cash price response to a shock in the New York futures price is identical to the response in Honduras but the impulse response appears as a monotonically increasing function that settles at a new equilibrium slightly above the

[15] As noted by an anonymous reviewer, it would be interesting to examine coffee price dynamics using daily data, and thus be able to make a direct comparison to the results of Fortenbery and Zapata. Unfortunately, however, we were unable to acquire daily export price data.

equilibrium of the Honduran export price. When the Guatemalan export price is shocked the response of the New York futures price is flat and close to zero. Guatemalan export prices decline quickly and almost monotonically, but remain positive throughout the adjustment period until they settle at basically the same equilibrium level that the futures prices do. It appears from the impulse responses that New York futures prices have a strong effect on Honduran and Guatemalan export prices, and that these prices settle at a new equilibrium level following a change in futures price. However, futures prices show only a minimal reaction to changes in either cash price series.

Tests for ARCH effects in the model residuals suggest that not only are price levels in Guatemala and Honduras affected by changes in futures prices, but cash price variances are also affected by futures market price activity. ARCH tests reveal significant (5% level of significance) ARCH(6) and ARCH(2) effects from the residuals of the futures price ECM models for Honduras and Guatemala, respectively.[16]

Based on traditional interpretations of cointegration tests, one might conclude that the coffee markets are relative price efficient, that the futures market leads the cash market in price discovery, and that using the New York coffee futures contract as a hedge vehicle would result in a reduction of price risk for the coffee exporting countries considered.

Efficiency is a confounding concept, however. The cointegration results only tell us that the two markets share information, and that they price the information similarly. However, if a futures market is to enhance overall market performance, it should not impose additional risks on cash market participants. In the case of first moments (i.e.,

[16] Both futures market equations revealed significant ARCH effects, as well as the cash equation for Honduras. Only the Guatemalan cash price equation revealed no ARCH effects. The specific test results are available from the authors.

price levels) we know from the cointegration impulse response functions that the New York coffee futures market is serving as the point of initial price discovery, and that the cash markets considered are responding to the futures market price changes. As such, average prices in both markets are linked. Further, the detection of ARCH behavior in the futures price equations suggests that cash price variances are also impacted by futures market activity. What we do not know is whether overall price risk in the cash markets is increased, decreased, or unaffected by trading activity in the futures market. If it is decreased or unaffected, then the futures market serves as a total price risk reducing vehicle, and a strong argument can be made that it enhances overall market performance. From a policy perspective, this suggests that use of the foreign futures market to hedge by any part of the LDC coffee sector likely reduces overall sector income instability relative to no LDC hedging activity.

However, if futures market activity increases instability in cash prices, the case is less clear. To be of net benefit, the futures market would need to provide hedgers with full coverage of the risk introduced by the futures market itself, and also reduce some part of the price risk that would exist in the cash market in the absence of futures.[17] In addition, cash market participants who do not directly hedge (small scale producers, merchandisers unable or unwilling to fund a margin account in foreign currency, etc.) would need access to other forward market opportunities, or income instability in the

[17] As pointed out by an anonymous reviewer, if futures market activity affects volatility in both cash and futures markets in a similar fashion, optimal hedge ratios do not change, and market agents who hedge enjoy the same level of risk protection as would be the case if futures activity did not adversely impact volatility (this of course assigns a minimal cost to the potential for increased activity in the futures margin account). However, for market agents unable to hedge on a foreign futures exchange, an increase in price volatility increases their price risk, and if there is not a local mechanism for managing this increased risk, an LDC policy makers ability to rely on market contracts (as suggested by Gimmel and Morgan et. al) as a part of an income stabilization policy is compromised.

coffee sector could actually be higher than it would be without a futures market at all regardless of whether some market agents hedge.

## 6. Trader Composition Tests

If Witherspoon's hypothesis is correct, and excessive speculation in the futures market results in increased cash price volatility even in markets that are cointegrated, then LDC policy makers need not only be worried about whether a developed country's futures market provides hedging opportunities to LDC producers/exporters, but also whether trade activity in the developed futures market impacts cash price risk and adversely affects market participants not able to hedge on a foreign futures exchange.

