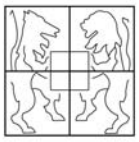
GROUPE D'ECONOMIE
MONDIALE



SCIENCES PO

Market Power in International Commodity Processing Chains: Preliminary Results from the Coffee Market

Ben Shepherd

March 2004

MARKET POWER IN INTERNATIONAL COMMODITY PROCESSING CHAINS: PRELIMINARY RESULTS FROM THE COFFEE MARKET

Ben Shepherd[*]
Groupe d'Economie Mondiale (GEM)
Institut d'Etudes Politiques de Paris
2, Square de Luynes
75007 Paris, France

This Draft Dated: 10 March 2004

Abstract: Vector autoregressions are used to model price transmission through the coffee processing chain, from producers to the world market and from the world market to consumers. A comparison is made of price dynamics against a backdrop of two very different market structures: pre-1989, producers exerted market power through export quotas and state-controlled marketing channels; post-1989, government interventions are minimal, but private actors at intermediary, processing and retailing levels have become quite concentrated. Interestingly, the analysis shows that liberalisation has not improved price transmission as significantly as expected and in some respects appears to have worsened it noticeably. One possible explanation is market power amongst private actors at intermediate levels in the processing chain.

JEL Codes: C32; L11; L66; Q13; Q17.

Keywords: Vector Autoregression; Market Power; International Trade; Commodity Market Liberalisation; Coffee.

---

[*] Encouragement and helpful comments on previous drafts are gratefully acknowledged from Profs. Richard Baldwin & John Cuddy (Graduate Institute of International Studies, Geneva), Mr. Patrick Low (WTO) and Prof. Patrick Messerlin (Sciences-Po). Remaining errors are my own responsibility.

Contact: benjamin.shepherd@sciences-po.org.

> *"Martin Luther used to wonder what people actually do in heaven. For most participants in the intensely competitive food manufacturing industry, contemplation of Nestlé's soluble coffee business must seem like the commercial equivalent of Luther's spiritual meditation."*
> (Oxfam (2002) citing a Deutsche Bank report)

1. Introduction

The continuing strong performance of Nestlé and other giants of the processed beverage world is in striking contrast with the apparently ever increasing impoverishment of ordinary coffee farmers at a time of historically low green coffee prices; the point is well encapsulated in Oxfam's (2002) image of "penniless farmers" versus "profiteering roasters". While the bulk of recent work suggests that the sources of the current crisis are essentially structural (see e.g., Varangis et al. (2003) and ICO (2002, 2003d)), there is nonetheless an undercurrent of suspicion born of that contrast: is there something special about the structure of the coffee processing chain that could be a contributing cause to this apparent decoupling of fortunes?

The present study is an attempt to bring some analytical rigour to bear on that question, which is dealt with only partially and inadequately by the very small body of existing literature. My starting point is that market liberalisation in the late 1980s and early 1990s was a defining event in terms of market structure: prior to mid-1989, producer countries generally used export quotas and state-controlled marketing channels in an attempt to exercise market power and keep world prices high.[1] In July 1989, the first element of that approach—the economic clauses of the International Coffee Agreement (ICA)—effectively broke down and has not been replaced in any serious way since (see Akiyama (2001) and Gilbert (1996)). In the years following the ICA's collapse, most producer countries also dismantled their centralised marketing systems, meaning that what had once been a highly regulated "producer's market" is now a relatively free market in which the vast majority of activity is left to the private

[1] In terms of the producer countries examined here, Guatemala is the only exception to the rule: it has always had a free coffee marketing system and prior to July 1989 was constrained only by the ICA's export quotas.

sector (for an overview, see Akiyama (2001) and ITC (2002)).[2] With these points in mind, the research question can now be re-posed: has realisation of the expected benefits of liberalisation been hampered by the activities of private agents large enough to influence market outcomes? I call this the "profiteering roasters hypothesis".[3]

After reviewing some basic information on firm concentration and assessing the adequacy of the existing literature in Section 2, I present the dataset and model to be used in Section 3. In a nutshell, vector autoregressions (VARs) are used to analyse the dynamics of price transmission through the coffee processing chain in major producer and consumer countries, both prior to and following liberalisation. Certain characteristics of price transmission that would be expected to change following liberalisation—speed and completeness, direction, symmetry and price differentials—are examined by testing hypothesised model restrictions that reflect the characteristics in question, as well as through the analysis of impulse response functions (IRFs). Section 4 presents the results obtained using this approach, while Section 5 concludes with some elements of an agenda for further research.

