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Publication date:
2008

Citation for published version (APA):
Mohan, S., & Russell, B. (2008). Modelling thirty five years of coffee prices in Brazil, Guatemala and India. (Dundee Discussion Papers in Economics; No. 221). University of Dundee.

Dundee Discussion Papers in Economics

MODELLING THIRTY FIVE YEARS OF COFFEE PRICES IN BRAZIL, GUATEMALA AND INDIA

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Working Paper
No. 221
December 2008
ISSN:1473-236X

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11 December 2008

ABSTRACT

Over the past thirty five years coffee markets have been subject to market controls and regulations culminating in the liberalisation of coffee markets in the early 1990s. This paper models the relationship between the producers' and world prices of coffee in Brazil, Guatemala and India allowing for the effects of changes in market structures. We find that liberalisation has benefited producers substantially in terms of higher real coffee prices and a higher share of the world price of coffee.

Keywords: coffee prices, cointegration, coffee markets, liberalisation, coffee producers, transfer costs
JEL Classification: Q11, Q17, Q18, C32, C52, F13, F14.

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1. INTRODUCTION

Prior to the 1990s unilateral and multilateral interventions in coffee markets were common.[1] The broad objective of the interventions was macroeconomic stabilisation for the general welfare of the population and price stabilisation for the specific welfare of coffee producers.[2] The interventions took the form of export supply management through regulations or buffer stock schemes and in many cases the domestic market was also regulated through the administration of the prices received by producers. In terms of producer welfare, the interventions are generally regarded as unsuccessful.[3] The initiation of economic reforms in developing countries in the late 1980s resulted in most countries liberalising their coffee sector by replacing state-controlled marketing systems with markets run by private agents. The pace and scope of liberalisation varied across countries but has resulted in a more competitive international coffee market that is now mostly subject to market forces.

The liberalisation of coffee markets is expected to bring clear benefits to producers from the introduction of more efficient markets but it also exposes the intermediaries and producers in developing countries to the vagaries of the market. The commonly held view is that liberalisation has increased the producer's share of the terminal price of coffee because of the reduction in intermediation costs arising from the greater degree of vertical integration in coffee markets (Mohan, 2007).[4]

Changes in coffee policies at both the domestic and international levels and the eventual liberalisation of coffee markets raise a number of issues when modelling coffee prices. For

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[1] Unless specified otherwise, 'coffee' means green (raw or un-roasted) beans and coffee prices imply prices of green beans.

[2] Coffee producers include growers and/or semi-processors, who sell their coffee as cherries, parchment or green beans. If producers sell their coffee as cherry or parchment, the prices are converted to green beans by using a 'green bean equivalent'.

[3] For example, see Raffaeli (1995), McIntire and Varangis (1999), Jerome and Ogunkola (2000), Varangis et al. (2002), Winter-Nelson and Temu (2002), Krivonos (2004) and Boudreaux (2007).

[4] The terminal price of coffee is the spot price of coffee as traded in international markets and the producer price of coffee is the cash price received by producers.

example, consider Graph 1 of terminal and producer prices for Brazilian, Guatemalan and Indian Arabica coffee.[5] There are three striking features common to these graphs. First, the price of coffee received by producers at the beginning of the Twenty First Century is much the same as it was in the 1970s suggesting a large fall in real terms. This fall in the real price of coffee is demonstrated in Table 1.[6]

Second, the gap between the terminal and producer prices of coffee varies considerably over time in all three countries. This gap can be thought of as an indirect measure of the costs of transferring coffee from the producer to the terminal markets. Between January 1973 and December 1989 the average transfer costs were around 85 (141 per cent of the average producer price), 45 (54 per cent), and 58 (72 per cent) US cents per pound of coffee for Brazil, Guatemala and India respectively. Following the liberalisation of coffee markets there has been a decline in transfer costs. Since January 1990 average transfer costs were around 18 (28 per cent), 32 (46 per cent) and 30 (42 per cent) US cents per pound of coffee for the three countries respectively. Such large reductions in transfer costs are unlikely to be explained by changes in the freight, handling and related costs alone. It is more likely the reductions are due to changes in the economic rents received by intermediaries and governments in the transfer process.

The third feature follows from the second. Large changes in transfer costs associated with changing government policies, regulations and market structure causes shifts in the producers' share of the terminal price of coffee. The share is the ratio of the producer to the terminal price of coffee and is also referred to in the paper as the coffee price ratio. These shifts are at times quite sudden and persistent as demonstrated in Graph 2 of the coffee price ratio for the three countries.

If the terminal and producer prices of coffee are closely related then any modelling of the two prices must take into account the shifts in the coffee price ratio. If the shifts are not

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5 Details of the data are provided in Appendix 1.

6 The real price of coffee in Table 1 is measured in terms of the United Nations (UN) index of unit values of exports. Similar results are obtained if the real price of coffee is measured in terms of the United States consumer price index (CPI).

accounted for then the model will result in biased and poor estimates that may lead to incorrect inferences. This paper, therefore, models the relationship between the terminal and producer prices of coffee in Brazil, Guatemala and India allowing for the shifts in the coffee price ratio. These three countries are chosen due to their important positions in the world coffee market and the variation in the policies and market structures over time in each country and across countries. We demonstrate that the modelling approach we adopt is successful in dealing with this variation.

The next section sets out the standard empirical modelling approach to coffee prices and explains the source of the biases in the standard empirical literature. Section 3 reports the results of the estimated models which are surprisingly similar for the three countries given their different experiences.

We estimate that the equilibrium producer's share of the terminal price of coffee has increased in all three countries since coffee market liberalisation to around 0.85 in Brazil and India and 0.8 in Guatemala. If liberal markets lead to these high producer shares then we can calculate the loss to producers from coffee market regulations and interventions over the years. In section 4 we show the loss is substantial. For example the cumulative loss to producers between 1973 and 1989 is 30.2, 1.0 and 1.8 billion US$ for Brazil, Guatemala and India respectively. This can be compared with the cumulative total of payments to producers over the same period of 31.7, 6.1 and 3.8 billion US$. Also shown in Section 4 is that these losses are now almost non-existent following the liberalisation of coffee markets.

2. MODELLING COFFEE PRICES

The standard approach to modelling coffee prices can be motivated with reference to the Enke (1951), Samuelson (1952), Takayama and Judge (1971) spatial models of prices and the 'law of one price'.[7] These models argue that when two markets attain equilibrium prices the prices differ only by the costs of transferring the goods between the markets. The transfer

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[7] See also Ardeni (1989), Badiane and Shivley (1998), Baffes (1991), McNew (1996), Abdulai (2000), and Fackler and Goodwin (2002) and Conforti and Rapsomanikas (2005). The coffee model can be thought of as 'spatial' in terms of the geographic locations of producer and terminal coffee markets.

costs include the shipping and storage costs associated with moving produce between markets along with the economic rents of intermediate agents in the supply chain. In this model, demand and supply shocks are fully transmitted between the two markets in equilibrium.

The equilibrium in coffee prices between the terminal and producer markets can be represented in these models as:

$$P_{P,t} \quad = \quad P_{T,t} * U^{e} \qquad (1)$$

where $P_{P,t}$ and $P_{T,t}$ are the producer and terminal prices measured as price per unit of coffee respectively, U^{e} is the constant ratio that coffee prices in the two markets attain in equilibrium and the '*t*' subscript indicates the time period of the data. Note that even though the producer price of coffee is the subject of the equilibrium relationship in equation (1) it does not imply causation between the two prices which is conceptually bi-directional.

With $U^{e} < 1$ in equation (1) we can identify transfer costs, TC_{t}, associated with the movement of coffee between the two markets such that $TC_{t} = P_{T,t} - P_{P,t}$ which are also measured in price per unit of coffee. In the short run the equilibrium relationship (1) need not apply due to the incomplete transfer of information between markets and other rigidities. However, in the long run we expect this equilibrium relationship to hold if information is shared efficiently between markets and all agents make normal profits.[8]

An assumption of this model that is not often highlighted in the literature is that the transfer costs in equilibrium are a fixed ratio of both the terminal and producer prices of coffee. For example, transfer costs as a ratio to, or share of, the terminal price of coffee in equilibrium is:

$$\frac{TC_{t}}{P_{T,t}} = \frac{P_{T,t} - P_{P,t}}{P_{T,t}} = 1 - U^{e} \qquad (2)$$

Importantly, this implies that if the equilibrium in coffee prices is adequately described by this model then the statistical process of the transfer costs is the same as that of the two coffee prices in equilibrium. If this was not the case then when equilibrium coffee prices are attained in the two markets, transfer costs will not have returned to its equilibrium ratio in terms of the respective coffee prices. This implication is important for our modelling of coffee prices below.

