Coffee Market Liberalization and the Implications for Producers in Brazil, Guatemala and India

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SUPPLEMENTARY APPENDIX

This appendix provides further background, discussion and detail concerning the paper. The order of this appendix loosely conforms to the order the issues are raised in the paper.

SOME FURTHER ISSUES CONCERNING THE COFFEE PRICE MODEL

(i) *An Alternative Empirical Modelling Strategy*

An alternative way to proceed than that taken in the paper would be to model the coffee price ratio using non-linear threshold modelling techniques.[1] For example, one could estimate a logistic (LSTAR), exponential (ESTAR) or self-exciting (SETAR) smooth transition autoregressive models of the coffee price ratio. These models can be thought of as regime-switching models and the implied long-run, or equilibrium, level of the coffee price ratio for each regime can be 'backed out' from the estimated models. Typically however, these models consider many fewer regimes than the number we identify in the analysis below. Furthermore, any non-linearity identified in these models is thought to reflect 'real' changes in economic relationships and not simply to account for the non-linearities introduced by structural breaks in the coffee price ratio. Given our strong a priori belief that structural change has occurred in coffee markets we argue that it is better to identify and account for the breaks themselves rather than trying to model the non-linearity introduced by the breaks.[2]

Yet another way to proceed would be that of Gonzalez and Terasvirta (2008) who explicitly model the time varying shifting mean within an autoregressive model (SM-AR). However, this approach does not allow us to identify the equilibrium relationship between the producer and terminal prices of coffee which is our primary focus of concern so that we can calculate the loss in revenue to producers from coffee market regulation.

(ii) *Short Run Losses*

In the short run the coffee price ratio U_t in equation (3) in the paper 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

1 For example see van Dijk, Terasvirta and Frances (2002) for an excellent survey of smooth transition autoregressive models.

2 Timmermann (2000), Koop and Potter (2000) and Carrasco (2002) make the general argument that it is difficult to distinguish between non-linear autoregressive models and similar models that incorporate structural change as they are observationally very similar.

lead agents to exit the market until intermediaries make 'normal' profits and $U^e < 1$. The 'law' that underpins the equilibrium relationship is based on the concept of perfect competition which must be inconsistent with actual markets whether of coffee or otherwise due to missing information. Instead the empirical analysis in the paper considers whether movements in one coffee price are matched by movements in the other coffee price once we account for changes in policies and that competition, such as it is, drives the coffee price ratio back to its equilibrium value, U^e, in the long run.

(iii) *Our Measure of Transfer Costs*

The measure of transfer costs employed in the paper is not independent of our measures of the terminal and producer prices of coffee. Therefore, explanations of changes to the coffee price ratio are equally valid explanations of changes in transfer costs relative to one of the coffee prices. Given our transfer costs data is not independent of the coffee price data and the focus of the paper is the impact of policy on coffee price ratio we do not elaborate on the issues that drive transfer costs in the paper.

(iv) *The Impact of Stocks on Coffee Prices*

Fluctuations in the stocks of coffee are largely due to variations in the supply and demand for coffee and the real interest rate. These fluctuations are likely to be stationary processes and so do not affect our estimate of the equilibrium relationship in equation (5) in the paper. Instead they are reflected in the short-run dynamics of coffee prices.

(v) *The Impact of other Economic Variables on the Estimates*

Changes in economic variables such as technology and real interest rates may also affect transfer costs. However, the changes in these variables are usually gradual and not sudden and so will not introduce a discrete break in transfer costs and the mean of the coffee price ratio. For example, new technologies may have an 'invention' date but in practice they are introduced over a long period of time. Similarly, real interest rates in the mid-1970s (based on backward looking inflation expectations) were so very low that they may well have led to changes in coffee market inventory behaviour and significantly lower the cost of holding inventory. However, we can see from

Figure 1 in the paper that the 1970s were a period when the coffee price ratio in general fell for the three countries suggesting that if the low real interest rates did lower transfer costs (implying a rise in the coffee price ratio) the effect was outweighed by other considerations.