Figure 3 reveals that the percent of total speculative activity in the New York coffee contract has been increasing. The ratio of non-commercial to commercial open interest has gone from consistently less than 30 percent to in excess of 50 percent. Further, while we do not have data that break down daily volume between commercial and non-commercial traders, it appears total volume has been increasing (Figure 4). Interestingly, as both volume and the percentage of open interest accounted for by speculators have increased prices have fallen. However, this may simply represent informed and skilled speculation, with reduced commercial trade activity indicating commercial buyers expect yet lower prices and are thus not aggressively hedging.

If speculators tend to be technical traders, meaning they generate their price expectations purely from past price action and trade volume, and do not monitor or account for underlying fundamental supply/demand conditions in the markets they trade, they may simply be noise traders, and generating trade decisions based on noise may exacerbate the level of market noise. Put simply, if prices falling over a number of days leads speculators to believe that prices will continue to fall, they may become aggressive sellers, pushing the market to even lower levels, when in fact a careful analysis of market fundamentals would lead one to believe price should go no lower. When fundamentals finally impact price levels, prices rebound, but the resulting trading range is greater than would be the case if no noise trading occurred.

To test the relationship between speculative activity and volatility in coffee markets, we use weekly data to estimate the following model:

$$FUTVOL_t = \alpha + \beta_1 NCOIL_{t-1} + \beta_2 NCOIS_{t-1} + \beta_3 NCOISP_{t-1} + \beta_4 4trdrl_{t-1} + \beta_5 4trdrs_{t-1} + \beta_6 price \quad (8)$$

where:

$FUTVOL_t$ is futures volatility, defined as the standard deviation of the percent change in daily prices for a given week, $NCOIL_{t-1}$ is the percent of open interest accounted for by long non-commercial traders as of Friday the previous week, $NCOIS_{t-1}$ is the percent of open interest accounted for by short non-commercial traders the previous week, $NCOISP_{t-1}$ is the percent of open interest accounted for by non-commercial spread traders the previous week, $4trdrl_{t-1}$ is the percent of total long open interest accounted for by the four largest traders the previous week, $4trdrs_{t-1}$ is the percent of total short open interest accounted for by the four largest short traders the previous week, and price is the nearby weekly average New York futures price.

As noted earlier, the model above clearly understates speculative activity since it does not account for speculative positions held by non-reporting traders, or speculative activity by commercial traders. As such, it measures the lower limit of speculative impacts on price volatility. The results of estimating equation 8 are presented in Table 2.[18]

Note that the impact of noncommercial traders on futures price volatility is significant. Further, because of the recursive nature of equation 8, it appears that changes in market composition are followed by changes in price volatility. Increases in both the percent of total long open interest and the percent of total short open interest accounted for by speculators is followed by increased price volatility in the futures market. An increase in non-commercial spreading also appears to result in increased futures price volatility. In addition, the futures price is significant suggesting that price risk increases as prices increase.

The market share of the largest traders does not affect the level of market volatility. Neither the long nor short four-trader concentration is significant in equation 8.

Combining the evidence from Table 2 with the detection of ARCH effects in the futures price equations earlier provides evidence that the level of futures market speculation may impact cash price volatility. Specifically, the more speculators dominate trade activity in the New York coffee futures market, the greater the cash price volatility faced by LDC coffee market agents. This provides a challenge to LDC policy makers interested in using forward contracting as a vehicle in stabilizing agricultural sector incomes in coffee producing countries. For market agents sophisticated and large enough to hedge directly on a foreign futures exchange, hedging will likely reduce overall price

[18] The results of unit root tests for the price series used in the cointegration analysis earlier confirmed the existence of a unit root in monthly average futures prices. We also fail to reject the existence of a unit root in weekly average prices used in this analysis. However, the null hypothesis of non-stationarity in the residuals from equation 8 is rejected at the 1 percent level.

risk. However, for a large part of the LDC population, opportunities to hedge directly on foreign exchanges may not exist. If this group represents a large enough share of the LDC coffee sector, sector-wide incomes may be less stable than if there were no coffee futures market at all. For LDC policy makers focused on income stability, providing access to price risk management opportunities for all sector participants will be critical to reducing income instability. One potential option is to develop a local futures exchange. Critical to the success of any local futures exchange, however, will be the ability to generate sufficient volume to insure a liquid market.

