University of Wisconsin-Madison
Department of Agricultural & Applied Economics

March 2004 **Staff Paper No. 472**

Responding to the Coffee Crisis: What Can We Learn from Price Dynamics

By

Aashish Mehta

and

Jean-Paul Chavas

AGRICULTURAL & APPLIED ECONOMICS

STAFF PAPER SERIES

Responding to the Coffee Crisis: What can we learn from price dynamics?

Aashish Mehta
Department of Agricultural and Applied Economics
University of Wisconsin-Madison

Jean-Paul Chavas
Department of Agricultural and Resource Economics
University of Maryland-College Park

Abstract:

We develop a semi-structural price vector autoregression to capture coffee price dynamics over various time horizons. The presence of the International Coffee Agreement is permitted to alter supply responses to price signals through yield and planting effects. In the short run, the ICA caused Brazilian farm prices to become disconnected from international prices. In the long run, the ICA promoted supply response by providing a stable environment in which producers could use current price information to predict future prices. In the intermediate run, it muted supply response by necessitating an institutional price wedge between wholesale and farm level prices. In net, the ICA created a price cycle that does not exist in non-ICA periods. Oxfam's proposal to burn 300 million pounds of coffee will provide temporary relief to farmers, but cannot be used repeatedly as a long term strategy. The low coffee prices experienced since the disintegration of the ICA may be due to the interaction of supply lags, a shift in the composition of coffee demand, and low price response due to price uncertainty. No evidence of asymmetric price transmission is found

Citation information: This is a draft. It will be designated a working paper soon. Please see www.aae.wisc.edu/aashish for citation information after 1/22/04, and updated drafts.

I. Introduction

The last century saw four separate attempts to control international coffee prices. This is hardly surprising given: the impact of coffee prices on producing nations' terms of trade and welfare; the sensitivity of coffee supply to droughts and frosts; the medium term price inelasticity of supply; the inelasticity of coffee demand; and the consequent volatility of prices. Each of these agreements was successful for a time, but eventually ended amidst disagreements between signatory nations. The International Coffee Agreement (ICA) was the last of these attempts, in effect intermittently from 1962 until 1989.

Prices have been low since the collapse of the ICA, although two frosts in Brazil muddle this impression (see figure 1). While green coffee prices do dip periodically, 2002 saw prices lower than they have been since 1967, in nominal terms. The disastrous welfare consequences of this price trough have prompted renewed interest in international price intervention. Oxfam (2002) calls for the burning of 5 million 60 lb. bags of coffee, as well as "quality controls" requiring the exclusion of a significant portion of coffee supply from the market. The International Coffee Organization (ICO) is also calling for quality controls. Meanwhile, many involved with the 'fair trade' movement advocate for market-wide price guarantees. It is therefore fitting to study the impacts of previous interventions. This should allow insight into whether such agreements are advisable, and if so, how to better ensure their longevity.

Prior econometric work[1] assessing the impact of the ICA quota system on contemporaneous coffee prices has run into difficulty. This is primarily because, under the ICA, low prices activated the treaty's economic provisions (quotas). This creates a simultaneity problem which makes the impact of the agreement on prices impossible to measure from a simple time-series model. Amongst the structural attempts to capture coffee price determination, Akiyama and Varangis (1990) develop a model of world markets which models coffee production and stocks explicitly. Their results suggest that the ICA reduced price volatility by encouraging the build-up of stocks during quota years. When subsequent supply shocks caused prices to rise and the quotas to be suspended, the release of these stocks reduced the magnitude of the price spike. Thus, the ICA appears, in these studies, to stabilize prices in the short and medium run.

Such structural studies, however, fail to adequately incorporate price dynamics. They presume that planting and other supply responses to price information are unaffected by the ICA. Economic theory regarding investments under uncertainty suggests that this presumption may be

[1] See, for example: Akiyama & Varangis (1990), Coggins (1996), Vogelvang (1988), Palm & Vogelvan (1991).

inappropriate. The agreement was designed to alter the forward path of prices, and hence the expected returns to investments conditional on recent prices. This could alter supply behavior with substantial implications for future prices. Traditional time series work on coffee prices, limited as it is by its inability to identify structural economic parameters, is also unable to shed light on the subject.

In order to bridge this gap, we develop a semi-structural time series specification in the price domain. We model the impact of long ago prices on investments in coffee trees, and therefore on current prices. By permitting these long ago impacts to differ depending on whether the ICA was in place at the time of the investment, we allow the data to express the long term dynamic effects of the agreement. We are careful to account for the effects of weather, inventory accumulation and temporal effects. Our model is embedded in a flexible vector autoregression form devised by Chavas and Mehta (2004) to capture potentially asymmetric price transmission in a vertical sector.

This methodology is employed to answer four questions, all relating to long term supply adjustment under uncertainty. Coffee trees, once planted, take four to five years to become productive, and remain productive for fifteen to twenty-five years thereafter. In combination with the view that coffee prices are nearly impossible to predict at the five year horizon and that farmers therefore rely on adaptive expectations when investing, this suggests the potential for a coffee price cycle. We therefore ask, first, whether the ICA had an impact on the existence and magnitude of such a cycle, and if so, why. We argue that the agreement did induce a price cycle, because it created a stable investment environment in which farmers and governments could forge long term supply responses to current prices.

Second, we ask whether supply responds to price information in the post-ICA years, and whether this helps us to understand the low prices experienced during this time. We find that aggregate supply responds little to price information. Technological changes that have increased the competitive advantage of "lower quality" coffees have led to large supply increases on the part of their producers, especially Brazil and Vietnam. Other producers have been slow to cut back on supply. While this owes much to the long term nature of crop, we argue that the duration of the price trough is connected to an inability to respond to such information under price uncertainty.

Third, we ask what the impact would be of Oxfam's suggested policy of raising prices by burning five million bags of coffee. Our simulations suggest that in the absence of a price control agreement, the impact of such a policy would be felt for a year and taper off to nothing within two years. During the ICA years, such a policy would have triggered a price cycle.

Fourth, we ask whether price transmission in coffee markets between the Brazilian farm sector, U.S. wholesale sector and U.S. retail sectors is asymmetric, as has been alleged by many concerned with the increased market concentration at the roasting/retail level since the late 1980s. We find that the evidence of this is weak.

In the next section, we present the economic features of the agreement salient to understanding coffee supply response. Section III presents our data. Section IV derives our econometric specification, and details how ICA activity might be expressed in price dynamics. Section V provides and interprets the regression results. Section VI presents the results to our policy simulation exercises. Results on price transmission exercises are presented in section VII. Section VIII discusses our findings, their policy implications, and concludes.

II. Supply response under the ICA

The international coffee agreement was signed in 1962 by a large majority of the coffee producing and consuming nations of the world. It collapsed at the end of the cold war in July 1989, perhaps reflecting its fundamentally political purpose from the perspective of some participants. During the period covered by our data, the agreement operated through a flexible quota system. A price index, calculated by the ICO, was established to synthesize price information from different sectors of the global wholesale market. A graduated series of export quotas was also agreed upon. Quota levels were tightened when the price index fell below $1.20/lb, and loosened when it rose above $1.40/lb. During periods of drought, when prices rose substantially, the quotas were suspended altogether. Internationally, the quota system was enforced through the requirement that exports to signatory importing nations be backed by coupons.

The task of ensuring that the quantity restrictions mandated by the agreement were met fell to national coffee boards and governments in producing countries. These coffee authorities were compelled to drive a wedge between high (relative to market clearing) international prices and farm prices in order to balance production levels with export allowances. This was done through direct taxation of coffee production and sales, the requirement that coffee be sold at discriminatory exchange rates, or purchasing programs. This price wedge, which is visually apparent in figure 1, clearly generated substantial quota rents. The distribution of such quota rents lie at the heart of any discussion of the equity implications of international price controls. Indeed, understanding how these quota rents were distributed under the ICA may explain why the US State Department was eager to enter into an agreement that would raise US coffee prices.