(vi) *The Identification of Structural Breaks*

There is now a substantial literature on the identification of structural breaks in models. Perron (2006) reviews techniques which identify single breaks in models. For our purposes these techniques are too restrictive and we therefore consider techniques that identify multiple structural breaks in mean with unknown break dates.

There are two broad ways to proceed when modelling the structural breaks in the coffee price ratio. The first is the one-step procedure of Qu and Perron (2007) that identifies multiple structural breaks in estimated systems of equations. This approach restricts the breaks to occurring at the same time in all equations of the system and therefore can only detect breaks in the ratio when they occur in the component series simultaneously but with different magnitudes. It may also identify simultaneous breaks of similar magnitude but these would not lead to breaks in the coffee price ratio. While there may be numerous events that impact simultaneously on both price series the discussion in the paper focuses on changes to policy and market structure that impact on the coffee price ratio and may not impact on the two coffee price series simultaneously. Consequently, our preferred approach used in the paper focuses on identifying breaks in the mean of the coffee price ratio directly by applying the Bai and Perron (1998) algorithm.

In an innovative paper, Mehta and Chavas (2008) estimate a VAR model of producer, terminal and retail coffee prices conditioned on dummies that represent periods when the ICA agreements were operating. In contrast, we statistically identify structural breaks in the data to model the impact of changing coffee market policies at both the international (ICA) and domestic levels. This approach is taken because we believe the potential number of breaks are large, difficult to identify individually, and most importantly, the impact of changing domestic and international policies on coffee prices is varied with an indeterminate lag structure.

(vii) *Other Causes of Breaks in the Coffee Price Ratio*

Some observers might argue that the structural breaks that we identify in the coffee price ratio may not necessarily be due to changing policies but due to changes in a range of economic variables such technology and real interest rates that also affect transfer costs. However, the changes in these variables are usually gradual and not sudden and so will not introduce a discrete break in transfer costs and the mean of the coffee price ratio. Instead they are more likely to be stationary or trend stationary processes and so drive an ever increasing or decreasing wedge between the two coffee prices. Therefore, these effects will be identified in the trend in the coffee price ratio unless they cancel each other out and the trend is insignificant. However, if the latter occurs then we can still identify the policy induced structural breaks as they will appear independent of the economic effects on transfer costs.

Larson (2007) develops a spatial and inter-temporal model of trading where inventories play an important role in the dynamics of prices. However, in our case we argue that the role of inventories is a stationary process and so does not affect our estimate of the equilibrium relationship.

(viii) *What does the 'Law of One Price' Mean?*

The Editor and a referee raised the philosophical issue of what the law of one price (LoOP) means when we condition on breaks. One could say that the LoOP does not hold in the raw data which appears to be the case as shown in Table 3 in the paper. However if we model the breaks and then ask does the LoOP hold conditioned on the breaks, as we do in Table 4 in the paper, we find the 'law' holds. In a sense the editor and the referee are right that underpinning the model is the idea that the LoOP holds and that failure to find the relationship must be due to some impediment. For example, two identical products sold in stalls next to each other should have the same price. If they do not, then either the products are not identical or there is some impediment. If we quantify the impediment and model the two prices we find that they have the same price and the LoOP holds. What we should be focusing on is not the 'law' and whether or not it holds but on the size and source of the impediment. In our case in a free coffee market it is logical that the coffee price ratio should be

constant and the LoOP holds. When we find it is not constant then our interest is in the impediment and in our case whether it is government inspired.

S1 REGULATION OF COFFEE MARKETS

This appendix outlines some of the more important domestic and international policies that may have affected either directly or indirectly the market for coffee. The numbers in square boxes are important events that coincide with particular structural breaks identified in the mean of the coffee price ratio as reported in Table S4 in Supplementary Appendix S4 where the numbers are also shown alongside the break reported in that table. Note that the changes in coffee market policies identified below do not include changes in the administered producer price of coffee in each country which may also cause structural breaks.