## 7. Conclusions

Empirical evidence suggests that the New York coffee futures market currently serves as the center for price discovery in Latin American coffee exporting countries. Further, the failure to reject cointegration between the futures and cash markets considered suggests that the futures contracts in New York offer hedging opportunities to coffee sector participants in Central America. The long adjustment period between futures and cash price changes does suggest that hedging may only be risk efficient for relatively long planning horizons.

While the coffee futures market appears to offer risk management opportunities to participants in the cash market, it also appears that increased speculative activity increases the price risk faced by cash market participants. For hedgers this my not be important, but for small producers and merchandisers unable to access a foreign futures exchange (either because of scale of operation or because of an inability to establish and manage a margin account in the US), overall risk exposure may increase as speculative activity increases in the futures market. As such, it is not clear whether a locally important product trading on a foreign futures exchange provides the environment necessary to stabilize local incomes through market based contracting, even ignoring exchange rate risk.

Earlier work has suggested that hedging provides an alternative to supply management strategies in managing price risk for export commodities in LDCs, and therefore a strategy for stabilizing domestic incomes. It was further argued that the choice between hedging a LDC export commodity on an established exchange in a developed country or developing a local futures contract priced in the domestic currency hinged on a comparison of the relative costs of either managing exchange rate risk through a direct hedge, or incurring exchange rate risk when local currencies are not represented by traded futures, with the relatively high costs of developing the infrastructure and regulatory environment necessary to develop a successful local futures market. The research here suggests that there are additional costs to consider. We show that even when exchange rate risk does not negate the risk management benefits from using a foreign futures contract, other costs may exist. If activity in the foreign futures market has a destabilizing impact on LDC cash prices, additional incentives exist to develop local trade environments.

The development of local LDC futures exchanges can mitigate the exchange rate risk faced by direct hedgers, may transmit price changes from futures to local cash markets more quickly if the current time lags are a result of frictions in information flow from New York to LDC cash markets, and increase access to forward pricing opportunities for that segment not able to hedge directly on a foreign futures exchange. However, generating sufficient trade volume will be critical to the success of a local futures exchange. Neither the work here nor the previous work cited here has addressed this important topic directly.

Note that this paper does not conclude that excessive speculation exists in the coffee market, but does provide some initial evidence pointing in that direction. Before definitive recommendations can be made relative to LDC development of local futures markets, three points need further clarification. First, a specific test of variance causality between futures and cash prices needs to be considered and tested. While we find correlation between futures market composition and cash price volatility, we do not explicitly test for causality in variance, a subject of future research. Second, perhaps using Witherspoon's theoretical formulation, explicit tests need to be conducted to determine the optimal threshold of speculative activity. At what point does the speculative/commercial trade interest become unbalanced, resulting in excessive speculation? Third, if a market is determined to be experiencing excessive speculation, one must determine that any policy choices focused on addressing the problem (such as speculative position limits, limits on concentration by individual traders, etc.) do not impose costs that exceed the cost of excessive speculation. For example, restrictions on speculative activity that result in a significant reduction in market liquidity may impose costs that exceed those associated with too much speculation. The above three points are the current subject of additional work.

**References**

Bessler, D. and T. Covey (1991). Cointegration: Some Results on U.S. Cattle Prices. *The Journal of Futures Markets* 11: 461-474.

CIA (2002). World Fact Book, WWW.OCDI.GOV/CIA/PUBLICATIONS.

Commodity Futures Trading Commission. Commitment of Traders Report. various issues, Washington DC.

Commodity Research Bureau. Infotech Historical Commodity Data. Chicago, IL.

Fortenbery, T. R. and H. O. Zapata (1993). An Examination of Cointegration Between Futures and Local Grain Markets. *The Journal of Futures Markets* 13: 921-932.