For current purposes, however, we are concerned with the impact of adjustments in the wholesale – farm price wedge on the incentives to plant coffee. Under the ICA, authorities had incentives to adjust the price wedge in response to price fluctuations in order to dampen the impact of price shocks. Failure to do so would have resulted in overproduction, the storage and management of which would have been expensive. From this perspective, the existence of the ICA should have dampened supply response through these *price wedge effects*. In the extreme case, if authorities over-reacted to price fluctuations, overshooting price wedge adjustments could even have reversed supply responses. To wit: if wholesale price increases induced authorities to increase the price wedge sufficiently to *reduce* the farm price, then supply could have actually contracted as a result.

Conversely, the *price stabilization effects* of the ICA should contribute to a magnification of supply response. Because the ICA stabilized the forward path of prices, it provided farmers with a stable investment planning horizon. Hence, current price information may have become a more useful predictor of future prices, prompting investments in trees through planting and maintenance to respond to price signals. The overall effect of the ICA on supply response, then, remains an empirical question. National coffee boards and governments have incentives to dampen supply response in order to avoid the management and storage costs association with overproduction, while the effects of the agreement on the investment decisions of farmers act in a countervailing fashion.

III. The Data

All price data are in nominal terms and measure a monthly average price in dollars per pound. Farm prices from Brazil were provided by the ICO, and were converted to U.S. dollars at contemporaneous exchange rates. Retail prices are from the U.S. Bureau of Labor Statistics, and reflect the price of ground coffee only. Prices of whole bean gourmet coffee and coffee drinks are not reflected in this price. The bulk of the green coffees used in ground blends are Brazilian and lower grade Columbian *Arabica* coffees, as well as Asian and Brazilian *Robusta* beans. We have, therefore chosen to utilize wholesale price information on the monthly average spot price of 'Brazilian and Other Natural Arabicas' determined at the New York Board of Trade.
Because wholesale prices of the different varieties of coffee co-move, much can be learned about aggregate market behavior from an examination of just this one wholesale price indicator.

Dates for weather shocks are drawn from the ICO and from Bates (1997).

IV. Econometric Specification

Our econometric model consists of a structurally derived wholesale price determination equation, couched within a vector autoregression (VAR) model allowing for conditional heteroskedasticity. Beginning with the outer shell, the VAR is specified as follows:

$$\text{(1a)}\quad p_t = \begin{bmatrix} p_t^F \\ p_t^W \\ p_t^R \end{bmatrix} = \begin{bmatrix} f(p_{t-1}, p_{t-2},..p_{t-k}, x_t, x_{t-1},..x_{t-l}) \\ g(p_{t-1}, p_{t-2},..p_{t-m}, x_t, x_{t-1},..x_{t-n}) \\ h(p_{t-1}, p_{t-2},..p_{t-o}, x_t, x_{t-1},..x_{t-q}) \end{bmatrix} + e_t;$$

Here p_t is a vector of farm (p_t^F), wholesale (p_t^W), and retail (p_t^R) prices. It is conditioned on lagged values of the price vector and a vector of exogenous variables (x_t), including a time trend, seasonal dummy variables, and indicators of whether the ICA was in effect in the recent past. The error vector possesses a conditionally heteroskedastic normal distribution. This is allowed for using a Cholesky decomposition to ensure a positive semi-definite variance matrix.

$$\text{(1b)}\quad e_t = \begin{bmatrix} e_t^F \\ e_t^W \\ e_t^R \end{bmatrix} = A_t\varepsilon_t = \begin{bmatrix} a_{1t} & a_{4t} & a_{6t} \\ 0 & a_{2t} & a_{5t} \\ 0 & 0 & a_{3t} \end{bmatrix} \begin{bmatrix} \varepsilon_t^F \\ \varepsilon_t^W \\ \varepsilon_t^R \end{bmatrix}; \ \varepsilon_t \sim N(0, I_3);$$

$$\text{(1c)}\quad a_{it} = a(p_{t-1}, z_{t,} z_{t-1})$$

Dummies indicating periods when the market faced unexpected weather shocks, and when ICA was in place are included in z_t. Mathematically, these equations imply (collecting the time subscripts for convenience):

$$\text{(1d)}\quad \Sigma_t = A_t' A_t = \begin{bmatrix} a_1^2 + a_4^2 + a_6^2 & a_2 a_4 + a_5 a_6 & a_3 a_6 \\ a_2 a_4 + a_5 a_6 & a_2^2 + a_5^2 & a_3 a_5 \\ a_3 a_6 & a_3 a_5 & a_3^2 \end{bmatrix}_t = \begin{bmatrix} \sigma_F^2 & \sigma_{FW} & \sigma_{FR} \\ \sigma_{FW} & \sigma_W^2 & \sigma_{WR} \\ \sigma_{FR} & \sigma_{WR} & \sigma_R^2 \end{bmatrix}_t$$

Thus, the time varying Cholesky matrix (A_t) allows price volatility in sector *i* (σ_{it}^2) and the covariance of price shocks in sectors *i* and *j* (σ_{ijt}) to vary with market conditions (p_{t-1}), weather events (where the dummy $Sh_\tau = 1$ if $t = \tau$, where there were weather shocks in the months considered), and the presence of the ICA in the month prior (indicated by the dummy d_{t-1}).

Changes in the supply of substitute coffee varieties will effect our wholesale price indicator as they would their own. Farm prices may be shielded from such movements by price wedges. Similarly, retail prices may not reflect such movements well due to market power and private stock-holding. We therefore place the wholesale price equation at the center of our model to capture aggregate behavior in world markets. Past wholesale prices condition current retail and farm prices, and vice versa. However, past farm prices do not affect current retail prices, nor vice versa, except through the wholesale market.[2] We use the wholesale price equation to capture long term dynamics. We therefore turn now to determining a suitable form for the wholesale price equation.

We begin with a tree-stock equation, relating the current tree stock (N_t) to that last year (N_{t-12}) and the number of new trees currently entering into production φ_t.

(2) $$N_t = \beta N_{t-12} + \varphi_t$$

$(1-\beta)$ is the annual depreciation rate of trees. Output of beans (Y_t) is determined by the number of trees and the yield per tree (b_t).

(3) $$Y_t = b_t N_t$$

Inverse demand is given by:

(4) $$p_t^W = a_t - cQ_t;$$

where Q_t is the quantity demanded. This linear specification has the desirable property that demand elasticity increases with the price. This is a property of coffee demand, according to Junguito and Pizano (1999).Finally, the market clears through inventory accumulation (ΔI_t):

(5) $$Y_t = Q_t + \Delta I_t.$$

Applying the lag operator to (2) and solving (2)-(5) for p_t^W yields:

(6) $$p_t^W = \beta p_{t-12}^W + (1-\beta L^{12})(a_t + c\Delta I_t) - cb_t\varphi_t.$$

Turning next to the short run dynamics of the system, we note that demand may shift over time (t) and with the seasons, which we put capture through three quarterly dummy variables.[3] Hence:

(7) $$a_t = a(t, Q_1, Q_2, Q_3)$$

Inventory accumulation decisions are made with reference to recent prices $(p_{t-1},.., p_{t-r})$[4], and may depend upon whether the ICA was in place last month or not.

---

[2] Each of these restrictions was tested via likelihood ratio tests and accepted.
[3] In our specification the first quarter begins in January. Using a quarter scheme commencing in February or March yielded slightly lower likelihood scores.
[4] Using the Schwartz criterion we chose $r = 2$.

(8) $\Delta I_t = \Delta I(ICA_{t-1}, p_{t-1}, p_{t-2}, .., p_{t-r})$.

The medium run dynamics of the system are driven by yield effects, while the long run dynamics come from planting. As discussed in section II, the impact of prices in the past on prices today through yields and planting may be conditioned by the presence of an agreement through price wedge and price stabilization effects. Note also, that the trees just entering into production at time *t* were planted four or five years ago; and that their yields will depend on inputs of labor, mulch, fertilizer, irrigation and on pruning decisions one to three years prior. The following specification is immediate:

(9) $b_t = b(P_I, P_I * ICA_I; P_{II}, P_{II} * ICA_{II}; P_{III}, P_{III} * ICA_{III})$

(10) $\varphi_t = \varphi(P_{IV}, P_{IV} * ICA_{IV}; P_V, P_V * ICA_V)$;

where upper case prices with Roman subscripts represent lagged annual wholesale price averages. Thus, for example, $P_{IV}*ICA_{IV}$ represents the average wholesale price four years ago, multiplied by the fraction of that year for which the ICA was operative.