International Regulation

Coffee was one of the first commodities for which control of world trade was attempted. Pre-world war two attempts at manipulating the world coffee market in order to raise the price of coffee were all centred around Brazil with the 'valorization' process starting in 1902 and carried out by the Brazilian state of Sao Paulo. This process involved state action to raise the price of coffee, which was made possible at that time by the large share of production (between 75 per cent and 90 per cent) of Sao Paulo in terms of world coffee production (Lucier 1988). In the post-war period, control schemes involved other Latin American countries as well.

In 1940 the Inter-American Coffee Agreement set export quotas to the United States for 14 Latin American countries. It is thought that prices doubled in response to the quotas. Brazil and Colombia between 1956 and 1958 jointly decided to limit their total exports. Between 1959 and 1962 further producers joined Brazil and Colombia to limit their exports.

A formal system of multilateral interventions in coffee markets started with the signing of the United Nations sponsored first International Coffee Agreement (ICA) in 1962 by the major coffee exporting and importing countries and administered by the International Coffee Organization (ICO). The ICA allocated export quotas that were adjusted according to the changes in world prices. Quotas were reduced (increased) when coffee prices fell below (above) a particular level. The ICA was undermined by some member countries distributing their exports at lower prices through non-member countries and the inability to agree on quotas. Quotas were operational from October 1963 until December 1973. The quota system became ineffective in December 1973 owing to the disagreements about the size of the quotas. **1**

After December 1973 Brazil set up an international supply-withholding program in the form of a trading company financed by Brazil, Colombia, Cote d'Ivoire and Angola. Another company, Otros Suaves S.A., started up with the support of Mexico. The Inter-African Coffee Organization set up a Vigilance Committee to monitor trade in Robusta coffee. A coordinating committee was set up to implement a voluntary agreement to restrict exports. However, these voluntary efforts had little effect as countries were at the same time expanding their production using high-yielding varieties of coffee. In 1975 heavy frost in Brazil jolted the world coffee market. It reduced Brazil's output by more than one-half and world coffee output by around 17 per cent in 1976 and as a result world prices more than tripled between 1975 and 1977. The high prices encouraged the expansion of coffee-growing areas in many countries including Colombia leading prices to begin to fall after 1977. Brazil and some other Latin American countries tried to intervene in the futures market to raise prices but it had little if any effect on prices. Operation Patricia of Brazil in 1986 involved several exporting companies acting at the behest of the Brazilian government to buy and take delivery of about $300 million worth of coffee for which the government never paid. The purpose was to raise the international price of coffee and run down excess stocks by selling them to the local market at lower prices. This operation failed leaving exporters angry at the failure of the government to pay for the intervention carried out on their behalf.

Quotas were reactivated under the final version of the ICA from October 1980 **2** until July 1989. The quotas were lifted between February 1986 **3** and October 1987, as world coffee prices were already high owing to a severe drought that substantially curtailed Brazil's coffee production. The Agreement was suspended in 1989 (ICO, 1989). **4** Following termination of the ICA, coffee prices fell sharply and remained low for five years as countries and private speculators liquidated stocks in case a new Agreement was negotiated and countries with large exports would likely obtain large export quotas (see Akiyama 2001). Even if the ICA was not reactivated it was useful to liquidate stocks (Jarvis 2005) so as to reduce holding costs and so the coffee prices remained low until early 1994. **5** The end of the liquidation of stocks coincided with two severe frosts in Brazil in late June and early July 1994 which raised coffee prices throughout the mid-1990s.

After the suspension of the ICA, some coffee-producing countries formed the Association of Coffee Producing Countries (ACPC) in 1993 to regulate coffee exports and raise prices. The ACPC had a limited impact because it failed to police agreements and

contained no punitive powers leading several important exporting countries such as Guatemala, Indonesia, Mexico and Vietnam not to join the Association.