2. Firm Concentration in the Coffee Processing Chain

The issue of whether firms at intermediate levels in the coffee chain are large enough to have a significant influence on market prices and quantities—and if so, whether they in fact use such market power to the detriment of consumers and/or producers—has assumed an important place in some of the literature on the current "coffee crisis" (see e.g., Oxfam (2002), Ponte (2002) and Talbot (2002)) and, indeed, has echoes in at least one government position paper lodged with the WTO (Kenya et al, 2003). It is certainly possible to marshal a

[2] For present purposes, only Colombia is exceptional in this regard: the National Federation of Coffee Growers (Federacafé) still accounts for around 40% of total exports.

[3] Of course, the question potentially applies much more widely than just to the coffee market: see e.g., Murphy (1999, 2002) & Morisset (1997, 1998).

respectable number of basic statistics in support of the view that some intermediate agents are big enough to make such price manipulation plausible:

- In 2000, the top ten roasters had a combined share of 63% of the global processed coffee market (ITC, 2002).
- The top five roasters account for 80% of the market in the USA and 84% in Germany, figures that are by no means exceptional amongst importing countries (ITC, 2002).
- The British competition watchdog found that Nestlé had a 56% share of the national market and a return on capital employed in its soluble coffee business of over 100% in 1989 (MMC, 1991). In the end, however, it concluded that this was not against the public interest.
- In Colombia, five companies account for around 70% of all private sector exports. (See ITC, 2002; LMC International Ltd, 2000b; and USDA, 1999.)
- In Uganda, three-quarters of all new entrants went bankrupt within two years of liberalisation, leaving the top ten companies with 80% of the total export market (Akiyama et al., 2001).
- In Guatemala, around 100 exporters are active in the market, but the top five have a combined market share of approximately 50%. Six companies are linked to multinationals and together account for around 35% of the export market (see ICO, 2002; LMC International Ltd, 2000c; and Varangis et al, 2003).
- In Mexico, around 200 companies are active in the export market, with the top 15 having a combined market share of 67.5% in 1997 (see ITC, 2002; ITF, undated; and USDA, 1995).

- On the other hand, there are over 200 registered exporters in Brazil and no single firm has a market share greater than 10%. Similarly, over 100 exporters are active in the Indian market (see Akiyama, 2001; ITC, 2002; and LMC International Ltd, 2000a).

These basic statistics suggest that concentration is a serious phenomenon in most, but not all, producer and consumer markets. Although a detailed exploration of its causes is not possible here, the existing literature identifies a number of factors that might be at work: strong product differentiation in consumer markets following the "latte revolution" (Fitter & Kaplinsky (2001) and Ponte (2002)), important scale economies in production (ITC (2002) and UNCTAD (1999)), the difficulties of new firms in accessing finance (Akiyama et al. (2001)) and the importance of distribution networks (cf. Dolan & Humphrey (2000) in the vegetable marketing context).

2.1. Previous Quantitative Work

However, the fact that there is some basic statistical evidence supporting the plausibility of the market power story does not mean that the "profiteering roasters" hypothesis is necessarily true. More formal analysis is required, in particular focusing on the dynamics of price formation and transmission, which can be seen as one of the principal external expressions of market power. However, it is just this type of research that has, to date, lagged behind (see WTO (2003) for a selective overview). In particular, the situation in producer countries—which is the main motivating force behind Oxfam (2002) and similar NGO literature—has been largely ignored.

A rare exception is Moss & Guerra Galindo (2001),[4] in which the authors investigated market power amongst Mexican processors. In a standard regression of the world-producer price

[4] Two additional papers should be noted in passing. Winter-Nelson & Temu (2002) used survey data from the Tanzanian market to conclude that while the marketing margin for coffee seemed to have fallen following

spread, neither processor concentration nor total exports were statistically significant, leading the authors to conclude that the evidence did not indicate either market power amongst processors or Mexico's having the ability to affect world market prices. Although their interpretation of these results seems correct in as far as it goes, it is unfortunately difficult to tell whether the methodology adopted was appropriate or not, as basic diagnostic statistics and test results are not provided. The dataset is also problematic, as the concentration measure used in fact changed very little during the sample period (1980-1999), so its apparent lack of explanatory power is not surprising.