In the coffee price literature, the equilibrium model of coffee prices has a straightforward time series interpretation in terms of cointegration analysis.[9] We can write (1) as:

$$p_{P,t} \;=\; p_{T,t} + u^{e} \tag{3}$$

where lower case variables are the natural logarithms of the equivalent upper case variables. If $p_{P,t}$ and $p_{T,t}$ are integrated processes and we can find a linear combination of the two prices such that;

$$p_{P,t} - \beta \; p_{T,t} \;=\; \omega_t \tag{4}$$

where ω_t is a stationary process with a constant mean then $p_{P,t}$ and $p_{T,t}$ are cointegrated in the sense of Engle and Granger (1987) and there exists a long-run cointegrating relationship between the two coffee price variables.[10] This relationship is interpreted as the equilibrium relationship in equation (3) if $\beta = 1$ so that the model displays long-run homogeneity. This means that a 1 percent increase in one coffee price leads to a 1 per cent increase in the other price in the long run so that transfer costs as a proportion of either the terminal or the producer price are unchanged. This also implies that transfer costs have increased by 1 per

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8 In the short run the coffee price ratio U_t may be greater than one implying that intermediaries make losses in the transfer of coffee between the two markets. However, this situation cannot continue in equilibrium as losses would lead agents to exit the market until intermediaries make 'normal' profits and $U^{e} < 1$.

9 For example see, Rapsomanikas *et al.* (2004), Fortenbery and Zapta (2004), Krivonos (2004) and Alizadeh and Nomikos (2005),.

10 See also Johansen (1988, 1991, 1995).

cent in the long run. With trending price and cost variables β needs to equal 1 so that a persistent change in the level of coffee prices does not lead to a persistent change in the gap between the two prices in equation (3). In other words, $\beta = 1$ means that a change in the level of prices leaves the coffee price ratio unchanged in the long run and transfer costs have increased in line with prices.

The long-run relationship of equation (3) is nested within a vector autoregressive-error correction model (VAR-ECM):

$$\Delta x_t = \delta + \Pi x_{t-1} + \sum_{i=1}^{k} \Pi_i \Delta x_{t-i} + \varepsilon_t \qquad (5)$$

where $x_t = \begin{pmatrix} p_P \\ p_T \end{pmatrix}_t$, Π is the long-run matrix containing the cointegrating vectors, Π_i is a matrix of short-run coefficients and Δ represents the change in the variable such that $\Delta x_t = x_t - x_{t-1}$. The vector of unrestricted constants is given by δ which can be written so as to incorporate u^e from equation (3). Estimating the VAR-ECM allows us to (i) formally test for the presence and the number of cointegrating vectors; (ii) test whether long-run homogeneity is a valid restriction; (iii) estimate the speed of adjustment back to the long-run relationship; and (iv) identify whether producer prices, terminal prices, or both adjust when prices are away from the long-run cointegrating relationship.

Two important assumptions concerning the equilibrium relationship (3) and the cointegration analysis are that the coffee price ratio, u_t, converges on a constant value, u^e, in equilibrium and that u_t is a stationary process with a constant mean equal to u^e. Looking closely at Graph 2 we can see discrete shifts in the mean of the coffee price ratio. These visual shifts in the ratio can be tested formally by applying the Bai and Perron (1998, 2003a, 2003b) technique for identifying multiple structural breaks in the coffee price ratio, u_t.[11] Defining a 'coffee regime' as a period with a constant mean coffee price ratio, the Bai-Perron technique

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[11] See Appendix 2 for details of the Bai-Perron estimates of the structural breaks in the coffee price ratio.

identifies 11, 9, and 12 coffee regimes for Brazil, Guatemala and India. These regimes are shown in Graph 2 as horizontal thin lines.

It appears, therefore, that the two important assumptions are not valid. This suggests there is a time dimension to the mean ratio of coffee prices and therefore the long-run coffee price ratio should be represented as u_t^e and equation (4) should be written:

$$p_{P,t} - \beta_1 \; p_{T,t} - \beta_2 u_t^e = \omega_t \qquad (6)$$

and $x_t = \begin{pmatrix} p_T \\ p_P \\ u^e \end{pmatrix}_t$ in the VAR-ECM.

If estimation of the model proceeds assuming that the ratio of coffee prices is time *invariant* as implicitly (or explicitly) assumed in the standard literature then the estimates of the long-run coefficients, β, and the adjustment coefficients in equation (5) will be poor and biased if the coffee price ratio, u_t, is non-stationary. The direction of this bias depends on whether the coffee price ratio is increasing or decreasing over the period. Consequently, how we model the coffee price ratio may affect our estimates in important ways.

There are three obvious ways to model the changes in the mean of the coffee price ratio. The first is to approximate the changing mean of u_t^e with a linear trend. In this case we introduce a trend, *T*, in the cointegrating space and the cointegrating relationship is:

$$p_{P,t} - \beta_1 \; p_{T,t} - \beta_2 T_t = \omega_t \qquad (7)$$

and $x_t = \begin{pmatrix} p_T \\ p_P \\ T \end{pmatrix}_t$ in equation (5). The second way is to introduce a series of shift dummies, D_i, in the cointegration space to capture the discrete changes in u_t^e associated with each coffee regime as shown in Graph 2. This provides:

$$p_{P,t} - \beta_1 \; p_{T,t} - \sum_{i=1}^{k} \alpha_i D_i = \omega_t \qquad (8)$$

and $x_t = \begin{pmatrix} p_T \\ p_P \\ D_1 \\ to \\ D_k \end{pmatrix}_t$ in equation (5) where k is the number of estimated 'coffee regimes'. The third option is combine equations (7) and (8) and include both a trend and the shift dummies in the cointegration space.

3. ESTIMATING AN ERROR CORRECTION MODEL OF COFFEE PRICES

In this section we report estimates of four models for each of the three coffee producing countries. The first model is the standard model from the literature as in equation (5). The remaining models include the more complicated proxies for the long-run coffee price ratio, u_t^e, outlined above. In model two the proxy is a linear trend as in equation (7). Model three includes a trend and a series of shift dummies that represent the coffee regimes identified previously by the Bai-Perron technique. Finally, in model four the proxy is just a series of shift dummies as in equation (8).

3.1 The Data

The models are estimated using the average monthly ICO Indicator Price for Arabica coffee as a measure of terminal prices and the average monthly producer price for Arabica coffee in Brazil, Guatemala and India for the period January 1973 to October 2007.[12] In analysing the data we should keep in mind the factors that could influence the evolution of coffee prices. The period 1973 to 1989 coincides with the operation of the International Coffee Agreement for regulating the market through export quotas.[13] Under the Agreement, export-quotas were allotted to exporting countries and they were changed according to changes in world coffee

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[12] Further details concerning the data are provided in Appendix 1.

[13] Its stated aim was to achieve price stabilisation, increase revenue from coffee and adjust production in line with demand.

prices. However, the Agreement did not always operate as there was failure to reach any agreement among participating countries in 1968, 1972, 1973 and between 1977 and 1980 (Raffaeli, 2005). The Agreement was finally suspended in 1989. The period from 1990 is marked by the liberalisation of the coffee trade at the international level with the abolition of all systems for regulating the coffee market and at the national level through the progressive dismantling of coffee marketing board monopolies in many coffee producing countries.

Brazil, Guatemala and India regulated their coffee markets, by way of controls on the production, sale and distribution of coffee, in compliance with the International Coffee Agreement. In addition to this, Brazil and India followed a system in which producers' coffee was pooled and auctioned for both the domestic and export markets. The producers were paid a guaranteed price which was fixed from time to time on the basis of auction prices. Although auction prices reflected market conditions, the producer prices were at times changed after a lag in time and involved bureaucratic delays as well as other considerations including government interventions. This system ended in Brazil in 1989 and since 1990 coffee marketing has been totally liberalised and run by the private sector. However, in India the system was phased out gradually from 1990 onwards and it was only by 1995 that coffee marketing was totally liberalised (ITF, 2005).

3.2 The Statistical Process of Coffee Prices

How we interpret the estimated models depends in part on what we believe is the statistical process of coffee prices. The standard way to proceed in the literature is to assume that both coffee price series $p_{T,t}$ and $p_{P,t}$ are integrated of order 1 (I(1)).[14] In this case a necessary condition for the model to be valid is that we accept the hypothesis of one cointegrating vector.[15] This implies there is a long-run relationship between the two coffee prices. Tests of the number of cointegrating vectors for each model reported in Table 2 do not provide compelling evidence of one cointegrating vector for all of the countries in any of the four

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14 See footnote 9.

15 This is not a sufficient condition as we also need to accept the homogeneity restriction, $\beta = 1$, plus other tests of the model's overall performance.

models. Furthermore, as we improve the proxy for the ratio of coffee prices, μ_t, in the estimated models the evidence of one cointegrating vector becomes even less compelling.

The problem is that over the last thirty five years coffee prices do not appear to be I(1). This can be seen in Graph 1 and is supported by the univariate unit root tests reported in Table 3 where we can reject the null hypothesis of a unit root in the data of all the coffee price series for all three countries. Furthermore, after including the shift dummies corresponding to the coffee regimes we find even 'stronger' evidence that the producer price and the terminal price of coffee are stationary processes.