In May 2000 **6** fourteen members of the (ACPC) and five non-ACPC members introduced a price support scheme. Under the plan, up to 20 per cent of exports were to be held off the market when the 15-day ICO composite indicator price falls below 95 cents/lb and only released when prices are above US$1.05/lb. A similar scheme had been tried for short periods in 1993 and 1995. The scheme in 2000 had little or no impact on the coffee price and was abandoned soon after implementation and marked the last 'serious' attempt by collective action to intervene in world markets to manipulate the price of coffee.

Domestic Regulation in Brazil, Guatemala and India

Coffee exporting countries regulated the production and marketing of coffee both before and during the ICA period. Regulation often took the form of producers having to sell their produce to the coffee or commodity marketing board at an administered price. At times producers also were required to obtain a license for the production of coffee. The suspension of the ICA and the shift in the late 1980s and early 1990s away from intervening in markets led to the replacing of state-controlled marketing systems with markets run by private agents.

Brazil

The domestic regulation of coffee in Brazil was carried out by the Instituto Brasileiro do Café (IBC) under which the coffee of all producers' was pooled and auctioned by the IBC for the domestic and export markets. Exporters and international buyers were not permitted to buy coffee directly from producers. The producers were paid a guaranteed price fixed by the IBC from time to time. The price was supposed to be fixed on the basis of auction prices after taking into consideration the marketing costs of the IBC. The IBC changed producer prices promptly to changes in international coffee prices. Until 1987 the IBC distributed coffee export quotas free of cost to exporters based upon previous export levels. In response to concerns regarding the distribution of quota rents among exporters it switched to a quota auction in 1987. **7** Exporters therefore accrued quota rents prior to 1987 although it is likely that some rents were passed on to government agencies. Under the auction system, the quota rents were captured by the government as argued by Mehta and Chavas (2008). Around 1987 the IBC introduced a retention programme under which exporters were to retain one bag of coffee for each bag exported. The IBC was abolished in March 1990. **8** Since March

1990 coffee marketing has been totally liberalised and run by the private sector. The state's involvement is now limited to the funding of research and the provision of credit to the coffee sector. The coffee strategy for Brazil is now developed by the Conselho Deliberativo da Política do Café (CDPC) which is composed of representatives of the Government and the private coffee sector. Prior to 1997 a transport tax was levied when coffee crossed a provincial boundary. **9**

Guatemala

Guatemala had no state run commodity or coffee board and the interests of the sector were represented by a coffee producers' association, Asociación Nacional de Café (ANACAFE). The ANACAFE imposed market controls mostly in compliance with the ICA export quotas which were abolished following the ending of the ICA. The ANACAFE acts as the coffee sectors representative in government negotiations and providing policy advice and is funded by a levy of around one per cent on all coffee exports.

In November 1992 **10** on the recommendation of the IMF a coffee export tax was introduced to restrain inflation. From 1993 onwards the period of 'speciality' coffee begins. In 1993-1994 production is above expectations although ANACAFE arranges for compliance with international retention schemes in place at the time. **11** In November 1998 the strong winds and heavy rains of Hurricane Mitch cause about 25 per cent loss of the coffee crop and the spread of a fungal disease which affected future production. **12** Record production of coffee occurs in 1999-2000 which coincides again with the implementation of an international retention scheme of the ACPC in October 2000. **13**

India

In India, the Coffee Board of India was responsible for the domestic regulation of coffee. Its coffee marketing functions were similar to that of the Instituto Brasileiro do Café. The only difference being that, unlike Brazil, the administered prices were often adjusted with considerable lag due to bureaucratic delays and other considerations. The liberalisation of coffee marketing was phased in over a period of four years starting in 1992/93 **14** when producers were allowed to directly market up to 30 per cent of their produce in the internal market with the remaining 70 per cent continuing to be pooled by the Coffee Board for auction. The 30 per cent was increased to 50 per cent in 1994 **15** and producers were

allowed to directly market both in the internal and external market. In September 1996 **16** the Coffee Board's involvement in marketing was completely removed and producers were free to market their produce as they chose. The Indian currency was devalued against the United States dollar by 72 per cent between December 1990 and March 1993 **17**. A number of events occur in 1992 **18** affecting the Indian coffee market including (i) the first outbreak of berry borer disease is discovered, (ii) collapse of the Soviet Union which was a major importer of Indian coffee, (iii) the end of the subsidised sale of coffee to eastern Europe, and (iv) the abolition of export taxes.