Fortenbery, T. R. and H. O. Zapata (1997). An Evaluation of Price Linkages Between Futures and Cash Markets for Cheddar Cheese. *The Journal of Futures Markets* 17: 279-301.

Gemmill, G. (1985). Forward Contracts or International Buffer Stocks? A Study of Their Relative Efficiencies in Stabilizing Commodity Export Earnings. *The Economic Journal* 95: 400-417.

International Coffee Organization. WWW.ICO.ORG.

Johansen, S (1988). Statistical Analysis of Cointegrating Vectors. *Journal of Economic Dynamics and Control* 12: 169-210.

Johansen, S. and K. Juselius (1990). Maximum Likelihood Estimation and Inference on Cointegration – With Application to the Demand for Money. *Oxford Bulletin of Economics and Statistics* 52: 169-211.

Labys, W. C. and C. W. J. Granger (1970). *Speculation, Hedging, and Forecasts of Commodity Prices*. Lexington, MA: D. C. Heath and Co.

Lütkephol, H. (1993). *Introduction to Multiple Time Series Analysis.* Second Edition. Berlin, Germany: Springer-Verlag Ed.

Lütkephol, H. and H-E. Reimers (1992). Impulse Response Analysis of Cointegrated Systems. *Journal of Economic Dynamics and Control* 16, 53-78.

Massell, B. F. (1969). Price Stabilization and Welfare. *Quarterly Journal of Economics* 83: 285-297.

Morgan, C.W., A. J. Rayner, and C. Vaillant (1999). Policy Arena: Agricultural Futures Markets in LDCs: A Policy Response to Price Volatility? *Journal of International Development* 11: 893-910.

Newberry, D. T. and J. S. Stiglitz (1981). *The Theory of Commodity Price Stabilization*. Oxford, UK: Oxford University Press.

Nguyen, D.T. (1980). Partial Price Stabilization and Export Earning Instability. *Oxford Economic Papers* 32: 340-52.

Schroeder, T. C. and B. K. Goodwin (1991). Price Discovery and Cointegration for Live Hogs. *The Journal of Futures Markets* 11: 685-696.

Sims, C. (1980). Macroeconomics and Reality. *Econometrica* 48: 1-49.

Witherspoon, J. T. (1993). How Price Discovery by Futures Impacts the Cash Market. *The Journal of Futures Markets* 13: 469-496.

Zapata, H. O. and T. R. Fortenbery (1996). Stochastic Interest Rates and Price Discovery in Selected Markets. *Review of Agricultural Markets* 18: 634-654.

Table 1. Unit-Root and Cointegration Tests, Futures and Selected Cash Markets for Coffee, March 1990 – December 2001.

| Series | Unit-Roots | | Cointegration Tests | | | | |
|---|---|---|---|---|---|---|---|
| | LAG | T-test | LAG | λmax | Trace | L-B | LM(1) |
| Futures (NY) | 1 | -0.90** | | | | | |
| Guatemala | 1 | -1.15** | 2 | 28.98 | 31.14 | 0.01 | 0.23 |
| Honduras | 1 | -2.09** | 6 | 34.20 | 34.20 | 0.57 | 0.91 |

** Statistically significant at the 5 percent level.
Note: Unit-roots statistics calculated using Phillips-Perron "t-type" tests at truncation lag (LAG) for a model with a constant but no trend. In cointegration Tests block, LAG is the number of lags in the ECM using a modified LR-test on a levels representation of the model. Johansen and Juselius tests for the null of no cointegration are L-max and Trace with 10% critical values of 10.29 and 17.79, respectively. The Ljung-Box (L-B) and LM test p-values for no autocorrelation are given on the last two columns. Bivariate ECMs between futures and each of the cash series are for the cointegration tests. For instance, the λmax rejects no cointegration between New York futures and Guatemalan cash prices. ARCH(6) and ARCH(2) for Honduras and Guatemala, respectively, were significant, lending support to variance effects. Only the cash price equation for Guatemala did not have ARCH effects in the residuals from the ECM.