Fortunately this does not affect the interpretation of our results in a meaningful way. If we find $\beta = 1$ so that the homogeneity restriction is valid and the error correction mechanism is significant then in the long run the coffee price ratio, u_t, converges on some constant value irrespective of whether coffee prices are integrated or stationary. If coffee prices are integrated of order 1 with one cointegrating vector and $\beta = 1$ then we have identified a long-run cointegrating relationship in the Engle and Granger (1987) sense. In this case the coffee price ratio converges on a unique value in the long run. Alternatively, if both coffee prices are stationary with constant means (after allowing for a trend and/or shifts in mean) then the significant error correction term again returns the coffee price ratio to some unique value in the long run.

Therefore, any long-run relationship between the two coffee prices estimated in the VAR-ECM can be interpreted in terms of the underlying theoretical model outlined in equation (1). Specifically, the estimated long-run relationship identifies the value to which the coffee price ratio, u_t, converges on in the long run.[16]

[16] This suggests that too much emphasis may be placed on cointegration in the coffee price literature. Furthermore, the common finding in the literature that coffee prices follow integrated processes may simply be due to the un-modelled structural breaks in the coffee price series.

3.3 VAR-ECM Estimates of Coffee Price Models

While there is some variation in the estimates of the three countries there is a strong pattern in the results. Beginning with model 1 reported in Table 4 we see that if we were not aware of the breaks in the coffee price series we might conclude that a VAR-ECM is a relatively poor representation of the dynamics of coffee prices. We can only accept the long-run homogeneity restriction that $\beta = 1$ for Guatemala and the adjustment coefficients are relatively small implying very slow convergence to the long-run coffee price ratio.

Table 5 reports estimates of model 2 that includes a linear trend. The restriction that the trend is significant is accepted for Guatemala and India but rejected for Brazil. The long-run homogeneity restriction that $\beta=1$ is now only accepted for Brazil and the adjustment coefficients remain low implying again that convergence to the long-run relationship is very slow.

Including a trend and shift dummies in model 3, Table 6 shows that we now accept at the 5 per cent level for all three countries the long-run restriction that $\beta=1$ but the trend is insignificant. It appears that the trend is dominated by the shift dummies as a proxy for the shifts in the long-run coffee price ratio. Finally, in model four of equation (8) reported in Table 7 we exclude the insignificant trend leaving only the shift dummies. We now find the shift dummies are highly significant, we can continue to accept $\beta=1$ for all three countries and the error correction mechanisms are strongly significant with large adjustment coefficients.

Model four is preferred for three reasons. First, it conforms to the theoretical spatial models of prices and our intuitive understanding of how terminal and producer prices are related. Second, it accounts for the expected structural breaks in the coffee price data in a way that is consistent with how we might expect policy changes to affect the coffee price ratio. And third, coffee prices converge on their long-run values very quickly as expected in commodity markets.

The preferred model finds that the two coffee prices move very closely together and that there is a very powerful error correction mechanism operating in all three countries. We also accept the restriction of linear homogeneity suggesting that changes in one coffee price are fully reflected in changes in the other coffee price in the long run once we account for the one-off impact of changes in policy on coffee prices and their ratio. Adjustment to the long-run coffee price ratio is also believably fast. Following a shock to the coffee price ratio, half of the adjustment to the new long-run equilibrium occurs in around 2 ½ months for Brazil and 1 month for Guatemala and India.[17] Finally, the long-run coffee price ratios estimated in model 4 are the same as the mean ratios already shown in Graph 2 as horizontal thin lines.

4. Cost to Producers of Coffee Market Regulation

The long-run equilibrium coffee price ratio (i.e. the producers' share of the terminal price of coffee) is particularly useful for examining the impact of government policies and changing market structures on the coffee market as it abstracts from short-run variations and shocks to the ratio. For example, since the liberalisation of coffee markets the long-run producers share has increased to around 0.85 for Brazil and India and 0.79 for Guatemala in the most recent period.[18] Assuming these ratios reflect the 'efficient' market outcome then we can estimate the loss to producers by examining the extent to which their share deviates from the efficient outcome.

The dashed and the black lines in Graph 3 show the annual value of coffee production measured at terminal and producer prices respectively for each of the three countries. The grey line is what coffee producers would have received according to the efficient outcome throughout the period.[19] The gap between the grey and black lines is the loss to producers

17 The adjustment speeds are calculated from simulations based on the estimates in Table 7.

18 The slightly lower figure for Guatemala may reflect idiosyncratic or fundamental market reasons.

19 Calculated as: $Q_t \bullet P_{T,t} \bullet U^e_{2007}$ where Q_t is the production of coffee and U^e_{2007} is the long-run coffee price ratio in 2007 for each country. This calculation assumes that production and the terminal price of coffee are independent of the efficient coffee price ratio.

relative to the efficient outcome which is shown as the solid thin line in Graph 4.[20] Graph 4 also shows this loss in real terms measured in 2007 prices.

We observe that producers suffered losses in all three countries during the 1970s and early 1980s. In 2007 prices, the real losses to producers peak at around US$7 billion in the early 1980s for Brazil and around US$0.45 billion for Guatemala and India in the mid 1970s. The losses trail off to negligible levels in the most recent periods following liberalisation in all three countries indicating that market interventions over the years have not been in the overall interest of producers.

Note that these measures of loss are in respect to the producers alone and not necessarily to the country as a whole. The loss, or a part of the loss, may simply represent a transfer from the producer to either the government or intermediaries in the transfer process.

5. ARE PRODUCERS BETTER OFF?

Are producers better off following the liberalisation of coffee markets? To answer this question we consider three interrelated issues since the liberalisation of the coffee markets. First, what has happened to the producer price of coffee? Second, what has happened to the quantity of coffee produced? And finally, what has happened to the share of the terminal price of coffee that goes to the producer?

The conventional view is that coffee market interventions increased the producer price of coffee. This suggests that the producer price of coffee should have fared better during the period of interventions than after liberalisation. This is not supported by Table 1. In the seventeen years prior to liberalisation, producer price inflation is only half that of the 'world' inflation rate of 6.6 per cent as measured by the UN index of unit values of exports or the United States CPI. Producer prices increased by 3.3, 1.0 and 2.3 per cent per annum in Brazil, Guatemala and India but in real terms they fell by 42, 60 and 50 per cent respectively. In contrast, during the period 1990 to 2007 when coffee markets witnessed the phase of liberalisation, producer prices increased by 3.6, 3.5, and 2.9 per cent per annum in Brazil,

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20 The loss to producers is calculated as: $Q_t \bullet P_{T,t} \bullet \left[U^e_{2007} - U_t\right]$.

Guatemala and India compared with 'world' inflation of less than 1 per cent per annum as measured by the UN index of unit values of exports. This means that the producer price of coffee increased by around 60, 55 and 40 per cent in real terms.[21]

Coffee prices therefore did not match the growth in 'world' prices during the years of coffee market interventions up to 1990 but increased by more than 'world' prices after the liberalisation of coffee markets. This is inconsistent with the conventional view. The magnitude of the turn around in the behaviour of real coffee prices since liberalisation is substantial. The producer price of coffee in 2007 is 164, 263, and 172 per cent higher in Brazil, Guatemala and India than the price that would have existed if the trend decline in real prices in the seventeen years up to 1990 had continued in the seventeen years after 1990.[22]

The data also shows there has been a large increase in coffee production following liberalisation in all three countries. Average coffee production in the seventeen years after 1990 is 1.3, 1.3 and 1.8 times the coffee production in the seventeen years prior to 1990 in Brazil, Guatemala and India respectively (ICO, 2007). There may be many reasons for this increase in production. However, a part of the increase may be attributed to the removal of restrictions imposed on the production of coffee prior to liberalisation and to the added incentive after liberalisation for producers to supply better quality coffee, which in turn has helped the growth in the consumption of coffee worldwide. In any case, as far as producers are concerned they have gained both in terms of prices and production following liberalisation. Finally, the empirical analysis above demonstrates that the producers' long-run share of the terminal price of coffee has increased systematically since liberalisation of coffee

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21 In the period 1990 to 2007 United States CPI deviates from the UN index of unit values of exports (see Table 1). However, if we use United States CPI as a measure of world inflation we find that producer prices still increase in real terms by around 15, 13 and 2 per cent respectively compared with the large falls in real coffee prices prior to coffee market liberalisation.

22 The increase in real coffee prices is calculated as: $\left[1 + rp_{After} - rp_{Before}\right]^{17} - 1$ where rp is the average annualised change in the real producer price of coffee both after and before 1990 (see Table 1). As an example, the calculation for Brazil is: $\left[1 + 0.028 - (-0.031)\right]^{17} - 1 = 1.64$. Consequently, the real producer price of coffee is 164 per cent higher than would have been the case if real prices had continued to fall at a rate of 3.1 per cent per annum after liberalisation.

markets in all three countries. This increase means that liberalisation has improved the returns to production by reducing the net transfer costs throughout the coffee supply chain.