Apart from that isolated example, most other quantitative studies focus on consumer markets. Bettendorf & Verboven (1997, 1998) and Koerner (2002a, 2002b) looked at the Dutch, US and German markets, using reasonably similar structural modelling techniques. In all cases, numerous *a priori* restrictions were imposed in terms of assumed functional forms and cost structures. Evidence was found of oligopolistic interactions in all three markets, though the welfare implications appeared more serious in the US than in Germany or the Netherlands. Indeed, Koerner (2002a, 2002b) suggested that a "price war" was in fact underway in Germany, with pricing below marginal cost.

Feuerstein (2002) took a fundamentally different approach, using a vector error-correction model (VECM) to investigate the relationship between green coffee prices and retail prices in Germany. She found that changes in the former were fully transmitted to the latter in the long run, but that adjustment was relatively slow. She also found evidence of asymmetric transmission of changes in green coffee prices.

liberalisation, the gains to farmers were offset to some extent—though usually not fully—by increased transaction costs in input markets. Lopez & You (1993) assumed the existence of oligopsony power amongst coffee exporters in Haiti and proceeded to investigate the factors determining it.

Gómez & Castillo (2001)[5] used the Box-Jenkins methodology and a VECM to analyse the US market. Their working hypothesis was that liberalisation of the world coffee trade in the 1990s did not result in an undistorted market, but rather in a transfer of market power from producer countries to international wholesalers. They found that the gap between world and US coffee prices had widened following liberalisation (taken as July 1989); however, their results must be treated with a certain scepticism, as the pre-liberalisation world-retail price spread was in fact found to be negative, which seems implausible as a long-run cointegrating relationship. Finally, they concluded on the basis of weak exogeneity tests that in the period prior to liberalisation, world market prices tended to be set independently with subsequent adjustment by retail prices, whereas the reverse was true following liberalisation. This was argued to be consistent with the acquisition of market power by international wholesalers at the expense of producers.

A comparative analysis of the US, French and German markets was undertaken by Gómez & Koerner (2002), again using time series rather than structural techniques. Evidence of short term asymmetric price transmission was found for all three markets, using an asymmetric VECM. However, differences in terms of market structure were also apparent among the three countries, with faster price adjustment observed for Germany than for either France or the USA.

2.2. Consolidation and Motivation of the Present Study

As can be seen from this brief review, the existing quantitative literature on the structure of the coffee market is patchy and does not provide strong evidence one way or the other in terms of the "profiteering roasters" hypothesis. This is due primarily to the fact that existing studies focus only on the links in the processing chain that mediate between the world market

[5] Sincere thanks to Dr. Miguel Gómez both for supplying a copy of the paper and encouraging my own research.

and the consumer; interactions between the producer and the world market have received scant attention and there has been no attempt to include all three levels in a single analysis.

The present study is an attempt to fill that gap in the literature and to provide a more complete picture of the underlying market structure than exists at present. The focus will be exclusively on the way in which information on the dynamics of price transmission can be used to draw inferences regarding market structure. A number of different tests (see below) will be combined, so as to strengthen the resulting inferences. Time series methodology will be used in preference to a more traditional, structural approach. This is because the former requires only an absolute minimum in terms of *a priori* assumptions and notably does not involve the imposition of particular functional forms designed to model producer and consumer behaviour. This is an important benefit when analysing market structure, as it avoids the principal shortcoming of structural models, namely that a single hypothesis regarding market structure cannot be tested independently of the hypothesis that producer and consumer behaviour are accurately captured by the functional forms used in the model (cf. Sexton & Lavoie (2001)).

3. Overview of the Data, Model and Testing Strategy

Now that some benchmarks regarding the aims of this research have been set, this section introduces in more detail the methodology to be adopted. The dataset is reviewed and the results of pre-testing are summarised. The modelling approach is then discussed, including problems of estimation and hypothesis testing.