S2 THE DATA

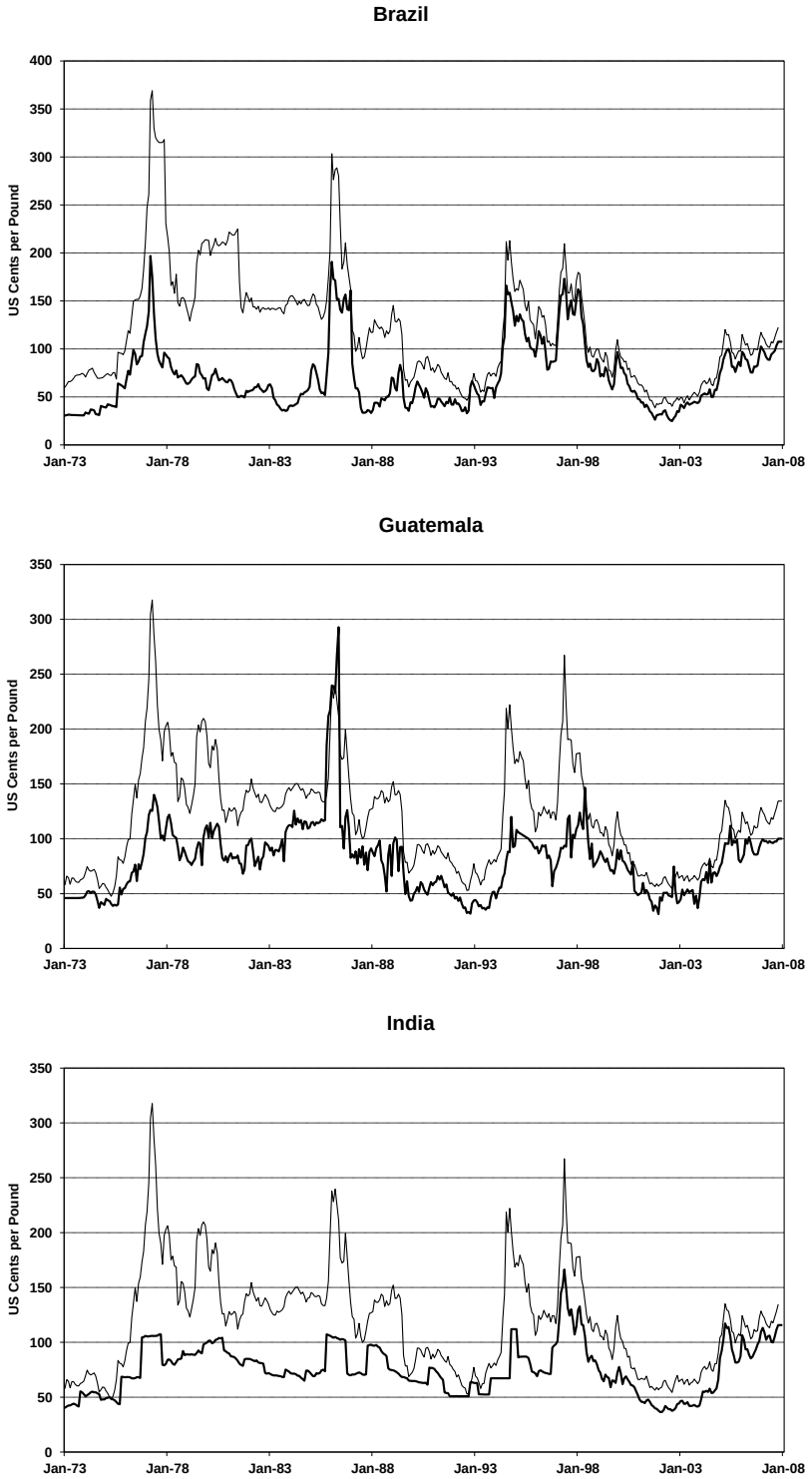
Variable & Mnemonic	*Details*
Producer price of coffee, P_P	The cash (gate) price received for Arabica coffee by coffee producers. They are the dollar equivalents, that is, prices in local currency converted to US$ at the contemporaneous exchange rates to arrive at a monthly average producer price in 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, where 'major' is determined on the basis of coffee traded in quantitative terms. To arrive at an average for the entire country an appropriate sampling methodology is adopted which uses the prices received by producers across different regions. The producer prices were obtained from the ICO database and the Coffee Boards of the respective countries.
Terminal price of coffee, P_T	The ICO Indicator Price for Arabica coffee (Brazil – Brazilian naturals. Guatemala and India – Other mild) 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	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 from current to constant terms and it shows the purchasing power (terms of trade) over manufactured goods from developed economies. Downloaded on 25 August 2008 from the United Nations Conference on Trade and Development. The index is obtained from the UNCTAD Handbook of Statistics (UNCTAD, 2009).
Coffee production	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. All data are available at www.BillRussell.info.