Therefore, the answer to the question of whether producers are better off since liberalisation appears to be unambiguously yes. Producers have benefited from a higher real price of coffee, higher coffee production, and a higher share of the terminal price of coffee.

6. CONCLUSION

This paper argues that to understand the dynamics of coffee prices we should model the effect that changes in government policies and market structure has had on the long-run producers' share of the terminal price of coffee (i.e. the coffee price ratio, u_t). To simply undertake a cointegration analysis of coffee prices is inadequate because there have been large shifts in the coffee price ratio that coincide with policy and other market changes.

For example, model 1 in Table 4 suggests that a long-run cointegrating relationship between the two coffee prices exists only for Brazil where long-run homogeneity is rejected and the speed of adjustment back to the long-run relationship is very slow. If we assume that coffee prices are integrated then one must conclude the theoretical model is not a valid representation of how the producer and terminal prices of coffee are related in any of the three countries examined.

Estimating the model allowing for the shifts in the coffee price ratio should improve the precision and reduce the bias of the estimates. The preferred estimated model reported in Table 7 contains features that are consistent with our theoretical understanding of the coffee market. First, terminal and producer prices move closely together in the long run. Second, shocks to the relationship between the two coffee prices are eradicated very quickly. Third, liberalisation of the coffee markets has coincided with large increases in the producer's share of the terminal price of coffee. In Brazil, the long-run share has risen from 0.6254 in the late 1980s to 0.8461 in the most recent period up to October 2007. Over the same period the long-run share to producers has increased from 0.6325 to 0.7896 for Guatemala and from 0.5485 to 0.8494 for India.

The systematic increase in the long-run producers' share of terminal coffee prices over the last seventeen years has greatly benefited the producers in these three coffee producing countries. The combination of the increase in the long-run producers share and the increase in the real price of coffee after liberalisation suggest that the benefit to producers in 2007 is around 3.63, 0.31 and 0.43 $US billion.[23] This can be compared with the actual payments to coffee producers of 4.63, 0.47 and 0.65 $US billion in 2007.

Finally, there have been calls for a return to coffee market interventions on the grounds that the liberalisation of coffee markets has not improved the plight of producers. For example, ActionAid (2008) and South Centre (2008) argue that the real producer price of coffee is lower in 2007 than it was thirty years ago and has not increased in line with the real retail price of coffee.[24] Furthermore, Sarris (2002) argues that the increase in price variations due to liberalisation could mean that large and unexpected negative price shocks might result in some producers going out of business. This may well be the case and the international community and policy planners could do a lot more for producers. However, this paper demonstrates that producers have benefited significantly since liberalisation and that returning to interventions of the kind that existed prior to liberalisation would not be in the interest of producers.

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[23] The total benefit to producers in 2007 is calculated as: $\left[Q_{2007} \bullet P_{T,2007} \bullet U^{e}_{2007}\right] - \left[Q_{2007} \bullet \frac{P_{T,2007}}{1+x} \bullet U^{e}_{1989}\right]$ where x is the benefit in terms of a higher real terminal prices of coffee calculated as in footnote 22. The first component of the calculation is what the producer actually received in 2007. The second component is what the producer would receive if the real terminal price was lower, $\frac{P_{T,2007}}{1+x}$, and they only received the 1989 equilibrium producers share, U^{e}_{1989}. The difference between the two components is the benefit to producers from higher real coffee prices and a higher equilibrium share of terminal prices. This calculation assumes that the quantity of coffee produced is unaffected by the real price of coffee or the coffee price ratio.

[24] The fall in real prices over the past 30 years is consistent with our findings. However, as shown in Section 5 producers have benefited from increases in real prices over the past 17 years during the liberalisation phase.

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APPENDIX 1: THE DATA

Variable	*Mnemonic*	*Details*
Producer price of coffee	P_P	is the cash (gate) price received for Arabica coffee by coffee producers. They are the dollar equivalents, that is, prices in local currency have been multiplied by the appropriate exchange rates to arrive at a monthly average producer price in US cents per pound. Although there may be many grades traded for Arabica coffee, most producing countries calculate a weighted average price of the major grades, major being determined on the basis of coffee traded in quantitative terms. The producer prices were obtained from the ICO database and the Coffee Boards of the respective countries.
Terminal price of coffee	P_T	is the ICO Indicator Price for Arabica coffee calculated by weighting the ex-dock prices on the international markets in New York, Bermen and Hamburg markets in US cents per pound. The prices are available on daily and monthly basis from the ICO database.
Coffee price ratio	U	is the producer price divided by the terminal price of coffee. It is equivalent to the producers' share of the terminal price of coffee.
United States CPI		refers to the all urban consumer price index (old base) downloaded 25 August 2008 from the United States Department of Labor.
UN index of unit values of exports		refers to the United Nations index of unit values of exports of manufactured goods from developed market economies. It is used to convert values/unit values from current to constant terms. Downloaded on 25 August 2008 from the United Nations Conference on Trade and Development.
Coffee production		is the annual data of total production of coffee by coffee exporting countries available from the ICO database.

Note: Lower case variables in the paper are the natural logarithms of the upper case variables.

APPENDIX 2 IDENTIFYING BREAKS IN THE MEAN RATIO OF COFFEE PRICES

The Bai and Perron (1998, 2003a, 2003b) approach minimises the sum of the squared residuals to identify the dates of k breaks in the natural logarithm of the ratio of the producer price of coffee to the terminal price of coffee and, thereby, identify $k+1$ 'coffee regimes'. The estimated model is:

$$u_t = \gamma_{k+1} + \tau_t \qquad \text{(A2.1)}$$

where u_t is measured as $p_{P,t} - p_{T,t}$ and $p_{P,t}$ and $p_{T,t}$ are the natural logarithms of the producer and terminal prices of coffee respectively for Brazil, Guatemala and India. The terms γ_{k+1} are a series of $k+1$ constants that estimate the mean coffee price ratio in each of the $k+1$ regimes and τ_t is a random error. The minimum size between breaks is assumed to be 24 months and the final model is chosen using the Bayesian Information Criterion.

The technique identifies 11, 8 and 10 breaks in the coffee price ratio for Brazil, Guatemala and India implying that there are 12, 9 and 11 coffee 'regimes' respectively in each country over the past 35 years. The estimated dates of the coffee 'regimes' are reported in the table below.

Table A2: Estimated Dates of the Coffee 'Regimes'

Brazil	**Guatemala**	**India**
January 1973 to November 1974	January 1973 to May 1975	January 1973 to February 1976
December 1974 to February 1977	June 1975 to November 1979	March 1976 to May 1978
March 1977 to July 1979	December 1979 to August 1983	June 1978 to May 1980
August 1979 to July 1981	October 1983 to April 1986	June 1980 to August 1982
August 1981 to November 1984	May 1986 to April 1988	September 1982 to November 1986
December 1984 to March 1987	May 1988 to March 1993	December 1986 to May 1989
April 1987 to March 1989	April 1993 to March 1995	June 1989 to March 1992
April 1989 to November 1991	April 1995 to January 1998	April 1992 to March 1984
December 1991 to July 1996	February 1998 to October 2007	April 1994 to August 1996
August 1996 to October 2000		September 1996 to October 2004
November 2000 to November 2002		November 2004 to October 2007
December 2002 to October 2007		

Table 1: Nominal and Real Coffee Prices

Brazil

	Nominal Values			Real Value		
	Producer Price	*Terminal Price*	*Transfer Costs*	*Producer Price*	*Terminal Price*	*Transfer Costs*
1973	31.02	69.20	38.19	1	1	1
1990	55.58	82.97	29.39	0.5832	0.4048	0.2599
2007	98.23	111.66	13.44	0.9273	0.4725	0.1030
Percentage Change						
1973 – 1990	72.7 (3.3)	19.9 (1.1)	- 23.0 (- 1.5)	- 41.7 (- 3.1)	- 59.5 (- 5.2)	- 74.0 (- 7.6)
1990 – 2007	83.3 (3.6)	34.6 (1.8)	- 54.3 (-4.5)	59.0 (2.8)	16.7 (0.9)	- 60.7 (- 5.3)
1973 – 2007	216.7 (3.4)	61.4 (1.4)	- 64.8 (- 3.0)	- 7.3 (- 0.2)	- 52.8 (- 2.2)	- 89.7 (- 6.5)