3.1. The Dataset

I use an International Coffee Organisation (ICO) dataset of monthly prices running from January 1982 to December 2001. All are expressed in nominal US dollars and have been collected and/or calculated by the ICO. The data are split into two sub-periods, denoted "pre-liberalisation" and "post-liberalisation" respectively. In the absence of any additional

considerations, July 1989 is used as the breakpoint. For models involving certain producer countries, however, a later breakpoint is used if justified by the different pace of domestic reform in that country, in which case a dummy variable is included to separate out domestic and international liberalisation effects.[6]

World prices (Figure 1) are proxied using the ICO's Indicator Prices: Colombian Mild Arabicas (CMA), Other Mild Arabicas (OMA), Robustas (RG) and Brazilian Naturals (BNG). Each indicator price is a weighted average of ex-dock prices for green coffee in the major international markets (the USA, France and Germany).[7] In addition, the ICO also maintains a Composite Index (CI), which is itself a weighted average of prevailing prices for those four coffee types (ICO, 2003b).

The ICO maintains producer price data (Figure 2) for all exporting member countries and retail prices (Figure 3) for all importing members, but to facilitate the analysis, it was decided to use only a subset of that data. A selection was initially made of the ten largest exporting countries based on 2001 export volumes. Limited data availability or concerns as to its reliability in respect of four of those countries—Côte d'Ivoire, Indonesia, Peru and Vietnam—led to their exclusion from the sample. The analysis was therefore undertaken using the six remaining countries (2001 export ranking in brackets): Brazil (1), Colombia (3), Guatemala (6), India (7), Mexico (8) and Uganda (9), which together accounted for over 50% of ICO members' exports in 2001. For similar reasons, only the USA and Germany (45% of 2001 imports) were considered on the consumer side.

---

[6] March 1990—coinciding with full liberalisation of the domestic market—is thus used as the breakpoint for Brazil. September 1996 is used for India, January 1993 for Mexico and January 1996 for Uganda.

[7] ICO (2001, 2003a & 2003b) set out the statistical definitions and procedures applied by the ICO in calculating its indicator prices. However, no precise explanation of the term "ex-dock" is given. General trade usage suggests that ex-dock prices include transport costs and trade measures such as tariffs imposed by the importing country. A search of the TRAINS database maintained by UNCTAD revealed that both the USA and the EU have bound duty-free access for green coffee, meaning that we need not take any further account of the potential effects of trade measures on the ICO's indicator prices.

3.1.1. Preliminary Tests

As summarised in Table 1, previous research has tended to treat coffee prices—at least at the world and consumer levels—as integrated of order one (I(1), or difference stationary). Further pre-testing is justified in the present case for three reasons. Firstly, producer prices have not been considered at all in previous work, while world and retail prices have been considered only partially. Secondly, sample periods and frequencies for those series which have been used previously are often different from those used here, and statistical properties might therefore differ. Thirdly, insufficient attention has been paid to the possibility of a structural break in the data coinciding with market liberalisation. Only Gómez & Koerner (2002) tested for the existence of such a break (and found it), though Gómez & Castillo (2001) also uncovered evidence of an important change in the data generating processes coincident with liberalisation. The point is important, as conventional stationarity tests can often mistake a structural break for a unit root (Perron, 1989), potentially leading to model mis-specification.

All series have therefore been re-tested, using three common methodologies (ADF, KPSS and Perron) and considering both the full sample period and the two separate sub-periods.[8] Results (based on tests at the 10% level of significance) are presented in summary form in Tables 2-4 and exhibit considerable differences from previous work.[9] Firstly, there is little uniformity amongst the three sets of series in terms of stationarity. Rather, the data appear to include a mixture of stationary and non-stationary processes, suggesting that the modelling methodology will need to be flexible enough to deal with this important fact.

[8] Both the Perron (1989) and ADF approaches (see Greene, 2000; Hamilton, 1994) test the null hypothesis of a unit root, the principal difference between the two being that the former explicitly takes into account the possibility of a structural break and is therefore particularly well adapted to use here. KPSS (Kwiatkowski et al., 1992), on the other hand, tests the null hypothesis of stationarity.

[9] Full results are available from the author on request.