S3 THE NOMINAL PRODUCER AND TERMINAL PRICES OF COFFEE

Figure S1 is of the nominal terminal and producer prices of Arabica coffee for Brazil, Guatemala and India. See the paper for a discussion about the prices.

Figure S1: Terminal and Producer Prices for Arabica Coffee



Note: Thin and thick lines are the terminal and producer prices of coffee respectively. Note the prices are in levels and not in natural logarithms.

S4 IDENTIFYING BREAKS IN THE MEAN OF THE COFFEE PRICE RATIO

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 $k+1$ shifts in the mean in the coffee price ratio. The estimated model is:

$$u_t = \gamma_{k+1} + \tau_t \qquad \text{(S3.1)}$$

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 represent the mean in the 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 mean coffee price ratios respectively in each country over the past 35 years. The estimated break dates are reported in the table below. The breaks were estimated in RATS 7.2 using the baiperron.src and multiplebreaks.src procedures written by Tom Doan and available at www.Estima.com.

Table S1: Estimated Break Dates of the Mean of the Coffee Price Ratio

Brazil	Guatemala	India
December 1974 **1**	June 1975 **1**	March 1976 **1**
March 1977	December 1979 **2**	June 1978
August 1979 **2**	October 1983	June 1980 **2**
August 1981	May 1986 **3**	September 1982
December 1984	May 1988 **4**	December 1986 **3**
April 1987 **3, 7**	April 1993 **10**	June 1989 **4**
April 1989 **4, 8**	April 1995 **5**	April 1992 **14, 17**
December 1991	February 1998 **12**	April 1994 **5, 14, 15**
August 1996 **5, 9**		September 1996 **16**
November 2000 **6**		November 2004
December 2002		

Notes: Numbers in square boxes indicate breaks corresponding with historical events numbered in Supplementary Appendix S1.

S5 ROBUSTNESS OF THE IDENTIFIED BREAKS

Towards the end of Section II in the paper we consider whether the results are in some way driven by the large number of breaks that we incorporated in the empirical model. To this end we undertake the following 'robustness check' of our results. We begin by imposing only half of the number of breaks on the coffee price ratio for each country. We therefore impose 6, 4 and 5 optimally Bai-Perron chosen breaks on Brazil, Guatemala and India instead of the 11, 8 and 10 breaks that we find respectively in the paper when we choose the number of optimal breaks using the Bayesian Information Criteria (BIC) and the Bai-Perron technique.

The final results assuming half the number of breaks are reported in Table S1 below and found to be very similar qualitatively and statistically to those reported in Table 4 in the paper that incorporates the full number of breaks. For example, for all three countries:

(i) The appropriate modelling framework is a VAR-ECM of stationary price variables with possible breaks in the error correction term;
(ii) The trend is insignificant;
(iii) The long-run restriction of $\beta = -1$ can be accepted suggesting the law of one price holds;
(iv) The adjustment coefficients are slightly smaller but similar in magnitude; and
(v) The residuals are largely free of serial correlation as in the full model.