Guatemala

	Nominal Values			Real Value		
	Producer Price	*Terminal Price*	*Transfer Costs*	*Producer Price*	*Terminal Price*	*Transfer Costs*
1973	46.03	62.30	16.27	1	1	1
1990	54.58	89.46	34.87	0.4004	0.4848	0.7235
2007	98.09	123.55	25.46	0.6240	0.5807	0.4581
Percentage Change						
1973 – 1990	18.6 (1.0)	43.6 (2.2)	114.3 (4.6)	- 60.0 (- 5.2)	- 51.5 (- 4.2)	- 27.6 (- 1.9)
1990 – 2007	79.7 (3.5)	38.1 (1.9)	- 27.0 (- 1.8)	55.9 (2.6)	19.8 (1.1)	- 36.7 (- 2.7)
1973 – 2007	113.1 (2.3)	98.3 (2.0)	56.5 (1.3)	- 37.6 (- 1.4)	- 41.9 (- 1.6)	- 54.2 (- 2.3)

India

	Nominal Values			Real Value		
	Producer Price	*Terminal Price*	*Transfer Costs*	*Producer Price*	*Terminal Price*	*Transfer Costs*
1973	45.37	62.30	16.93	1	1	1
1990	66.75	89.46	22.70	0.4968	0.4848	0.4527
2007	108.34	123.55	15.21	0.6992	0.5807	0.2630
Percentage Change						
1973 – 1990	47.1 (2.3)	43.6 (2.2)	34.1 (1.7)	- 50.3 (- 4.0)	- 51.5 (- 4.2)	- 54.7 (- 4.6)
1990 – 2007	62.3 (2.9)	38.1 (1.9)	- 33.0 (- 2.3)	40.8 (2.0)	19.8 (1.1)	- 41.9 (- 3.1)
1973 – 2007	138.8 (2.6)	98.3 (2.0)	- 10.2 (- 0.3)	- 30.1 (- 1.0)	- 41.9 (- 1.6)	- 73.7 (- 3.9)

Notes: Figures in brackets are the compounded annualised percentage change. Real values are calculated with reference to the UN index of unit values of exports. Annual values are averages of the monthly values. Nominal values are in US cents per pound. Transfer costs are the difference between the terminal and producer price. The table on the right shows the percentage changes in the UN index of unit values of exports and the United States CPI.

	Unit Values of Exports	*US CPI*
Percentage Change		
1973 – 1990	196.2 (6.6)	194.1 (6.6)
1990 – 2007	15.3 (0.8)	58.7 (2.8)
1973 – 2007	241.5 (3.7)	366.6 (4.6)

Table 2: Testing for the Number of Cointegrating Vectors

	Brazil			Guatemala			India		
H_0: r =	Trace	$CV_{5\%}$	p-value	Trace	$CV_{5\%}$	p-value	Trace	$CV_{5\%}$	p-value
Model 1 – Constant in the Cointegrating Space									
0	15.8840	15.4082	0.0421	43.7836	15.4082	0.0000	39.2301	15.4082	0.0000
1	3.4289	3.8415	0.0641	7.9300	3.8415	0.0049	6.6017	3.8415	0.0102
Model 2 – Constant and Trend in the Cointegrating Space									
0	23.8590	25.7310	0.0862	48.4878	25.7310	0.0000	44.6153	25.7310	0.0000
1	8.3049	12.4478	0.2345	8.5179	12.4478	0.2183	6.8484	12.4478	0.3709
Model 3 – Constant, Trend and Shift Dummies in the Cointegrating Space									
0	95.5834	81.1311	0.0026	157.1244	66.3054	0.0000	158.9223	76.1898	0.0000
1	26.5669	43.2295	0.6642	43.9173	34.8278	0.0032	31.5731	40.3406	0.2841
Model 4 – Constant and Shift Dummies in the Cointegrating Space									
0	94.8161	55.1580	0.0000	149.7019	42.5595	0.0000	139.3038	50.5940	0.0000
1	26.3182	19.6200	0.0060	40.3706	15.0355	0.0000	17.9809	18.1718	0.0556

Notes: The maximum number of cointegration vectors is given by r. Trace and the p-value are the Bartlett small sample adjusted values of the Trace test statistics and associated probability value respectively. $CV_{5\%}$ is the 5 per cent critical value of the Trace test. In Models 3 and 4, the inclusion of the shift dummies in the cointegration space affect the distribution of the test statistics in such a way as to reject cointegration too often i.e. the dummies increase the value of the Trace statistic relative to the critical value. In these models the simulated Trace statistic critical values are reported based on the actual finite sample behaviour of the data.

Table 3: ADF Univariate Unit Root Tests

Series	Original Data		De-meaned Data	
Brazil	Test Statistic	Probability Value	Test Statistic	Probability Value
Producer Price	- 3.48	0.0089	- 4.33	0.0005
Terminal Price	- 2.91	0.0454	- 4.02	0.0014
Ratio of Coffee Prices	- 3.33* #	0.0634	- 7.57#	0.0000
Guatemala				
Producer Price	- 3.01	0.0350	- 4.33	0.0005
Terminal Price	- 2.91	0.0454	- 4.02	0.0014
Ratio of Coffee Prices	- 6.10*	0.0000	- 11.61	0.0000
India				
Producer Price	- 3.00	0.0361	- 3.84#	0.0027
Terminal Price	- 2.91	0.0454	- 4.62	0.0001
Ratio of Coffee Prices	- 5.71*	0.0000	- 10.00	0.0000

Notes: Reported are the augmented Dickey-Fuller unit root test statistics and the associated probability values. The data are in natural logarithms. De-meaned data is the original data adjusted for the shifts in mean as identified by the Bai-Perron technique for each country (see Appendix 2). * indicates a significant trend in the unit root test. In all other cases the trend is insignificant and excluded prior to inference. A lag length of one was chosen on the basis of SIC in all cases except when zero as indicated by #. The ratio of coffee prices is the natural logarithm of the producer price divided by the terminal price of coffee.

Table 4: VAR Error Correction Model of Coffee Prices
Model 1 – A constant in the long run

BRAZIL

	Long-run Coefficients		Adjustment Coefficients	
	p_P	p_T	Δp_P	Δp_T
Unrestricted	1.0000	- 0.1312 (- 0.5)	- 0.0459 (- 3.5)	- 0.0200 (-2.0)
Restricted	1.0000	- 1.0000	- 0.0176 (-1.2)	0.0062 (0.5)

TLRR = 0.0246, LM_1 = 0.2353, LM_2 = 0.4244. Normality = 0.0000. Stationarity: p_P = 0.7397, p_T = 0.0171. Exclusion: p_P = 0.0171, p_T = 0.7397. Exogeneity: p_P = 0.0035, p_T = 0.0971.

GUATEMALA

	Long-run Coefficients		Adjustment Coefficients	
	p_P	p_T	Δp_P	Δp_T
Unrestricted	1.0000	- 0.9223 (- 12.5)	- 0.1879 (- 5.8)	0.0142 (0.7)
Restricted	1.0000	- 1.0000	- 0.1729 (- 5.6)	0.0226 (1.1)

TLRR = 0.4177, LM_1 = 0.1003, LM_2 = 0.0516. Normality = 0.0000. Stationarity: p_P = 0.0000, p_T = 0.0000. Exclusion: p_P = 0.0000, p_T = 0.0000. Exogeneity: p_P = 0.0000, p_T = 0.5489.

INDIA

	Long-run Coefficients		Adjustment Coefficients	
	p_P	p_T	Δp_P	Δp_T
Unrestricted	1.0000	- 0.7494 (- 10.5)	- 0.0853 (- 3.9)	0.0732 (3.2)
Restricted	1.0000	- 1.0000	- 0.0442 (- 2.6)	0.0673 (3.9)

TLRR = 0.0307, LM_1 = 0.3361, LM_2 = 0.5244. Normality = 0.0000. Stationarity: p_P = 0.0000, p_T = 0.0000. Exclusion: p_P = 0.0000, p_T = 0.0000. Exogeneity: p_P = 0.0006, p_T = 0.0040.

Notes: Reported as ( ) are t-statistics. The models and statistics are estimated with two lags of the core variables and an effective sample of 416 monthly observations for the period January 1973 to October 2007. The number of lags was chosen by a likelihood ratio test for lag reduction. TLRR is the finite sample Bartlett corrected probability values of the test of the long-run cointegrating restriction that $\beta = 1$. LM_1 and LM_2 are the probability values of the Lagrange Multiplier tests of no serial correlation in the errors of lags 1 and 2 respectively. Normality is the probability value of the Doornik-Hansen test for normal errors. Stationarity, Exclusion and Exogeneity are the probability values of the likelihood ratio tests that p_P and p_T (and trend if applicable) are stationary, can be excluded from the cointegrating space and/or weakly exogenous respectively. Models estimated using CATS 2.0.

Table 5: VAR Error Correction Model of Coffee Prices
Model 2 – A constant and trend in the long run

BRAZIL

	Long-run Coefficients			Adjustment Coefficients	
	p_P	p_T	Trend	Δp_P	Δp_T
Unrestricted	1.0000	- 0.7010 (- 4.7)	- 0.1828 (- 3.1)	- 0.0630 (- 3.0)	- 0.0044 (- 0.3)
Restricted	1.0000	- 1.0000	- 0.0048 (- 4.3)	- 0.0351 (-1.6)	0.0199 (1.2)

TLRR = 0.2875, TT = 0.1513, LM_1 = 0.2688, LM_2 = 0.4058. Normality = 0.0000. Stationarity: p_P = 0.0883, p_T = 0.0121. Exclusion: p_P = 0.0121, p_T = 0.0883, Trend = 0.0830. Exogeneity: p_P = 0.0494, p_T = 0.8594.