The structural break issue is apparently crucial, notably because the data sometimes appear to be stationary in the pre-1989 sub-period considered on its own, while in the post-1989 sub-period they often (though not always) appear to be I(1). It would therefore seem questionable to rely solely on results for the full sample period, which seem to show that the series are all I(1). Moreover, these results would seem to add weight to the arguments in favour of a modelling strategy that splits the sample into two sub-periods, and which therefore leaves room for different stationarity characteristics to be at work prior to and following liberalisation.

3.2. The Basic Model

My modelling approach draws heavily on the time series models discussed in Section 2, as well as on the growing quantitative literature analysing price transmission in vertically integrated supply chains (e.g., Chavas & Mehta (2002), Hartmann et al. (undated), Guillotreau et al. (2003), Zachariasse & Bunte (2003)) and studies of market integration (e.g., Baffes & Ajwad (1998), Bukenya & Labys (2002) and Sanjuán & Gil (undated)). I adopt what might be termed an eclectic approach to examining market power: rather than estimating a model designed to test for one or another indicator, I instead construct a more general statistical representation of the data, which is then used to test for a number of different indicators, *all on the basis of a single statistical model*.[10]

Rather than the VECM approach applied by a number of other researchers, simple VARs in levels and first differences will be used in this case, taking the general form of systems (1) and (2) and estimated on the basis of the full sample (with dummy variables) or one or other sub-sample, depending on the test being performed. This choice was made for two reasons.

[10] This approach owes a great deal to Sims (1980) and Johansen (1995) as well as to a draft manuscript entitled *The Cointegrated VAR Model: Econometric Methodology and Macroeconomic Applications*, kindly made available by Prof. Katarina Juselius on her website.

Firstly, the stationarity properties of the data series are neither easy to identify with certitude nor uniform over time and space, so there are potential benefits to adopting a modelling strategy that is not dependent on the strict assumption that all series are I(1) (or stationary) at all points in time. Secondly, and related to the first point, it was found that stable cointegrating relationships—the basis of VECMs—were difficult to establish with confidence over the full time period under consideration. Comparison of pre- and post-liberalisation results was particularly problematic and made the use of more general models all the more attractive.[11]

$$\left.\begin{aligned} p_t^w &= \mu^w + \Phi_{89}^w DU^{89} + \sum_{j=1}^{k} {}_w\Pi_j^w p_{t-j}^w + \sum_{j=1}^{k} {}_w\Pi_j^p p_{t-j}^p + \varepsilon_t^w \\ p_t^p &= \mu^p + \Phi_{89}^p DU^{89} + \sum_{j=1}^{k} {}_p\Pi_j^w p_{t-j}^w + \sum_{j=1}^{k} {}_p\Pi_j^p p_{t-j}^p + \varepsilon_t^p \end{aligned}\right\} \quad (1)$$

$$\left.\begin{aligned} \Delta p_t^w &= \mu^w + \Phi_{89}^w \Delta DU^{89} + \sum_{j=1}^{k} {}_w\Pi_j^w \Delta p_{t-j}^w + \sum_{j=1}^{k} {}_w\Pi_j^p \Delta p_{t-j}^p + \varepsilon_t^w \\ \Delta p_t^p &= \mu^p + \Phi_{89}^p \Delta DU^{89} + \sum_{j=1}^{k} {}_p\Pi_j^w \Delta p_{t-j}^w + \sum_{j=1}^{k} {}_p\Pi_j^p \Delta p_{t-j}^p + \varepsilon_t^p \end{aligned}\right\} \quad (2)$$

The variables p^w and p^p refer to world and producer prices respectively,[12] and ε is a stochastic i.i.d. (0, Ω) error term. In models where retail prices and not producer prices are used, p^r is substituted for p^p. The model is adjusted accordingly when more than one world price series is included. All price series are treated as endogenous—a major departure from the structural tradition, in which assumptions are generally made regarding exogeneity—while the deterministic terms in system (1) are limited to a constant and an intervention dummy set to zero prior to July 1989 and unity elsewhere; in system (2), taking first differences of the

[11] Full cointegration and VECM results are available from the author upon request.