Table 2. Regression Results from Equation 2.[1]

| Variable | Coefficient | T-Statistic |
|---|---|---|
| Constant | -1.7535 | -1.6503 |
| New York Futures Price** | 0.0130 | 4.2894 |
| Noncommercial Long Open Interest ( %)** | 0.0478 | 2.4858 |
| Noncommercial Short Open Interest (%)** | 0.0598 | 3.1479 |
| Noncommercial Spread Open Interest (%)* | 0.0957 | 1.9218 |
| Largest Four Long Trader Open Interest | -0.0076 | -0.1959 |
| Largest Four Short Trader Open Interest | 0.0318 | 1.4616 |

[1]Initial OLS estimation revealed autocorrelation. The data was transformed via Cochran-Orrcut, and the model re-estimated. Adjusted $R^2 = .207$
** Statistically significant at the 5 percent level.
* Statistically significant at the 10 percent level.

Figure 1. Nearby coffee futures prices.

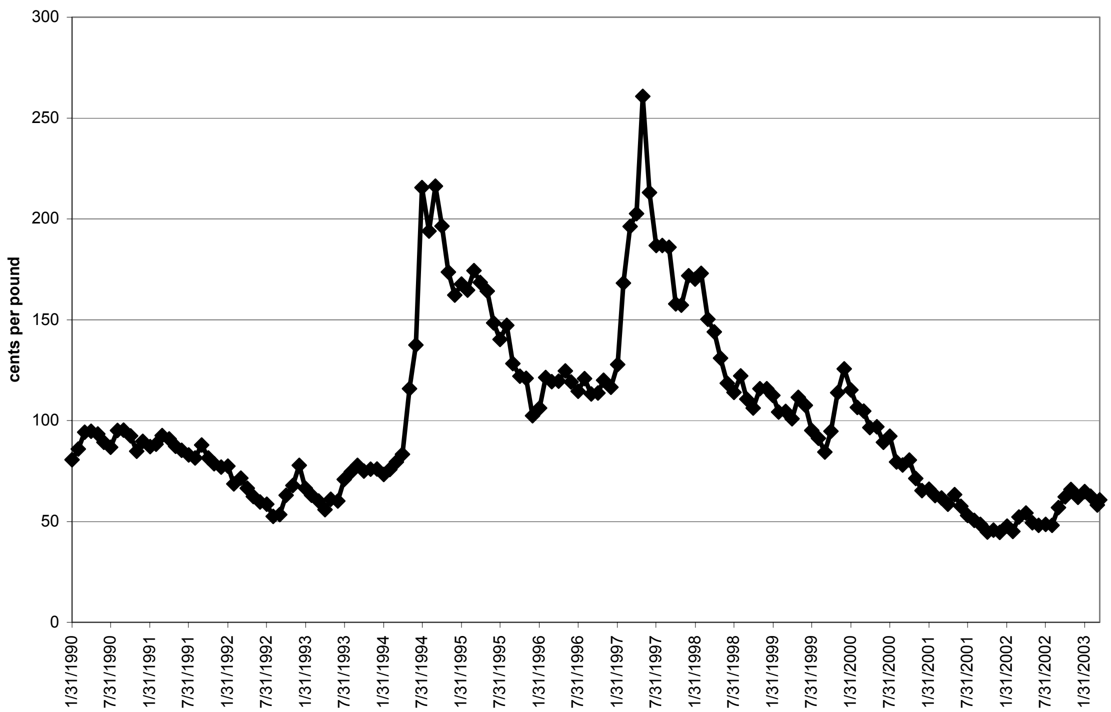
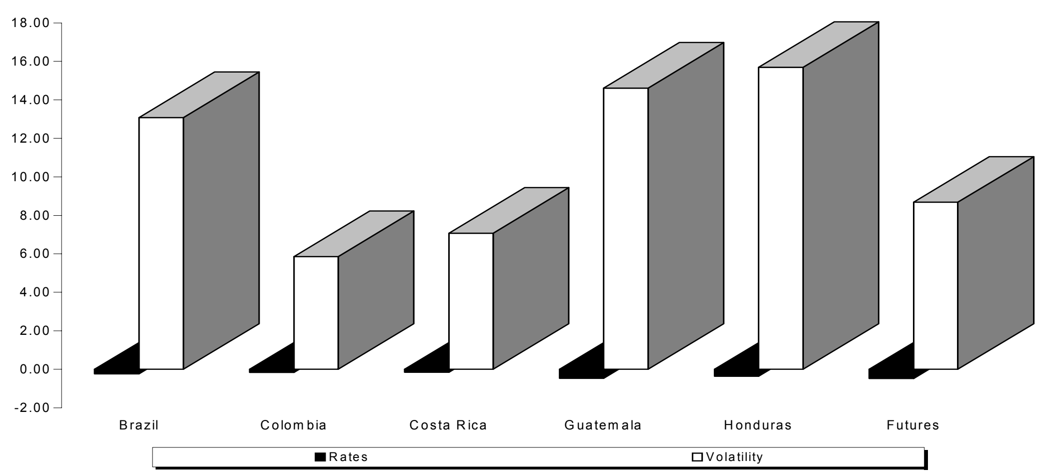