We may conclude, therefore, that the general results and policy implications of our paper are robust to halving the number of breaks. We might also conclude that if we rejected the number of breaks that we find using statistical tests and impose a smaller number our general results, policy conclusions and economic implications are largely unaffected.

Note that of the 15 breaks in mean that we have in the 'half-breaks' model, 12 of them occur in the first 17 years compared with 18 out of 29 breaks in the full-breaks model. It appears that the larger breaks are during the years of administered prices while the period of deregulation is dominated by the smaller and less frequent breaks. One might argue that this is what might be expected during deregulation which is a slower on-going process compared to the discrete changes in administrative prices. It also suggests that an important source of systemic risk in the coffee market as judged by the size and frequency of the breaks was the attempts of ICO to regulate the coffee market prior to liberalisation.

Table S2: VAR Error Correction Model of Coffee Prices
Model 2 – Bai-Perron Break Adjusted – Constrained number of breaks

BRAZIL – 6 Breaks

	Equilibrium Coefficients		Adjustment Coefficients	
	p_P	p_T	Δp_P	Δp_T
Unrestricted	1.0000	- 1.0357 (- 19.4)	- 0.1563 (- 4.1)	0.0371 (1.2)
Restricted	1.0000	- 1.0000	- 0.1618 (- 4.3)	0.0296 (1.0)

TT = 0.4076, TLRR = 0.5989, LM_1 = 0.1979, LM_2 = 0.2691. 6 Breaks in the mean coffee price ratio: April 1977, August 1979, December 1984, April 1987, April 1989, and December 1991.

GUATEMALA

	Equilibrium Coefficients		Adjustment Coefficients	
	p_P	p_T	Δp_P	Δp_T
Unrestricted	1.0000	- 0.9184 (- 22.2)	- 0.4044 (- 9.9)	0.0221 (0.8)
Restricted	1.0000	- 1.0000	- 0.3768 (- 9.4)	0.0438 (1.6)

TT = 0.0655, TLRR = 0.1189, LM1 = 0.0007, LM2 = 0.6182. 4 Breaks in the mean coffee price ratio: June 1975, September 1983, May 1986, and February 1998.

INDIA

	Equilibrium Coefficients		Adjustment Coefficients	
	p_P	p_T	Δp_P	Δp_T
Unrestricted	1.0000	- 1.1405 (- 18.2)	- 0.0935 (- 4.0)	0.1681 (7.3)
Restricted	1.0000	- 1.0000	- 0.1152 (- 4.5)	0.1676 (6.6)

TT = 0.1380, TLRR = 0. 0652, LM_1 = 0.0556, LM_2 = 0.1341. 5 Breaks in the mean coffee price ratio: March 1976, June 1978, June 1989, April 1994, and September 1996.