GUATEMALA

	Long-run Coefficients			Adjustment Coefficients	
	p_P	p_T	Trend	Δp_P	Δp_T
Unrestricted	1.0000	- 0.9571 (- 13.9)	- 0.0495 (-2.2)	- 0.2022 (- 6.0)	0.0218 (1.0)
Restricted	1.0000	- 1.0000	- 0.0528 (- 2.3)	- 0.1935 (- 5.9)	0.0268 (1.3)

TLRR = 0.0246, TT = 0.0564, LM1 = 0. 1204, LM2 = 0. 0683. Normality = 0.0000. Stationarity: p_P = 0.0000, p_T = 0.0000. Exclusion: p_P = 0.0000, p_T = 0.0000, Trend = 0.0381. Exogeneity: p_P = 0.0000, p_T = 0.3724.

INDIA

	Long-run Coefficients			Adjustment Coefficients	
	p_P	p_T	Trend	Δp_P	Δp_T
Unrestricted	1.0000	- 0.7783 (- 12.0)	- 0.0514 (- 2.4)	- 0.0913 (- 4.0)	0.0864 (3.7)
Restricted	1.0000	- 1.0000	- 0.3474 (- 2.4)	- 0.0508 (- 2.8)	0.0788 (4.3)

TLRR = 0.0316, TT = 0.0364, LM_1 = 0.3603, LM_2 = 0.5283. Normality = 0.0000. Stationarity: p_P = 0.0000, p_T = 0.0000. Exclusion: p_P = 0.0000, p_T = 0.0000, Trend = 0.0226. Exogeneity: p_P = 0.0003, p_T = 0.0009.

Notes: The trend is multiplied by 100. TT is the finite sample Bartlett corrected probability value of the likelihood ratio exclusion test of the estimated trend. For further details see the notes to Table 4.

Table 6: VAR Error Correction Model of Coffee Prices
Model 3 – A constant, trend and shift dummies in the long run

BRAZIL

	Long-run Coefficients			Adjustment Coefficients	
	p_P	p_T	Trend	Δp_P	Δp_T
Unrestricted	1.0000	- 0.8907 (- 15.9)	- 0.0975 (- 0.7)	- 0.2675 (- 6.8)	- 0.0360 (-1.1)
Restricted	1.0000	- 1.0000	- 0.0225 (-0.2)	- 0.2416 (- 5.9)	- 0.0029 (- 0.1)

TLRR = 0.1711, TT = 0.3457, LM_1 = 0.4823, LM_2 = 0.0597. Normality = 0.0000. Stationarity: p_P = 0.0000, p_T = 0.0000. Exclusion: p_P = 0.0000, p_T = 0.0000, Trend = 0.4679. Exogeneity: p_P = 0.0000, p_T = 0.3682.

Dec' 1974	- 0.2390 (- 2.6)	Aug' 1979	0.2867 (3.2)	Dec' 1984	- 0.5627 (- 6.5)	April 1989	- 0.4988 (- 5.6)	Aug' 1996	- 0.0526 (- 0.6)	Dec' 2002	- 0.1916 (-2.1)
March 1977	0.3996 (4.5)	Aug' 1981	- 0.1152 (- 1.3)	April 1987	0.4902 (5.4)	Dec' 1991	- 0.2442 (- 2.8)	Nov' 2000	0.2050 (2.3)		

GUATEMALA

	Long-run Coefficients			Adjustment Coefficients	
	p_P	p_T	Trend	Δp_P	Δp_T
Unrestricted	1.0000	- 0.9040 (- 24.0)	- 0.1006 (- 2.0)	- 0.4731 (- 10.6)	- 0.0423 (- 1.3)
Restricted	1.0000	- 1.0000	- 0.0845 (- 1.6)	- 0.4231 (- 9.7))	0.0779 (2.6)

TLRR = 0.0710, TT = 0.0893, LM1 = 0.0022, LM2 = 0.0001. Normality = 0.0000. Stationarity: p_P = 0.0000, p_T = 0.0000. Exclusion: p_P = 0.0000, p_T = 0.0000, Trend = 0.0575. Exogeneity: p_P = 0.0000, p_T = 0.2800.

June 1975	0.3238 (5.6)	Oct' 1983	- 0.3012 (- 5.3)	May 1988	0.0956 (1.6)	April 1995	- 0.0766 (- 2.8)
Dec' 1979	- 0.1104 (- 2.1)	May 1986	0.3367 (5.2)	April 1993	0.1333 (2.2)	Feb' 1998	- 0.1693 (-2.8)

INDIA

	Long-run Coefficients			Adjustment Coefficients	
	p_P	p_T	Trend	Δp_P	Δp_T
Unrestricted	1.0000	- 1.0114 (- 24.7)	0.0809 (1.4)	- 0.1957 (- 5.6)	0.2834 (8.3)
Restricted	1.0000	- 1.0000	0.0890 (1.8)	- 0.2010 (- 5.7)	0.2831 (8.2)

TLRR = 0.8445, TT = 0.2760, LM_1 = 0.1797, LM_2 = 0.3259. Normality = 0.0000. Stationarity: p_P = 0.0000, p_T = 0.0000. Exclusion: p_P = 0.0000, p_T = 0.0000, Trend = 0.2149. Exogeneity: p_P = 0.0000, p_T = 0.0000.

Mar' 1976	0.4984 (10.9)	June 1980	- 0.1761 (- 3.6)	Dec' 1986	- 0.2298 (- 5.3)	April 1992	- 0.1405 (- 3.0)	Sept' 1996	- 0.3108 (- 6.5)
June 1978	- 0.2232 (- 4.5)	Sept' 1982	0.2035 (4.6)	June 1989	- 0.2091 (- 4.6)	April 1994	0.4221 (8.7)	Nov' 2004	- 0.2604 (- 5.5)

Notes: Lower panels for each country are the estimated shift dummies in the restricted models. For further details see the notes to Table 4 and Table 5.

Table 7: VAR Error Correction Model of Coffee Prices
Model 4 – A constant and shift dummies in the long run

BRAZIL

	Long-run Coefficients		Adjustment Coefficients	
	p_P	p_T	Δp_P	Δp_T
Unrestricted	1.0000	- 0.9058 (- 17.2)	- 0.2652 (- 6.7)	- 0.0338 (-1.1)
Restricted	1.0000	- 1.0000	- 0.2420 (-5.9)	- 0.0036 (- 0.1)

TLRR = 0.2085, LM_1 = 0.5148, LM_2 = 0.0577. Normality = 0.0000. Stationarity: p_P = 0.0000, p_T = 0.0000. Exclusion: p_P = 0.0000, p_T = 0.0000. Exogeneity: p_P = 0.0000, p_T = 0.3981.

Dec' 1974	- 0.2449 (- 2.8)	Aug' 1979	0.2806 (3.3)	Dec' 1984	- 0.5702 (- 7.6)	April 1989	- 0.5049 (- 6.1)	Aug' 1996	- 0.0645 (- 1.1)	Dec' 2002	- 0.2014 (-2.8)
March 1977	0.3939 (4.8)	Aug' 1981	- 0.1225 (- 1.5)	April 1987	0.4842 (5.7)	Dec' 1991	- 0.2544 (- 3.8)	Nov' 2000	0.1965 (2.6)		

GUATEMALA

	Long-run Coefficients		Adjustment Coefficients	
	p_P	p_T	Δp_P	Δp_T
Unrestricted	1.0000	- 0.9189 (- 23.8)	- 0.4547 (- 10.2)	- 0.0578 (- 1.9)
Restricted	1.0000	- 1.0000	- 0.4117 (- 9.4)	0.0852 (2.9)

TLRR = 0.1309, LM1 = 0.0001, LM2 = 0.6317. Normality = 0.0000. Stationarity: p_P = 0.0000, p_T = 0.0000. Exclusion: p_P = 0.0000, p_T = 0.0000. Exogeneity: p_P = 0.0000, p_T = 0.1319.