[12] For producer countries, the world price is used which most closely mirrors the type of coffee produced and where more two types are produced, two world price series are used. For consumer countries, CI is used.

intervention dummy results in an "impulse" dummy that is zero everywhere except July 1989. Obviously, the dummy is deleted from all post-liberalisation models as well as those pre-liberalisation models for which the date used as the breakpoint between the pre- and post-liberalisation sub-samples is in fact July 1989. As notation becomes complicated when more than one world price series is involved, the following convention is adopted: for example, ${}_{BNG}\Pi_3^{RG}$ refers to the third lagged term of the RG series in the BNG equation.

3.3. Making the Basic Model "Talk"

Without more, models in the form of systems (1) and (2) are not terribly informative. The key is therefore to take them for what they are: nothing more than convenient mathematical representations of prices at two different market levels, which are believed *a priori* to be linked in some way, even though the precise nature of the link is unknown. What is important in terms of economic insight is to use these representations to test hypotheses that are economically meaningful. The next section presents the precise tests that are used, but it is useful at this point to introduce informally the aspects of the linkages between the two price series it is proposed to investigate:

1. Speed and completeness of price transmission: The move from state-dominated marketing channels and export quotas in producing countries to a relatively free market system is expected to make price transmission faster and more complete in both directions. On the other hand, consumer markets can be considered as liberal in both periods and there should therefore not be any significant change in the speed and completeness of price transmission following liberalisation.

2. Direction of price transmission: Prior to liberalisation, producer countries made a concerted effort both to exercise market power (by using export quotas to restrict supply and keep prices up) and to insulate farmers from external (world market) price shocks. In terms of the coffee processing chain, price transmission would therefore be

expected to be "bottom up" at first, in the sense that changes in farm gate prices translate into changes in world market prices and retail prices, but the reverse is not necessarily true (particularly regarding the producer-world market interface). Liberalisation would be expected to change this dynamic, by promoting price transmission simultaneously in both directions (bottom up and top down).

3. Symmetry of price transmission: Price Transmission Asymmetry (PTA) might be expected at the world-producer price interface prior to liberalisation, in line with the supply and price management policies followed in most producer countries. However, this would be expected to change following liberalisation and there is no reason not to expect a move towards more symmetric price transmission. Similarly, price transmission from the world market to consumers would be expected to be reasonably symmetric in both sub-periods.

4. Changes in marketing margins: One of the avowed goals of market liberalisation was to reduce the marketing margin facing coffee producers (e.g., Akiyama et al. (2001)). It is therefore expected that the gap between world and producer prices should be smaller following liberalisation than before it. On the other hand, no particular change would be expected in the gap between world and retail prices.

It can readily be seen that outcomes contrary to expectations in each of these areas could be consistent with an explanation in terms of market structure, namely that increased concentration at intermediate levels in the processing chain has prevented liberalisation from having its intended effects (cf. Gómez & Castillo, 2001). While it could be argued that one such outcome is not necessarily a "smoking gun" in terms of the "profiteering roasters" hypothesis, such an objection would lose some of its potency if, for example, all four outcomes were to be contrary to expectations: the analogy would then be closer to that of observing a loud bang, the smell of gun powder, fingerprints on a gun and a dead body. That

is, the use of a number of indicators provides a stronger circumstantial basis on which to draw inferences about the underlying phenomena in question.

4. Overview of Results

This section presents a summary of the major results obtained with the approach outlined above. Given the comparatively large number of models involved—a total of 56 including simple and lag-augmented VARs in levels and first differences, covering the full period or one or other sub-period—it is not possible to present detailed information on each model, so the emphasis here is on drawing together those results and deriving implications from them.[13]

4.1. Estimation and the Unit Root Problem

After first determining *k* (the number of lags of each endogenous variable to be included in the model), standard OLS regression was used to estimate the various models in the form of systems (1) and (2).[14] Both pre-testing (see above) and inspection of characteristic roots (Johansen, 1995) suggest that a number of the simple VARs in levels contain unit roots or near unit roots, meaning that those models as they stand cannot be relied on for hypothesis testing, due to the probable non-standard distribution of common test statistics.[15] The solution to this problem is a pragmatic one: while VARs in levels are used as the starting point for analysis, VARs in first differences and lag-augmented VARs in levels (Dolado & Lütkepohl, 1994) are used to buttress results as necessary. This should overcome the difficulties arising from non-stationarity, as all components in first-differenced VARs appear stationary, while

[13] All calculations were performed using E-Views versions 3.1 and 4.1. Full model results—including estimated parameters, diagnostic tests, results of hypothesis tests and IRF plots—are contained in a detailed statistical appendix, available from the author upon request.