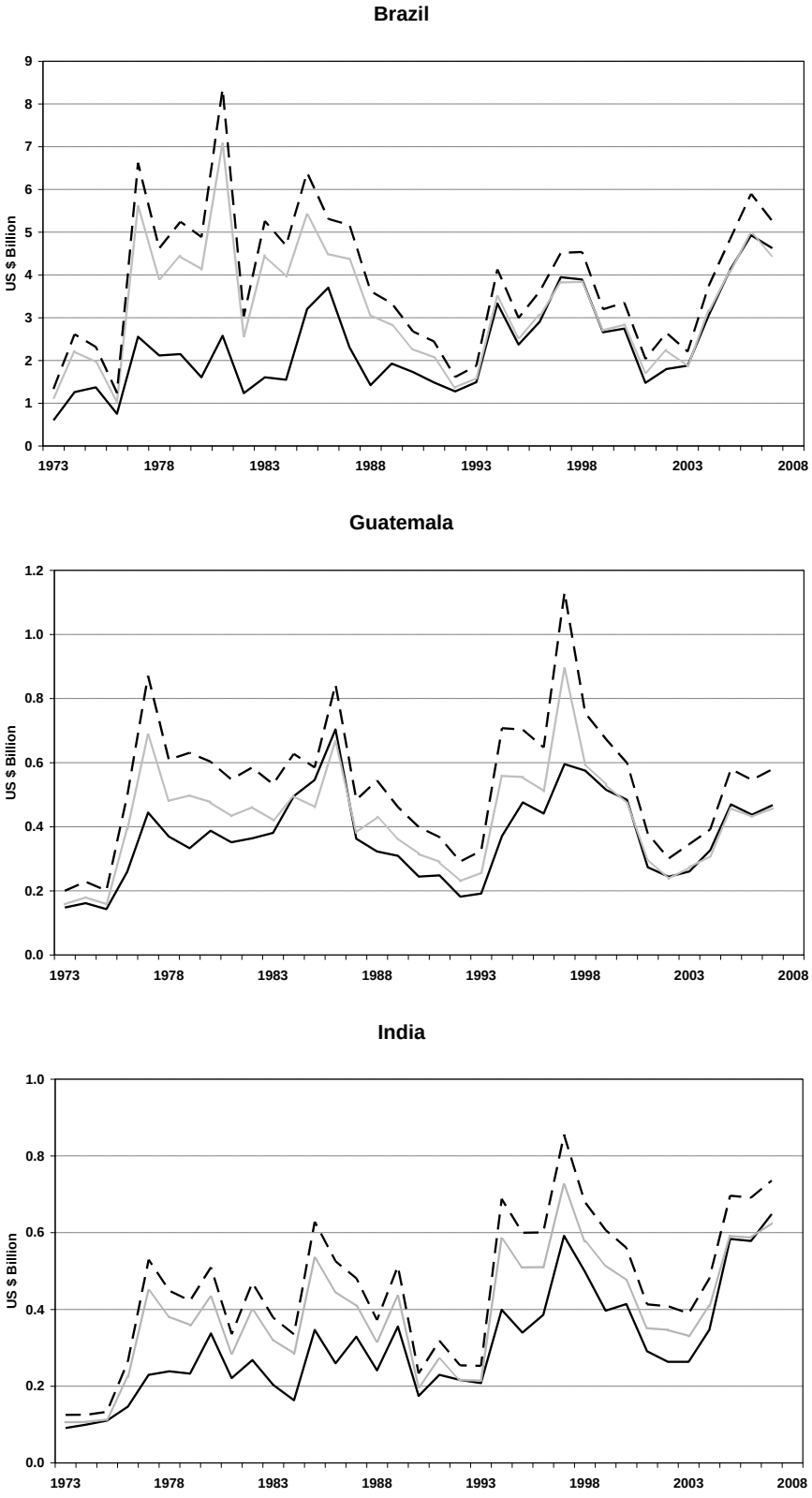
Notes: Reported as ( ) are t-statistics. TT is the finite sample Bartlett corrected probability value of the likelihood ratio exclusion test of the estimated trend. The trend is insignificant in all three models and excluded. TLRR is the finite sample Bartlett corrected probability value of the test of the equilibrium restriction that $\beta = -1$. 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. 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. Estimated with CATS 2.0.

S6 NOMINAL ESTIMATES OF THE LOSS IN REVENUE

The dashed and the black lines in Figure S2 below 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 de-regulated market based outcome throughout the period. It is 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 equilibrium coffee price ratio in 2007 for each country. This calculation assumes that production and the terminal price of coffee are independent of the market based coffee price ratio. Note that the law of one price means that U^e is 'unit free' and a real number. This allows the unit of $Q_t \bullet P_{T,t} \bullet U^e_{2007}$ to be measured in US cents.

The gap between the grey and black lines is the nominal loss in revenue to producers relative to the market outcome and calculated as: $Q_t \bullet P_{T,t} \bullet \left[U^e_{2007} - U_t\right]$. It is shown as the solid thin line in Figure 2 in the paper.

Figure S2: 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 market outcome, and the value of production at terminal prices respectively.

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