June 1975	0.2924 (5.4)	Oct' 1983	- 0.3316 (- 6.1)	May 1988	0.0607 (1.1)	April 1995	- 0.1062 (- 1.7)
Dec' 1979	- 0.1562 (- 3.3)	May 1986	0.3101 (4.8)	April 1993	0.1043 (1.8)	Feb' 1998	- 0.1693 (-2.8)

INDIA

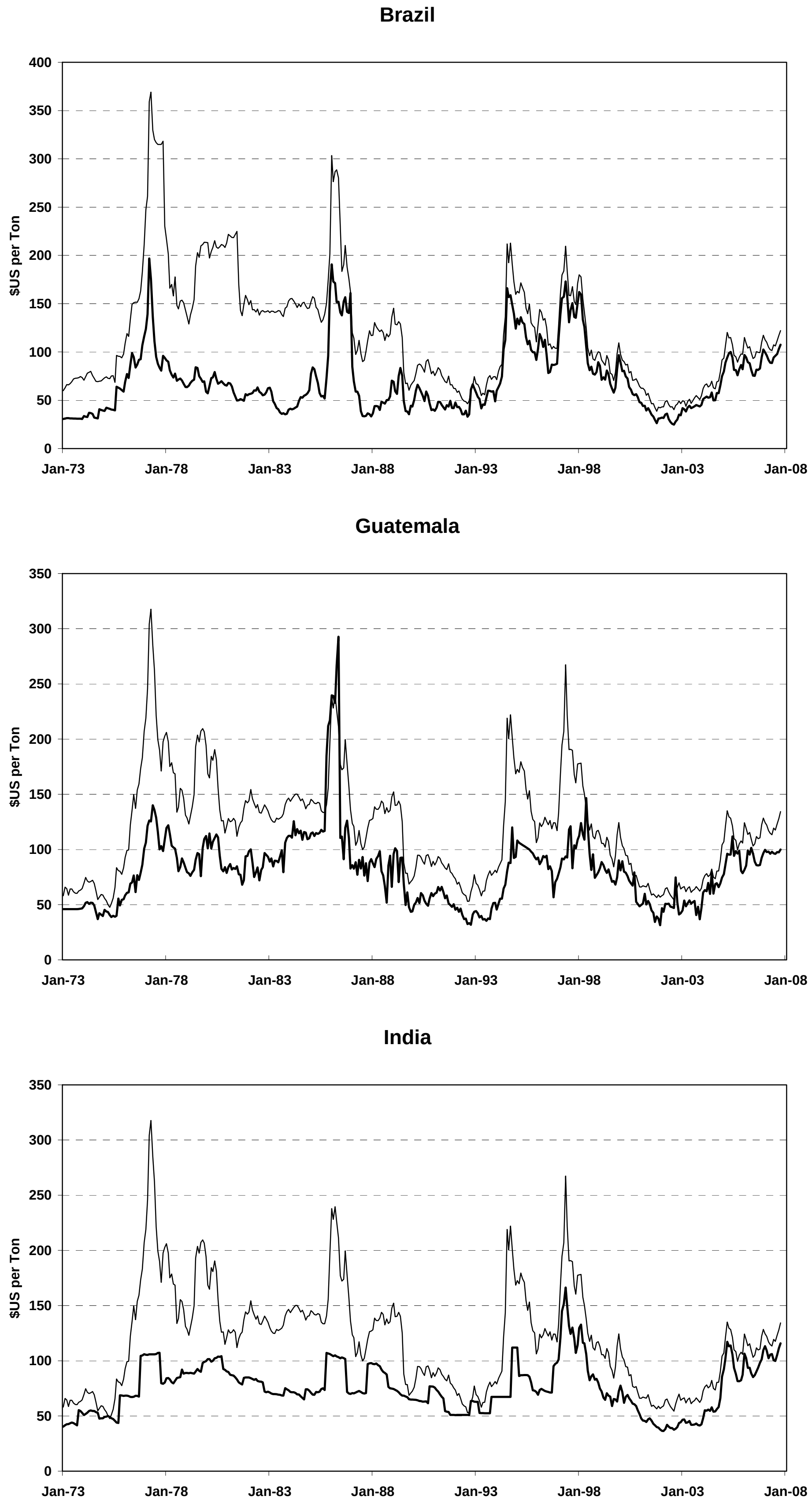
	Long-run Coefficients		Adjustment Coefficients	
	p_P	p_T	Δp_P	Δp_T
Unrestricted	1.0000	- 1.0391 (- 24.1)	- 0.1699 (- 5.8)	0.2250 (7.8)
Restricted	1.0000	- 1.0000	- 0.1813 (- 6.0)	0.2243 (7.5)

TLRR = 0.4704, LM_1 = 0.0083, LM_2 = 0.0777. Normality = 0.0000. Normality = 0.0000. Stationarity: p_P = 0.0000, p_T = 0.0000. Exclusion: p_P = 0.0000, p_T = 0.0000. Exogeneity: p_P = 0.0000, p_T = 0.0000.

Mar' 1976	0.5463 (10.5)	June 1980	- 0.1491 (- 2.6)	Dec' 1986	- 0.2019 (- 4.3)	April 1992	- 0.1102 (- 2.0)	Sept' 1996	- 0.2669 (- 6.2)
June 1978	- 0.2231 (- 3.9)	Sept' 1982	0.2442 (5.0)	June 1989	- 0.1842 (- 3.6)	April 1994	0.4594 (8.1)	Nov' 2004	- 0.2021 (- 5.1)

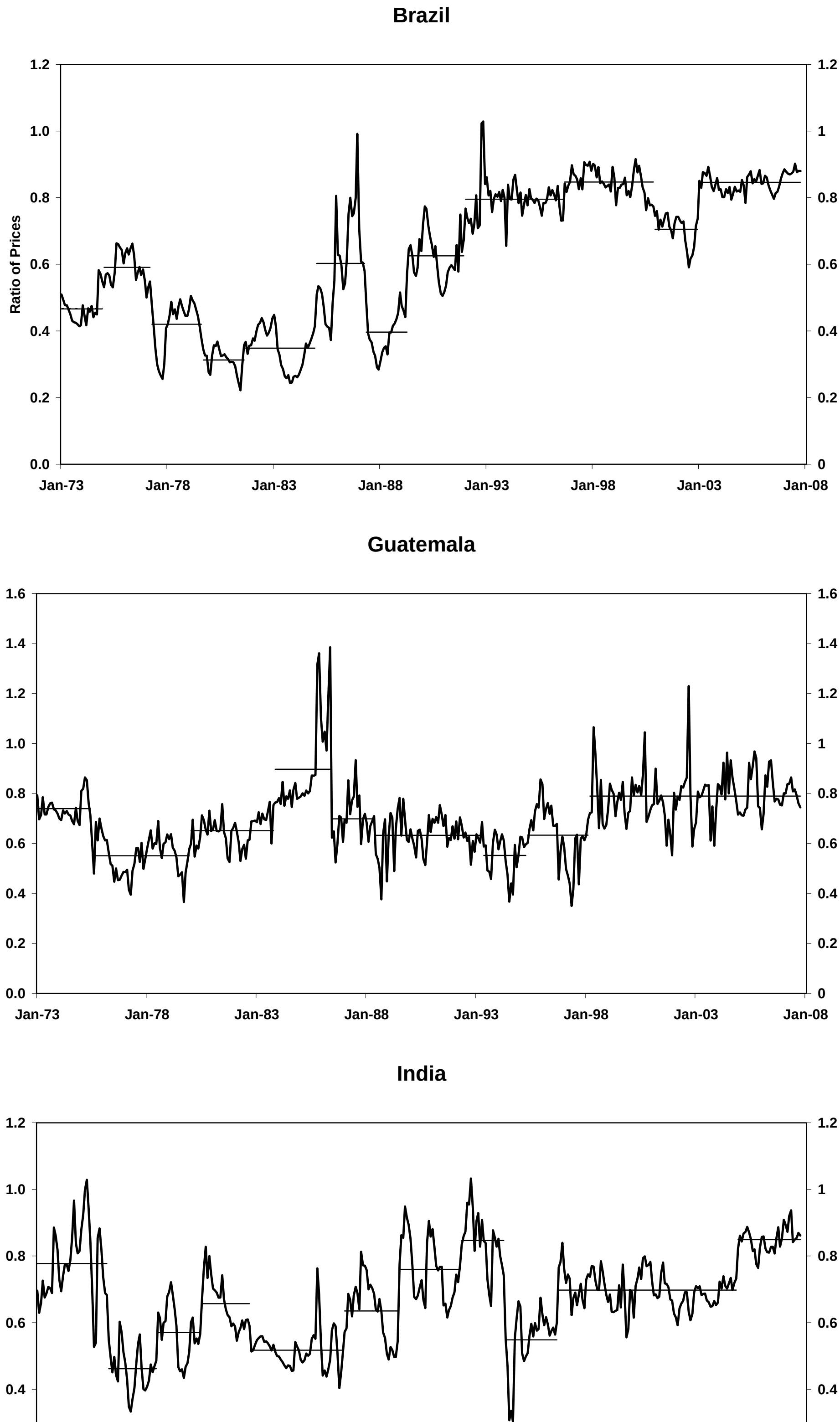
Notes: Lower panel for each country is the estimated cointegration shift dummies in the restricted model. For further details see the notes to Table 4, 5 and 6.