Substituting (7)-(10) into (6) yields a specification that is specified purely in terms of prices. Notice, from the lag operator in (6) that if p_{t-1} conditions wholesale prices, then p_{t-13} must do so as well.

Presuming, for simplicity, linear functional forms for (6)-(10), we run into a common identification problem. In particular, we find that *c* is not identified, and that the magnitudes of b_t and φ_t cannot be separately determined. Hence we estimate multiplicative combinations of these parameters with others, yielding measures of their relative importance in driving price dynamics. Suppressing the full algebraic form for the short term effects for notational reasons, this yields:

(6')
$$\begin{aligned} p_t^W &= \beta p_{t-12}^W + Short\ term\ effects \\ &+ \left(b_0 + \sum_{T=I,II,III} (b_T + b_T^A ICA_T) P_T\right)\left(1 + \sum_{T=IV,V} (\varphi_T + \varphi_T^A ICA_T) P_T\right) \end{aligned}$$

Now, suppose, for example, that $\left(b_0 + \sum_{T=I,II,III} (b_T + b_T^A ICA_T) P_T\right) > 0$. Then, finding that $\varphi_V^A < 0$ would indicate that the price stabilization effects of the ICA dominate its price wedge effects at the five year time horizon, and that the ICA stimulates supply response to prices. Finding, that $\varphi_V + \varphi_V^A < 0$, would indicate that, under the ICA, price increases five years ago are associated with price decreases today (holding all price dynamics in the interim constant), and vice versa.

The number of months of lagged prices to condition retail and farm level prices on was determined using the Schwartz criterion to be 2.

V. Regression Results

We estimated the specification provided by embedding (6) in (1) using maximum likelihood.[5] The short term effects were expressed in terms of differences, without loss, as differencing allows for simple extensions to test for asymmetric price transmission. Estimates of the price equation (1) are presented in table 1, while estimates of the Cholesky element equations are provided in table 2.

The impact of the ICA on average prices is not consistent in sign across sectors, and is statistically insignificant. This may reflect the same simultaneity issues that previous studies have encountered.

Seasonal effects are jointly significant.

Only retail prices display a statistically significant upward trend. However, relative to wholesale prices the trend is statistically insignificant, amounting to a two cent increase in the retail-wholesale margin over ten years. Farm prices decline, though not statistically significantly. Growth in the retail-farm margin is statistically, but not economically, significant, totaling seven cents in ten years.

We begin our analysis by looking at contemporaneous price transmission. From the elements of the Cholesky matrix, we can calculate coefficients of contemporaneous price transfer between sectors. For example, from (1d) we note that a one dollar shock in retail prices will increase wholesale prices by $C_{WR} = \partial p_t^W / \partial p_t^R = \sigma_{WRt} / \sigma_{Rt}^2 = a_{5t} / a_{3t}$ dollars.

Figure 2a depicts these coefficients between farm and wholesale prices across our sample period. The results are fascinating. Note that in the period since the dissolution of the ICA, both C_{WF} and C_{FW} are almost exactly equal to one. Thus contemporaneous price transmission between these sectors is close to perfect without the agreement. A price shock in one sector is transmitted fully, within the same month, to the other. During the ICA, these transfer coefficients are much smaller, averaging around 0.3 and occasionally even falling into the negative region. This is compelling evidence that price wedges during the ICA years dampened price transfer between the farm and wholesale sector.

[5] The model of fundamental wholesale price determination under perfect market intelligence detailed above yields multiple identification restrictions which relate ratios of coefficients on past prices to β. Likelihood ratio tests of these restrictions found them to be unacceptable. While back of the envelope calculations suggest values for β between 0.9 and 0.93, the model consistently puts β at around 0.1. We take this as an indication that short term dynamics are not driven by fundamentals alone. We also relax all the identification restrictions.

This evidence in favor of a price wedge view of the ICA's effects is well complimented by the statistical insignificance of wholesale prices in determining farm prices. Thus, under the ICA, when *only* lagged farm prices have statistically significant effects on farm prices, the transfer of wholesale shocks to farm prices is slow, with farm prices assuming a momentum of their own. Such momentum probably arises from political and inventory management pressures arising out of the need to conform to quota restrictions.

Figures 2b and 2c provide analogous coefficients for transfer to and from the retail sector. Contemporaneous price transmission between the retail sector and the farm or wholesale sectors is poor, averaging zero, and frequently negative. Negative price transmission coefficients occur if and only if the covariance between shocks is negative. The only convincing explanation that we have for the negative covariances with the retail sector is shocks to the marketing margin. That is to say, if the effects of consolidation at the roasting level on prices are not captured by our simple linear time trend, then 'unpredicted' prices effects of consolidation will be associated with retail price increases relative to wholesale and farm-level prices. This is exactly what we see during the period when consolidation proceeded apace.

Turning next to our estimates of the intermediate run effects of the ICA, we note that b_I^A and b_{II}^A are statistically significant and positive. The total price effects, $b_I + b_I^A$ and $b_{II} + b_{II}^A$ are also positive. Given that φ_t is positive at every point in our sample, this suggests that under the ICA, wholesale price increases one or two years in the past would actually *reduce* current supply, presuming that they didn't change prices in the interim. We take this as evidence that price wedge effects dominate the price stabilization effects of the ICA in the intermediate term, and that national managers overshoot in their determination of appropriate price wedges.

. In order to assess the economic importance of these intermediate term price wedge effects, we calculated the partial derivatives of current prices with respect to annual prices one (D1), two (D2) and three (D3) years prior. These are presented in figure 3. The results indicate clearly that overshooting price wedge effects on yield are economically important during the ICA years. One dollar price increases one and two years ago result in price increases today of around a dollar. The results during the non-ICA years stand in stark comparison. The one year effect becomes negative, consistent with standard supply response, while the two year effect essentially disappears. This is strong evidence that the ICA elicited supply responses.

In the case of long term, planting effects, the price stabilization effects of the agreement dominate $\left(\varphi_V^A < 0\right)$. This creates large supply responses to price changes which disappear when the ICA is not in effect (see figure 4). A ten cent price increase five years ago generates approximately a 20 cent price decrease today when the ICA is in effect. When it is not, the impact of the price increase is close to zero.

These results provide compelling evidence that enforcement of the ICA was associated with significant price wedge management, including some overshooting, that it dampened price transmission between the wholesale and retail sectors, and that by stabilizing prices, it generated strong incentives to respond to price increases by planting trees. However, even the partial derivatives calculated do not provide empirically usable estimates of the impact of the ICA on the links between past and future prices. This is because price shocks affect all future prices, violating *ceteris paribus* assumptions that these comparisons require. We therefore turn to policy simulations.

V. Policy Simulation Results

We conducted Monte Carlo simulations of one thousand iterations to uncover the impact of shocks on this system. Each iteration was conducted as follows: First, a random matrix of standard normal i.i.d. disturbances was generated, corresponding to ε_t. Then, picking conditions at a given date as starting values, the process was simulated forward. Next, a shock was introduced in the first period of simulation, the simulation was repeated, and the impulse response was calculated as the difference between the shocked and shocked price paths. All of these impulse responses were stored, and the 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} percentiles of their distribution at each point in time are plotted in figures 5 and 6.

The shock sizes simulated attempt to capture the effects of Oxfam's proposed burning of five million bags of coffee. The calculation combines figures for total annual world output from the ICO, with information about the current wholesale price and a demand elasticity to calculate the initial wholesale price shock that this would generate. Junguito and Pizano (1997) report demand elasticities between -0.2 and -0.4. We therefore picked an elasticity of -0.3. We calculate that Oxfam's proposals would result in a 28 cent price shock in July 1985, and a 14 cent price shock in December 2002. The ICA was in effect at the former date, but not the latter. Our simulations therefore assume the presence of an agreement for the 1985 simulations, but not the 2002 simulations.

Figures 5a and 5b demonstrate the effect of the shock in 2002. There is very mild evidence of cycling in the wholesale response, but no disastrous countervailing price response. Farm prices, on the other hand, do not display a cycle. The single peaked effect of the exercise on farm prices is modest, both in terms of magnitude and duration. They rise from about 15 cents/lb up to 17 cents, and then fall to 10 cents within a year and 4 cents within two. Thus the gains to producers from the move are middling.