Figure 2. Rates of change and volatility in monthly coffee prices, 1990-2001.[1]




[1] Rate of change is $(\ln P_t - \ln P_{t-1})*100$, and volatility is the standard deviation of rate of change over the previous 12 months.

Figure 3. Noncommercial to commercial open interest and nearby price – New York coffee futures.

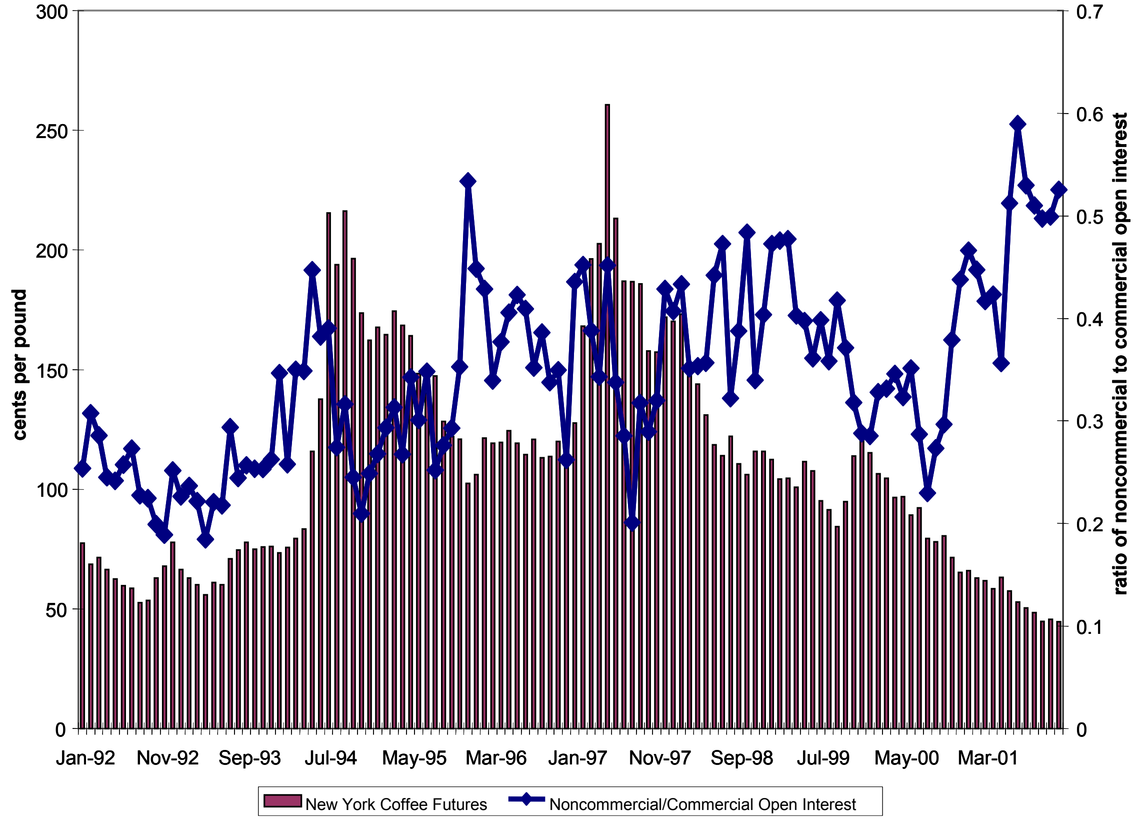



Figure 4. Monthly average trade volume – New York coffee futures contracts.