Graph 1: Terminal and Producer Prices for Arabica Coffee



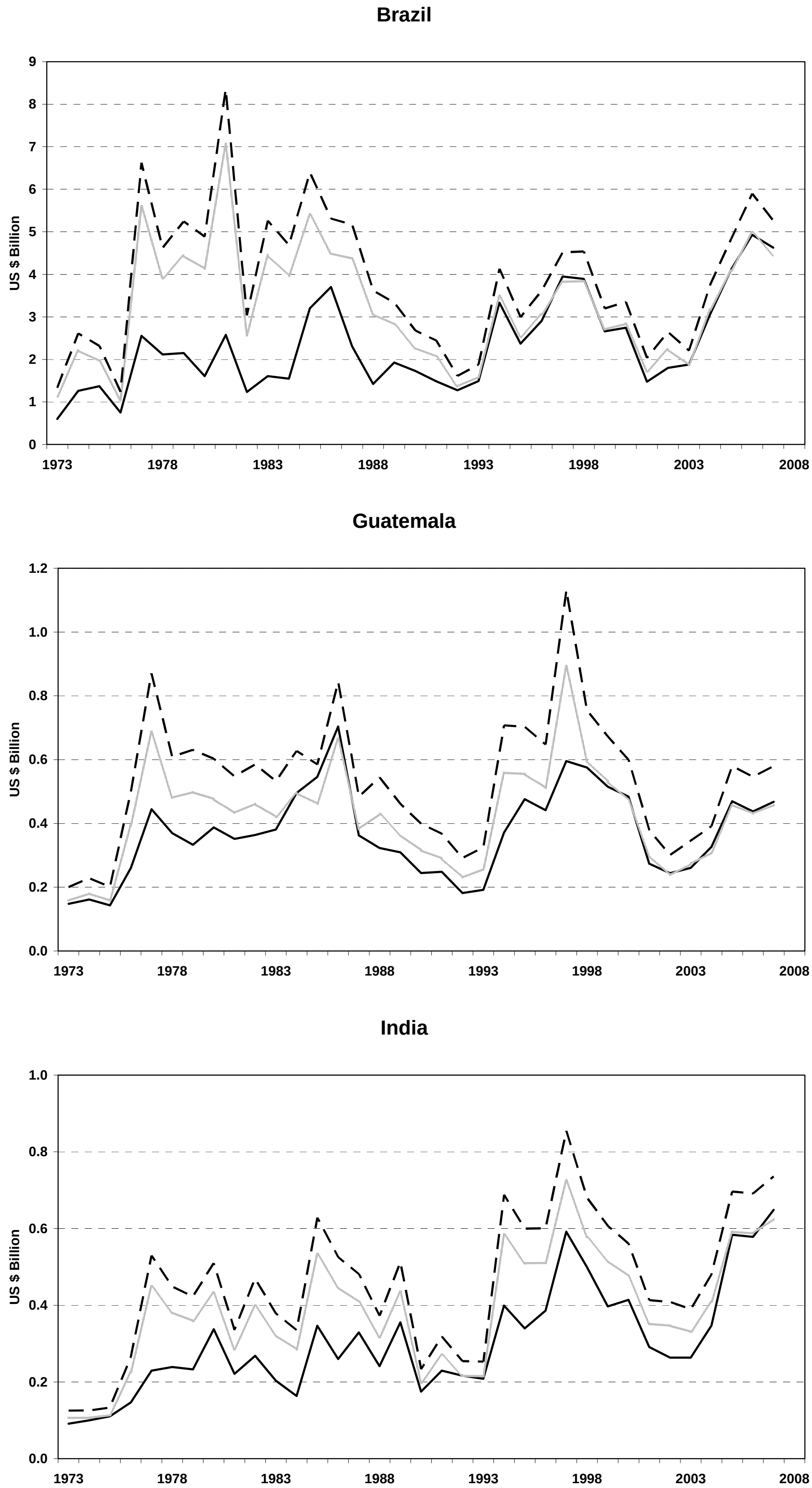
Note: Thin and thick lines are the terminal and producer prices of coffee respectively.

Graph 2: Ratio of the Producer Price to the Terminal Price of Coffee



Note: Thick line is the ratio of the producer to the terminal price of coffee. The horizontal thin lines are the mean coffee price ratio as estimated by the Bai-Perron technique.

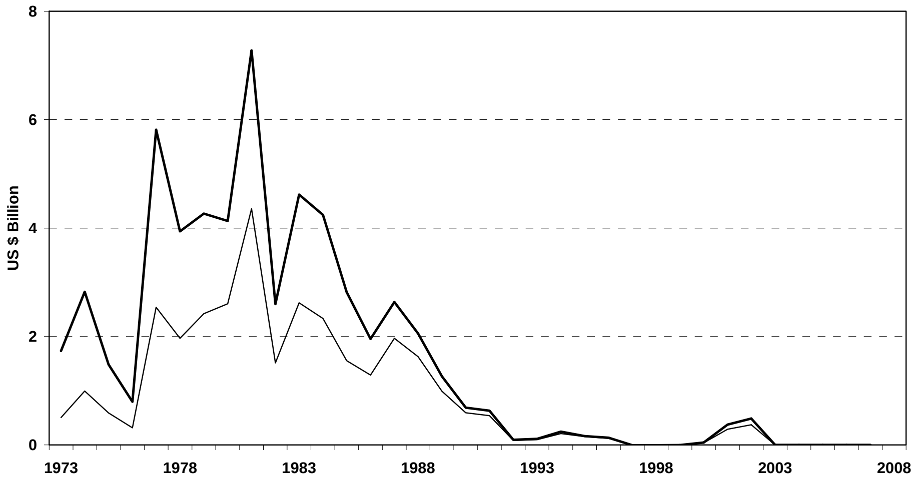
Graph 3: Value of Coffee Production



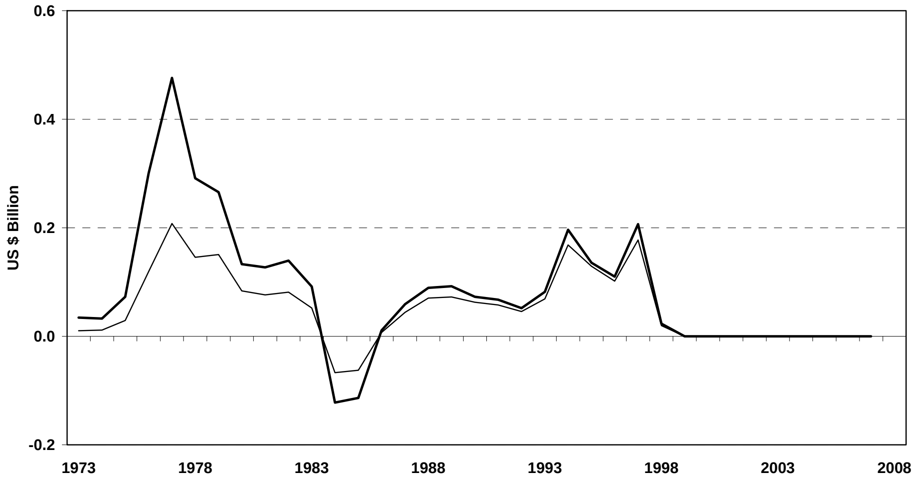
Note: The black, grey and dashed lines are the actual value of production to producers, the value of production according to the 'efficient' market outcome, and the value of production at terminal prices respectively.

Graph 4: Nominal and Real Losses of Coffee Producers

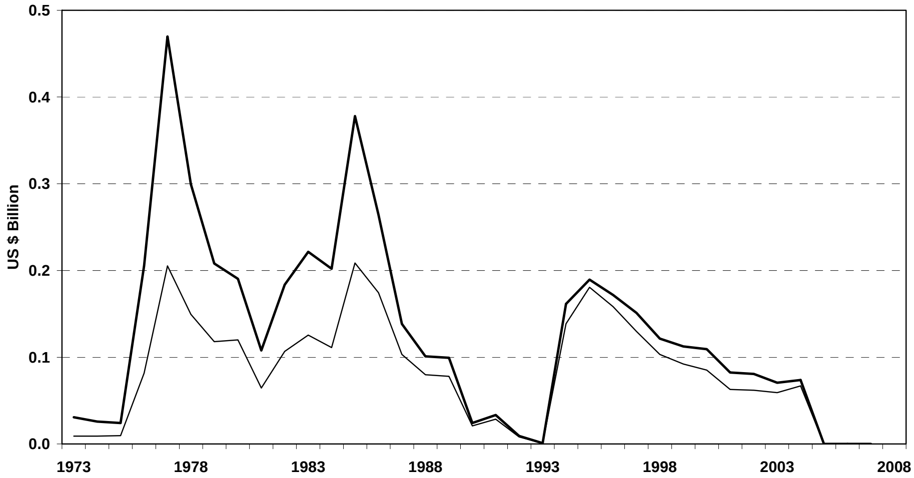
Brazil



Guatemala



India



Note: The thin and thick lines are the nominal and real values of the loss to producers. Real values are in terms of the UN index of unit values of exports.