Figures 6a and 6b present the results of the same burning policy under the ICA in 1985. There is clear evidence from the wholesale response that the shock generates a price cycle. Indeed, the wholesale price responds much like our coefficients suggested it would. Wholesale prices experience a little lift one and two years into the simulation, but reach a 7 cent trough about five-six years in. Farm prices also cycle in response to the shock, although the phase of this cycle does not match that of the wholesale cycle.

All the forgoing results indicate that our findings of exaggerated supply response under the ICA are economically meaningful. The ICA did, indeed, deepen the coffee price cycle.

VI. Introducing Price Transmission

The argument that retail coffee prices respond asymmetrically to wholesale price movements has been made often. For example, Talbot (1997) p.68, points out that following a Brazilian drought in 1986 which raised wholesale prices, retail prices rose as well, but didn't come back down again after the price fell. He takes this as evidence of asymmetric price transmission due to market power. However, US Stocks fell dramatically over the duration of the price peak[6]. It is not obvious that retail prices before and after the price spike should maintain the same relationship with wholesale prices despite the change in stock levels. The point is that important *ceteris paribus* assumptions are violated when using anecdotal evidence.[7]

The VAR model that we have refined in this paper was originally developed for the express purpose of testing for asymmetric price transmission in US butter markets.[8] While allowances for asymmetric price transmission have been suppressed thus far, they can be easily reintroduced. Instead of conditioning retail prices, say, on lagged wholesale price changes, we simply condition them on lagged wholesale price increases and decreases, separately. We did this using an earlier, cruder model of coffee markets, and found no statistically significant evidence that price transmission was asymmetric. We did, however, find that month old retail price increases led to current retail price increases, while month old retail price decreases did not lead to current retail price decreases. This is suggestive of a price leadership game, with firms unwilling to be the first to raise prices. This is consistent with the suggestion in commodity

[6] According to stock data available from the Green Coffee Association of New York.
[7] Bettendorf &Verbofen (2000) look at the related and often confused issue of incomplete price transmission, and argue that prices need not be transmitted fully when other, potentially non-constant, components of marginal cost exist.
[8] See Chavas & Mehta (2004).

journals, that other roasters watch Folgers' prices to determine when to respond to green coffee price increases.[9]

This is not to say that market concentration is not a problem in coffee markets (nor that it is). Indeed, our results on contemporaneous price transmission to the retail sector suggest the presence of 'unexplained' increases in marketing margins. However, evidence of asymmetric price transmission is scant.

VII. Discussion

Thus far, we have answered three and half out of the four questions posed. First, we have ascertained that that the ICA did create a coffee price cycle. It did so by providing future price stability, which encouraged supply response to price signals. Our simulations of positive price shocks suggest that they will lead to a cycle, although the median impulse response does not dip very far into the negative region. We also note that in order to restrict production to ICA quota restrictions coffee boards had to introduce a price wedge between wholesale and farm prices. This price wedge dampened price response at the one and two year horizon, and may even have reversed it when managers overshot in their estimates of the required wedge. However, it is not clear that the price wedges actually dampened the cycle. They may even have exacerbated it, by extending price upturns, leading to more planting and more serious downturns four to five years later.

Second, we have simulated the effects of burning five million bags of coffee. If this is done in the absence of a price stabilization mechanism, it will offer modest relief to farmers for one to two years, with prices returning to without-burn levels in two to three years. A 15 cent/lb price increase from prices of 34 cents/lb represents a significant welfare improvement. In December 2002, before subtracting the cost of the burn, it would have raised producer surplus by $765 million ($0.15/lb at 85 million remaining 60 lb. bags). The cost, presuming these bags were purchased at the prevailing wholesale price of 46 cents/lb, would be $138 million. The key questions, though, are who pays for the burn, which types of coffees to burn, and how to manage the expectation that such events would become regular. Such an expectation, our results suggest, might generate supply response by stabilizing future prices or raising the relative prices of coffee varieties targeted for burning. This would be counterproductive in the longer term.

[9] It is also similar in spirit to the findings of Bewley (1999), who finds, in an Australian context, that movements in prices of certain instant coffee brands Granger-cause movements in others.

Third, we looked for asymmetric price transmission and found little evidence of it, although there is evidence of what may be called marketing margin shocks. These may be interpreted to suggest increasing market power.

The final question, concerns supply response outside of the ICA, and what it tells us about why prices have remained so low for so long. Our key finding is that supply response to price information at the aggregate level is rather weak in the absence of an agreement. In part, this may be because in an unstable price environment farmers cannot use current price information to improve their investment decisions. This finding allows us to advance a tentative explanation for the low prices of the last thirteen years.

The statement that prices have been low for thirteen years requires clarification. We argue that the low prices of the early 1990s and the last three years are expressions of the same phenomenon. The two Brazilian frosts that raised prices substantially in the 1990s complicate the picture.

Recent technological changes have allowed roasters to increase the substitutability of different beans, and to use what might formerly have been considered unusable beans. Generalizing liberally, this has led to a shift in comparative advantage in coffee from the "higher quality" shade-grown smallholder Arabicas of Central America, to the "lower quality" estate grown Robustas of Vietnam and Brazilian Arabicas. These countries have responded by increasing supply drastically. This in turn has depressed prices below the average production costs of all producers. In a market for an annual or semi-annual crop, such an oversupply would conceivably be rectified within two or four years. Given the longer term nature of investments in (and disinvestments from) coffee trees, and the lack of obvious alternatives to coffee production for smallholder operations, it is reasonable to presume that exit from coffee markets would take more time.

Thirteen years of low prices, however, may be more than this simple adjustment cost story can explain. We argue that our results provide an answer. We have learned that in the absence of a price stabilization mechanism, supply response is slow, because making decisions that depend upon future prices when prices are volatile is difficult. From this perspective, the frosts of the 1990s may have made things worse.

The problem may well be exacerbated by shortages of information. Many smallholder coffee farms are in remote regions where even basic information, such as current local price levels, is unavailable. Information about current international tree stocks and inventories is even more difficult to come by. Hence, it is possible that the information necessary to forge careful exit decisions is simply unavailable.

Looking to the future, the clear message from our results on this question is that price stabilization programs must be intelligently designed. They must not attempt to raise prices too far above long run average production costs. Nor must they reduce price uncertainty too much. Doing either will generate excess supply which may scupper the program itself. It seems likely that the optimal mechanism will involve market sharing that allows for some price volatility and flexibility in quotas. It would also involve longer term instruments to spread price risk at competitive rates. The ICO should become a clearing house for information on tree and coffee stocks, and on the various government interventions in coffee markets. It should also utilize such information to develop price forecasts, being certain not to underestimate price risk. Further, given demand and supply inelasticity, any mechanism to control production will generate large quota rents. The distribution of these rents must be transparent and should not be tied to production.

Finally, a word on 'fair trade' coffee is probably in order. One important change in the structure of the international coffee market associated with the formation of the ICA, is the expansion of tariffs on imports of processed coffee products into consuming nations. This was a compromise with roasters concerned about rising raw materials costs under the agreement. These tariffs remain in place thirteen years after the agreement's collapse. From this perspective, 'fair trade' coffee brands should be seen as a form of tariff jumping. Tariff rents are captured by agents (fair trade roasters, retailers and coffee shops) acting domestically on behalf of foreign producers and sent back over the border. Thus, in the context of an unmanaged market, they are a welfare enhancing response to a policy distortion. We note however, that such interpretations would not apply to proposals to turn the entire market over to mandatory 'fair trade' mechanisms. Nor can such proposals be seriously addressed unless their provisions for managing supply and distributing quota rents are presented clearly.

One thing is certain, though. Reductions in these tariffs will enhance the welfare of producing nations and of consumers through improvements in quality, variety and price competition.

Bibliography:

Akiyama, T. & Varangis, P.N. (1990). The impact of the International Coffee Agreement on producing countries. *World Bank Economic Review*, 4(1), 157-173.

Bates, R.F. (1997). Open economy politics: the political economy of the world coffee trade. Princeton: Princeton University press.

Bettendorf, L. & Verbofen, F. (2000). Incomplete transmission of coffee bean prices: Evidence from the Netherlands. *European Review of Agricultural Economics*, 27(1) 1-16.