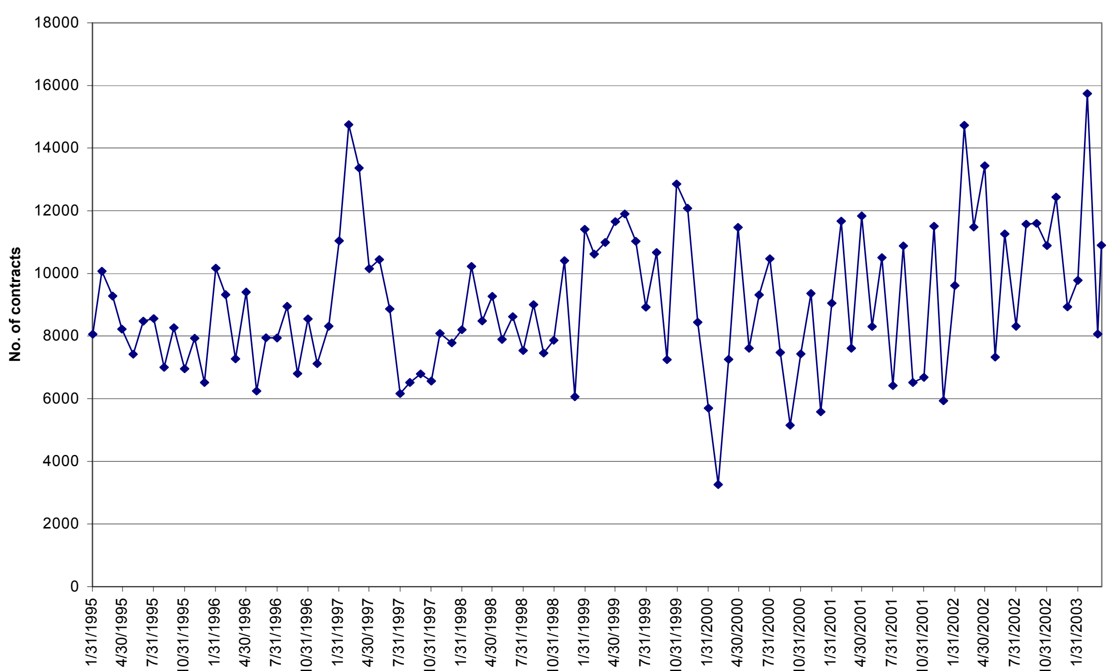
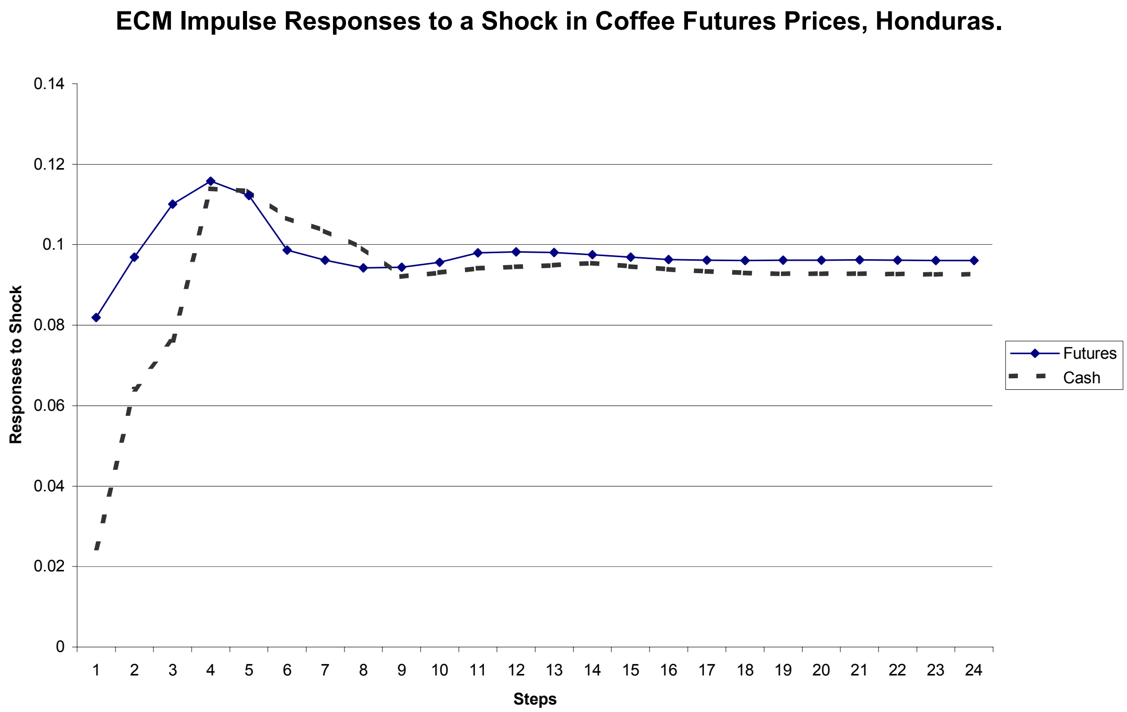