Bewley, R. (1999). An econometric analysis of the factors effecting the price of instant coffee. *Contributions to Economic Analysis*, vol. 240, 33-65.

Bohman, M., Jarvis, L., & Barichello, R. (1996). Rent seeking and international commodity agreements: the case of coffee. *Economic development and cultural change*, 44(2), 379-404.

Chavas, J.P. & Mehta, A. (2004). Price transmission in a vertical sector: the case of butter. *American Journal of Agricultural Economics* (forthcoming).

Coggins, J.S. (1996). Virtual decisions under imperfect competition: the case of the International Coffee Agreement. in *Industrial organization and trade in the food industries.* pp.293-315.

Edwards, R. and Parikh, A. (1976). A stochastic simulation of the world coffee economy. *American Journal of Agricultural Economics*,

Gilbert, C. (1987). International commodity agreements: design and performance. *World Development*. 15(5), 591-616.

Junguito, R. & Pizano, D. (1999). Continuity and change in the Colombian coffee industry. in *Contemporary Studies in Economic and Financial Analysis*, vol. 84: Colombia: an opening economy? 51-65.

International Coffee Organization. (2004) Coffee Crisis. *www.ico.org*

Oxfam (2002). Mugged: Poverty in your coffee cup. *www.oxfamamerica.org/pdfs/mugged_coffee-report.pdf*

Palm, F.C. & Vogelvang, B. (1991). The effectiveness of the World Coffee Agreement: a simulation study using a quarterly model of the world coffee market. in *International Commodity Market Models*. Eds. Guevenen, O., Labys, W.C., & Lesourd, J.B. London: Chapman and Hall.

Talbot, J. M. (1997). Where does your coffee dollar go?: The division of income and surplus along the coffee commodity chain. *Studies in comparative International Development,* 32(1), 56-91.

Vogelvang, B. (1988). *A quarterly econometric model of the world coffee economy.* Amsterdam. Free University Press.

Table 1: Price Equation Parameter Estimates

	Farm Price		Wholesale Price		Retail Price	
Effects of:	*Coeff.*	*Std. Err.*	*Coeff.*	*Std. Err.*	*Coeff.*	*Std. Err.*
Constant	**0.1125**	**0.0598**	0.0132	0.0846	0.0553	0.0692
Monthly Time Trend	-0.0002	0.0002	0.0004	0.0004	**0.0005**	**0.0002**
d_1	0.0029	0.0403	0.0061	0.0391	-0.0029	0.0234
d_{13}			-0.0183	0.0429		
$Quarter_1$	-0.0131	0.0178	-0.0072	0.0150	0.0245	0.0194
$Quarter_2$	**-0.0408**	**0.0174**	-0.0232	0.0147	0.0144	0.0165
$Quarter_3$	**-0.0379**	**0.0182**	-0.0120	0.0146	0.0252	0.0163
p_{t-1}^F	**0.9964**	**0.0792**	**0.3538**	**0.0938**		
Δp_{t-1}^F	0.2012	0.1498	**0.4551**	**0.1435**		
p_{t-13}^F			**0.1784**	**0.0543**		
Δp_{t-13}^F			-0.0915	0.0647		
p_{t-1}^W	-0.0370	0.0750	**0.7137**	**0.0777**	**0.1065**	**0.0350**
Δp_{t-1}^W	-0.0127	0.1358	**-0.2727**	**0.1487**	0.1079	0.0783
p_{t-12}^W			**0.1023**	**0.0313**		
p_{t-13}^W			**-0.2347**	**0.0572**		
Δp_{t-13}^W			0.0818	0.0643		
p_{t-1}^R			-0.0399	0.0244	**0.9017**	**0.0301**
Δp_{t-1}^R			-0.0060	0.0349	**0.2115**	**0.0829**
p_{t-13}^R			0.0299	0.0314		
Δp_{t-13}^R			-0.0319	0.0317		
Parameters capturing medium term effects						
b_0			-0.0005	0.0677		
b_I			-0.6104	0.5562		
b_I^A			**2.8441**	**1.0298**		
b_{II}			0.1205	0.3142		
b_{II}^A			**1.5284**	**0.6812**		
b_{III}			**-0.5935**	**0.2459**		
b_{III}^A			0.1603	0.3218		
Parameters capturing long term effects						
φ_{IV}			-0.6767	0.9228		
φ_{IV}^A			0.0334	0.5555		
φ_V			-0.7852	0.6116		
φ_V^A			**-3.4127**	**0.8131**		

Table 2: Estimates of Parameters Determining Variance

	Cholesky Equation					
	a1		a2		a3	
Effects of:	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Constant	**0.0269**	**0.0057**	-0.0134	0.0419	**0.0798**	**0.0484**
d_1	**0.0798**	**0.0140**	**0.0619**	**0.0246**	**-0.0493**	**0.0122**
p^F_{t-1}	**0.0552**	**0.0228**	**0.2067**	**0.0308**		
p^W_{t-1}	**-0.0355**	**0.0208**	**-0.0787**	**0.0305**	**0.0761**	**0.0169**
p^R_{t-1}			0.0076	0.0136	-0.0241	0.0174
$Shock_{94}$	-0.0417	0.0354	0.0353	0.0320		
$Shock_{99}$	**-0.0338**	**0.0027**	0.0187	0.0458		
	a4		a5		a6	
Effects of:	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Constant	0.0224	0.0192	0.1193	0.0804	0.1122	0.0706
d_1	0.0301	0.0289			-0.0116	0.0283
p^F_{t-1}	**0.2074**	**0.0359**	0.0044	0.0366		
p^W_{t-1}	**-0.0991**	**0.0386**	-0.0040	0.0269	0.0090	0.0270
p^R_{t-1}			-0.0407	0.0289	**-0.0416**	**0.0250**

Figure 1: Coffee Prices

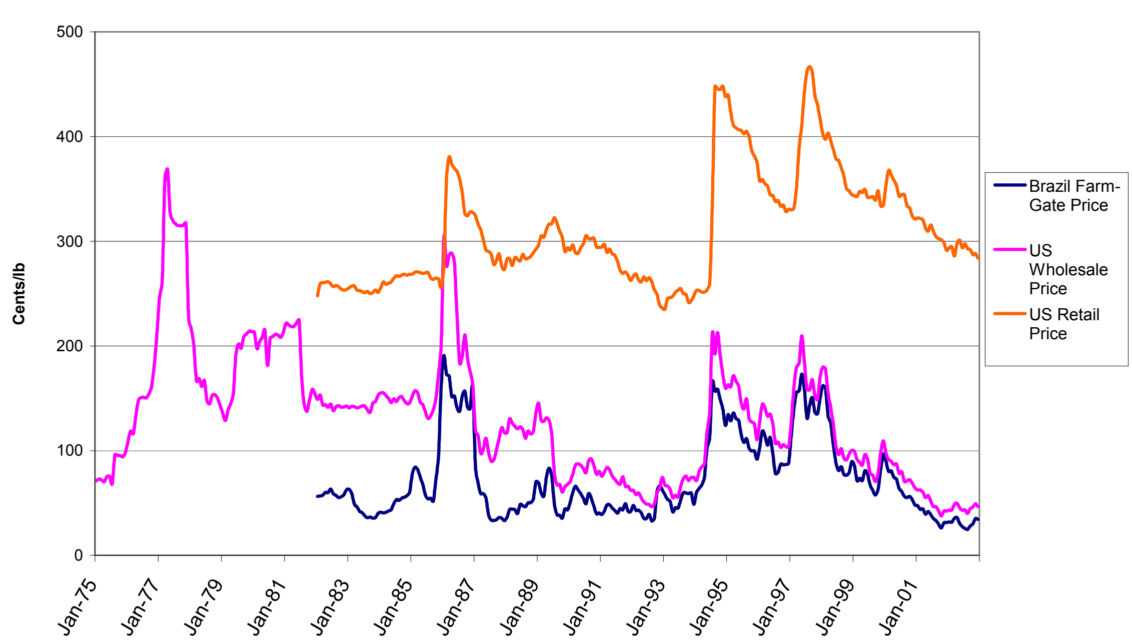


Figure 2a: Contemporaneous Price Transfer Coefficient, farm and wholesale prices

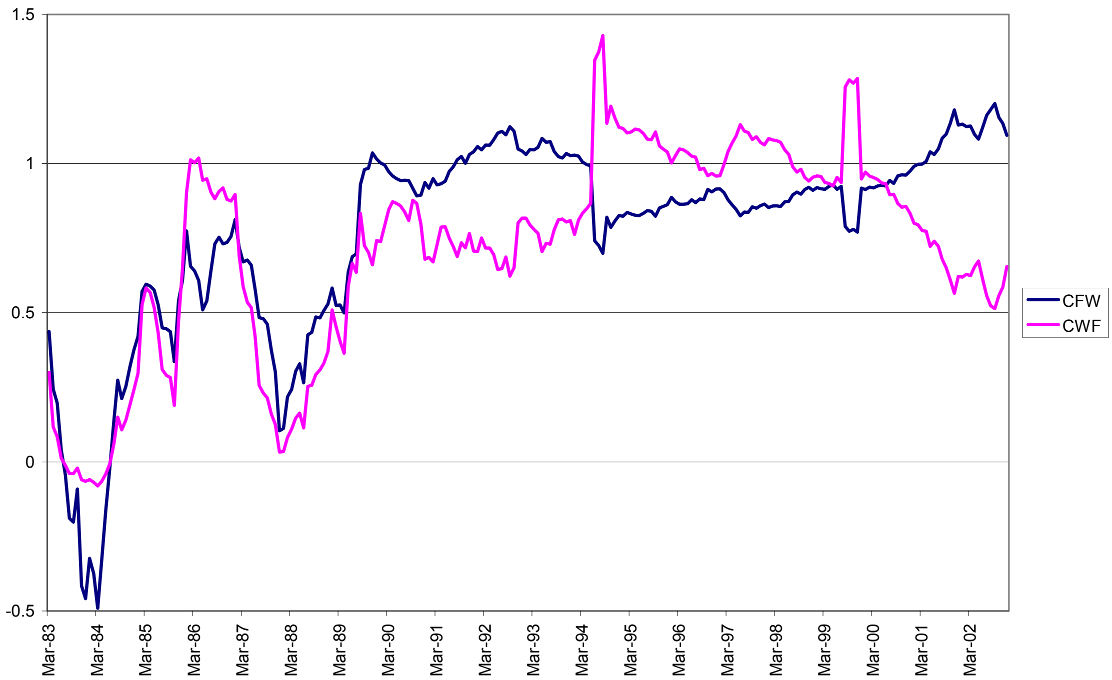


Figure 2b: Contemporaneous Price Transfer Coefficient, farm and retail prices

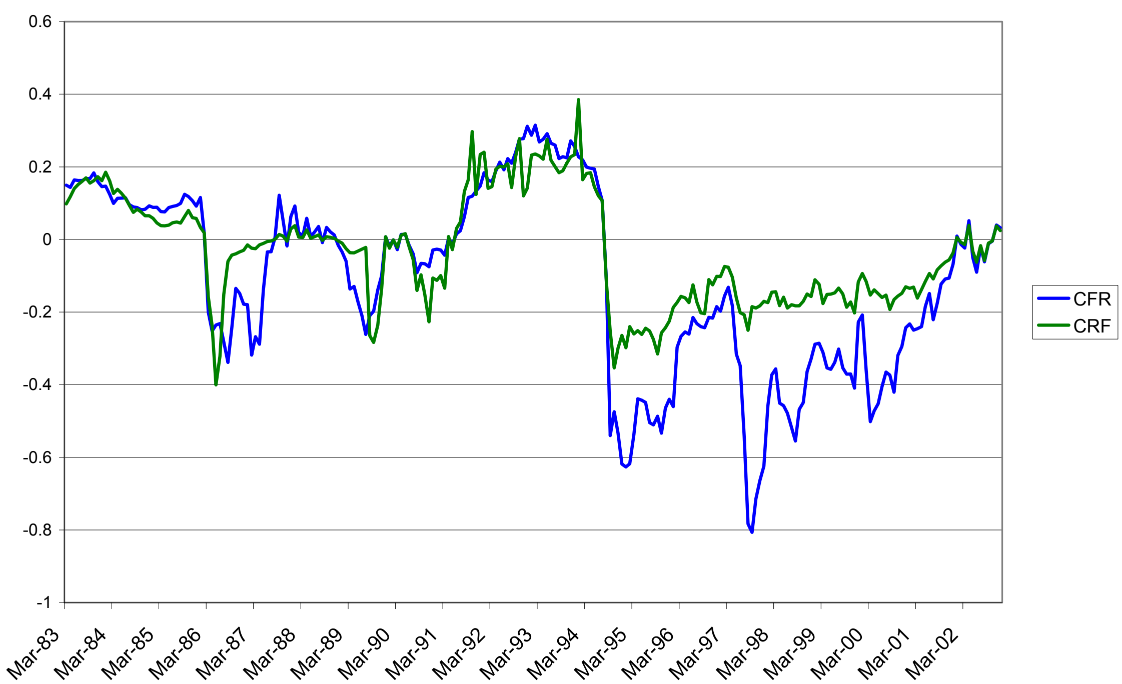


Figure 2c: Contemporaneous Price Transfer Coefficient, wholesale and retail prices

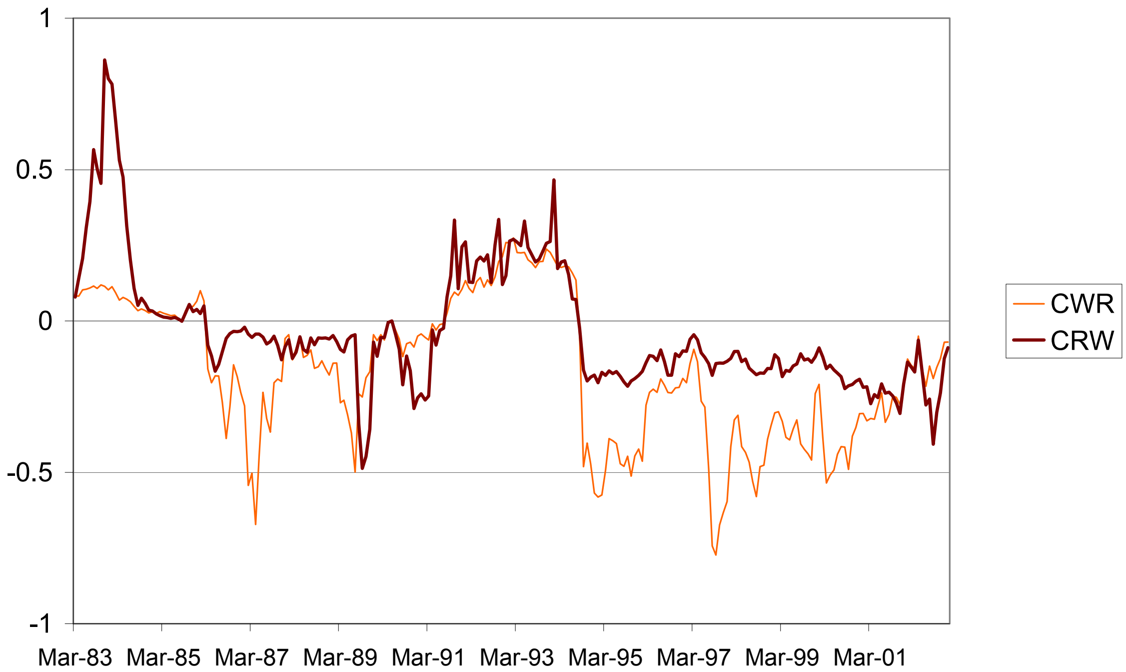
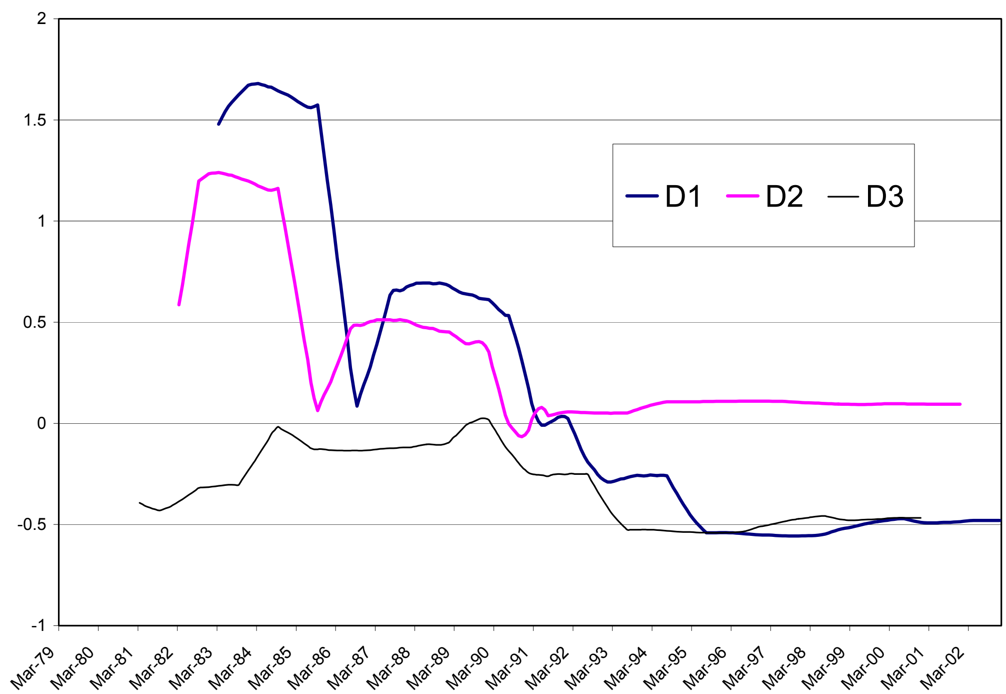