Figure 5. Impulse response functions for Honduras.



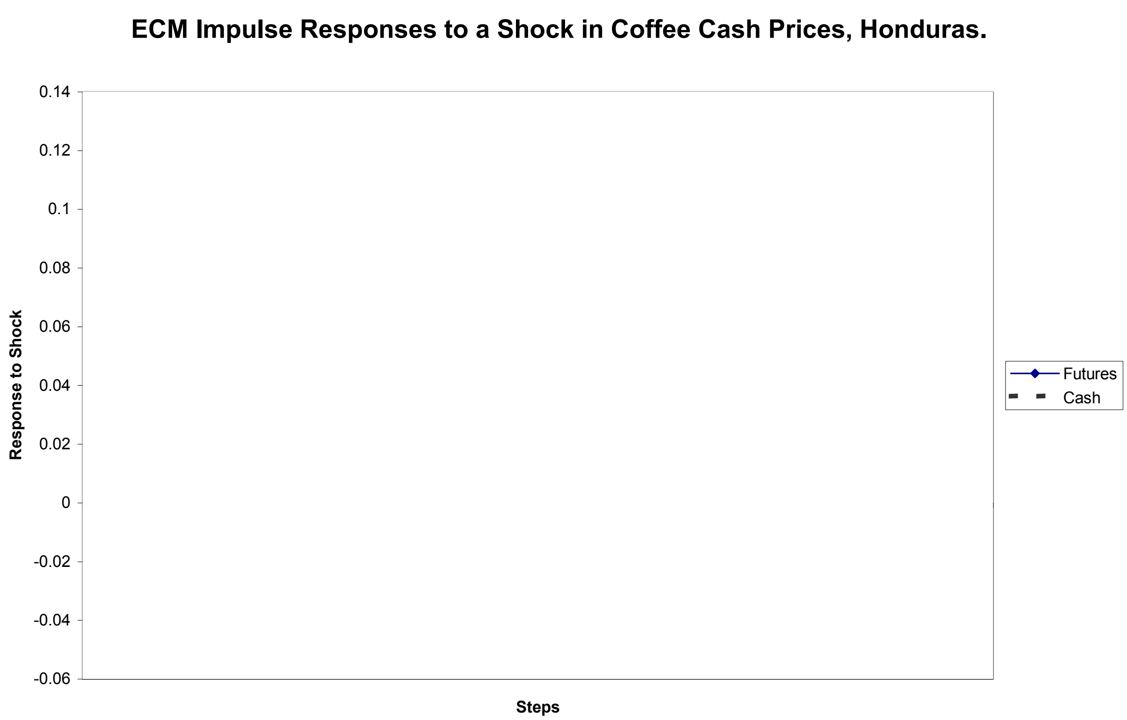



Figure 6. Impulse response functions for Guatemala.