Figure 3: Intermediate yield effects.



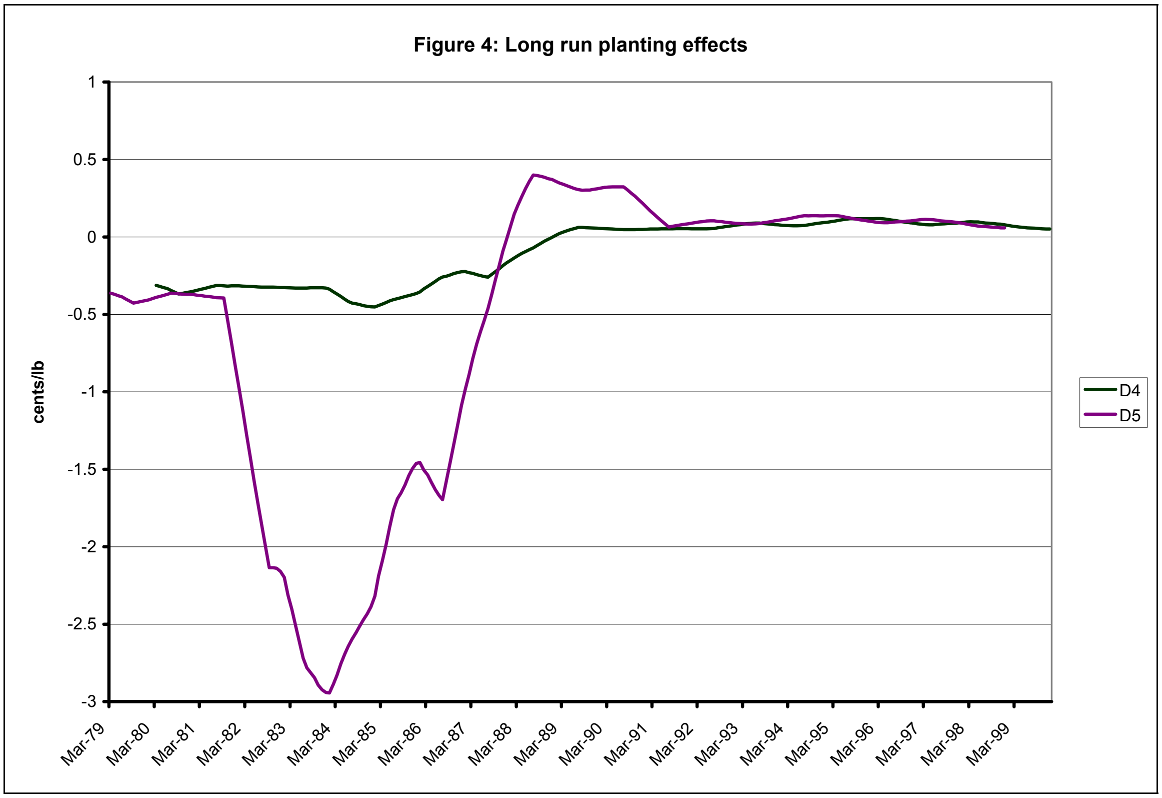


Figure 4: Long run planting effects
cents/lb
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
Mar-79
Mar-80
Mar-81
Mar-82
Mar-83
Mar-84
Mar-85
Mar-86
Mar-87
Mar-88
Mar-89
Mar-90
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
D4
D5

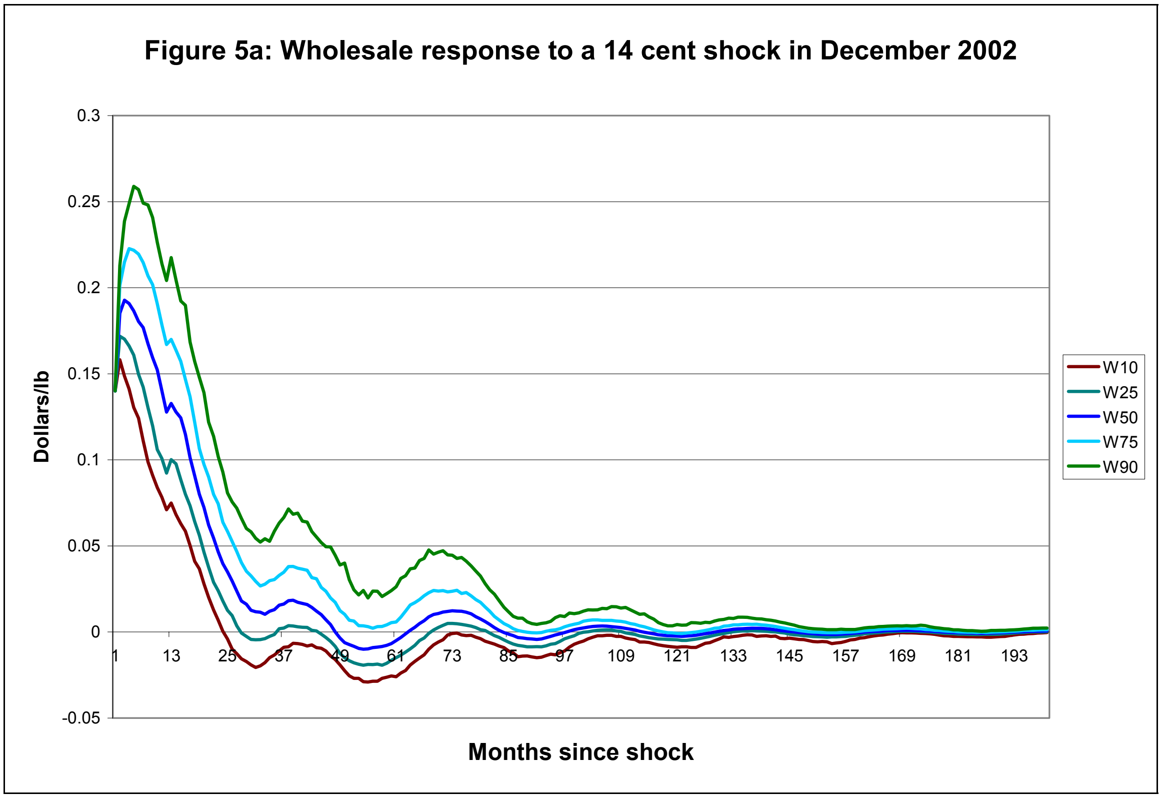


Figure 5a: Wholesale response to a 14 cent shock in December 2002
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
Dollars/lb
1
13
25
37
49
61
73
85
97
109
121
133
145
157
169
181
193
Months since shock
W10
W25
W50
W75
W90

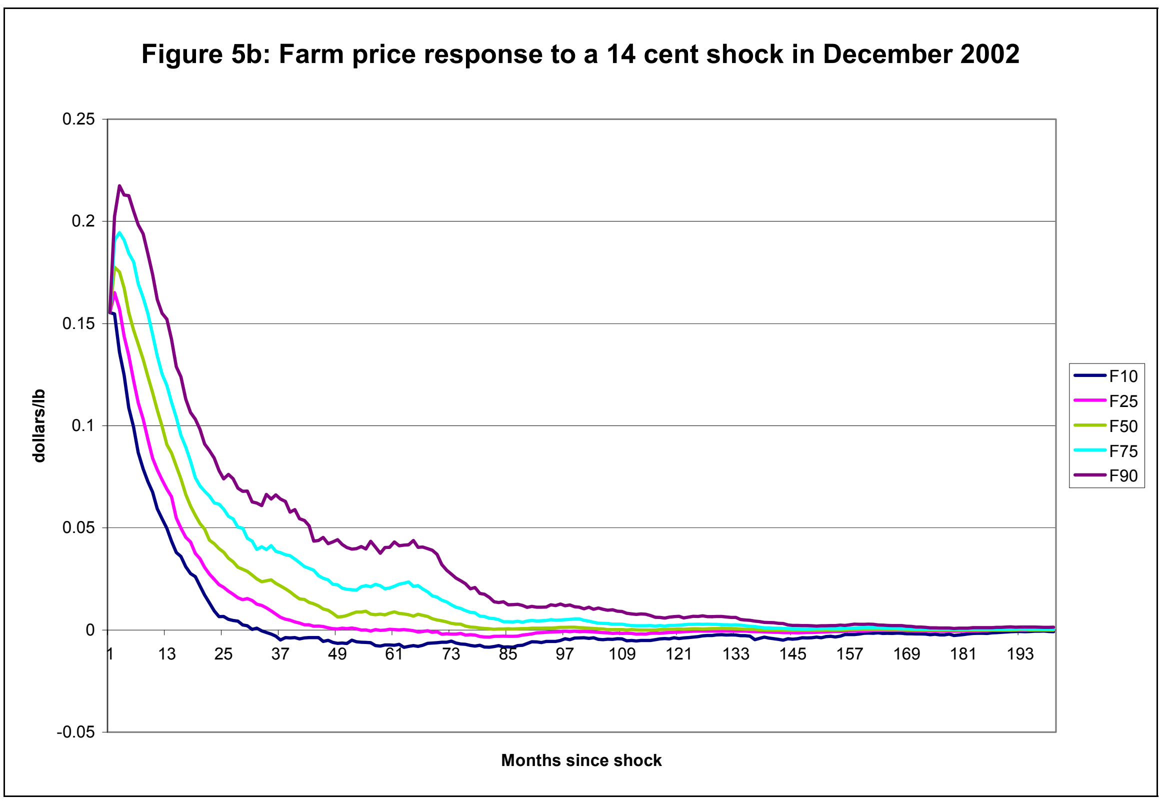


Figure 5b: Farm price response to a 14 cent shock in December 2002
0.25
0.2
0.15
0.1
0.05
0
-0.05
dollars/lb
1
13
25
37
49
61
73
85
97
109
121
133
145
157
169
181
193
Months since shock
F10
F25
F50
F75
F90

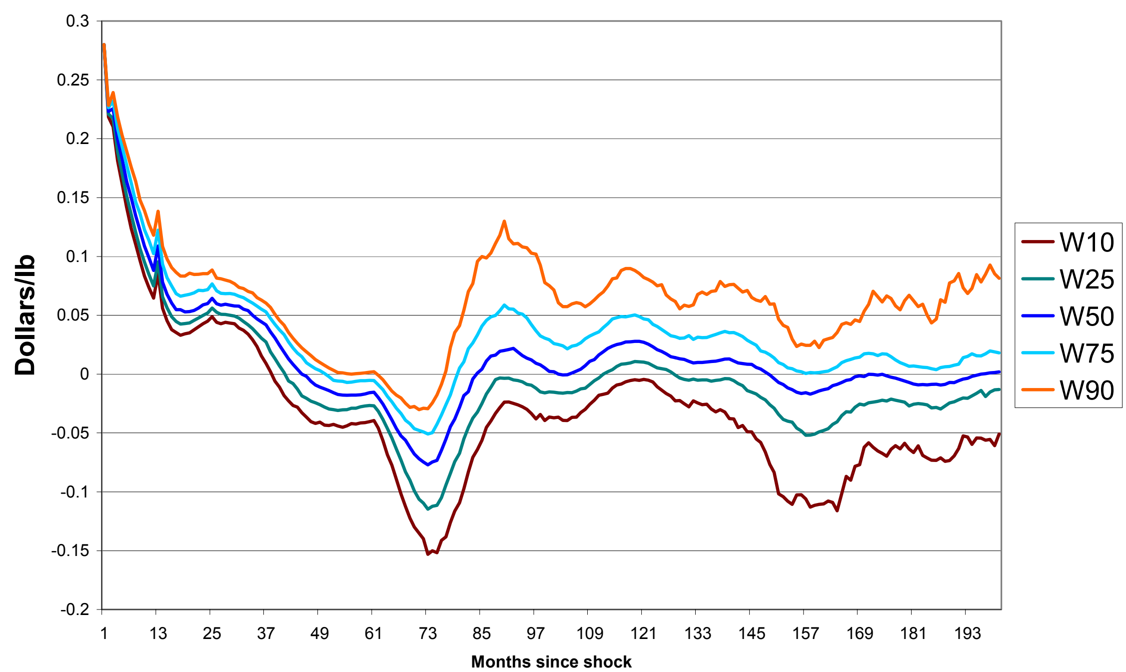


Figure 6a: Wholesale response to a 28 cent shock in July 1985

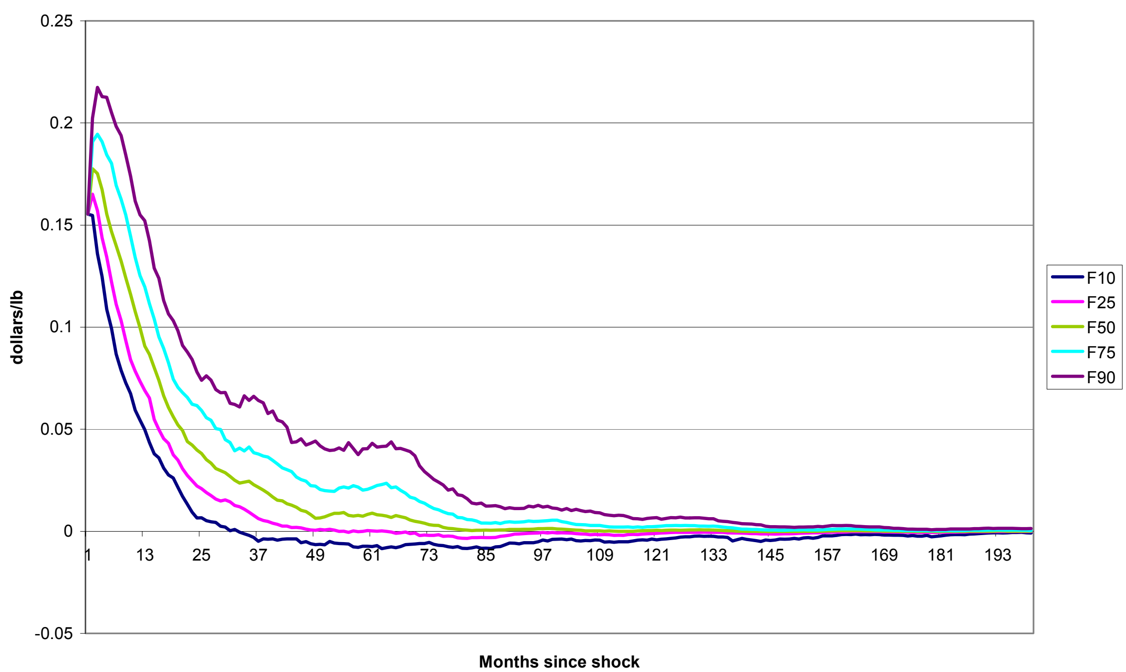


Figure 6b: Farm price response to a 14 cent shock in December 2002