[14] A number of methods are available for determining *k* (see Lütkepohl & Breitung (1996)). Here, it was chosen using standard model selection criteria and lag exclusion Wald tests as an initial guide, but the final decision was based on a pragmatic trade-off between the need for approximate white noise residuals and the importance of conserving degrees of freedom. Diagnostic tests suggest that the models thus constructed are tolerably well-specified.

[15] The modulus of the largest characteristic root in most of the VARs in levels is around 0.9.

Dolado & Lütkepohl (1994) have shown that addition of an extra lag to a non-stationary VAR can allow consistent testing of simple hypotheses, such as Granger causation, provided that the extra lag is left unconstrained (see also Toda & Yamamoto (1995) and Yamada & Toda (1998)).

4.2. Model Diagnostics

Models in levels appear at first glance to perform very well, with adjusted R^2 coefficients for individual equations in excess of 0.8 in almost all cases. Models in first differences, as would be expected, exhibit markedly lower adjusted R^2, more in the region of 0.1 to 0.2. In any case, R^2 should not be overemphasised as it could be inflated in the models in levels due to non-stationarity of the underlying series.

More general diagnostic tests[16] indicate that the VARs in levels and first-differences appear reasonably well specified, at least from the point of view of serial correlation.[17] Although LM tests occasionally indicate statistically significant higher order serial correlation, the problem is generally not too serious. Little weight is placed on Portmanteau statistics that appear to indicate more serious problems than do the LM tests, due to the probable distortion of the test statistic in the presence of a unit root or near unit root. In any case, residual correlograms were checked visually and disclosed in all cases a pattern of approximate white noise, only occasionally marred by a very small number of significant "spikes". Together with the other evidence, this is suggestive of the fact that any remaining serial correlation is minor and that

[16] The present discussion of diagnostic tests benefited greatly from the draft manuscript made available by Prof. Katarina Juselius on her website (referenced elsewhere). The relevant tests are also outlined in Johansen (1995) and Lütkepohl (undated).

[17] Residuals from these models almost always exhibit strong evidence of heteroskedasticity and non-normality; however, these problems are less important in terms of inference and hypothesis testing than is serial correlation. It would therefore appear that the models are acceptably well specified. From the observed pattern of the residuals, it is likely that GARCH-type effects linked to the peaks and troughs caused by Brazilian frosts are at the root of this problem.

the models can safely be used as the basis for inference—subject, of course, to the non-stationarity problem.

4.3. Speed and Completeness of Price Transmission

Impulse response function (IRF) analysis is the primary VAR tool for assessing the dynamics of price transmission, as it allows the researcher to trace the effect on all endogenous variables of a one-period shock to a single variable.[18] Table 5 presents summary results of IRF analysis conducted on pre- and post-liberalisation VARs in levels. One point that can immediately be noted is that in spite of the concerns raised previously regarding stationarity, only in two cases (India and Uganda in the post-liberalisation sub-period) did IRFs turn out to be explosive; all others settle down to zero eventually, though often decaying quite slowly.

The interpretation of simple IRFs is necessarily impressionistic, but in this case can nonetheless offer some valuable information on the dynamics of price transmission. Firstly, there is a comparative lack of generalised evidence suggesting that price transmission improved substantially following liberalisation. Although cumulative IRFs are larger and closer together for two producer countries—suggesting that price shocks are transmitted more fully after liberalisation than before—the opposite is the case for producer price IRFs in two other countries, suggesting that innovations are transmitted less fully to producers after liberalisation than before.

Secondly, the IRFs for three producer countries peak later following liberalisation than prior to it, suggesting that there is in fact a greater lag in price transmission now than in the 1980s. For nearly all producer countries, IRFs decay noticeably more slowly after liberalisation, suggesting that although in some cases price transmission may be more complete, it may also be slower.

[18] Pesaran & Shin (1998) generalised impulses were used to generate the IRFs.

Finally, the case of the consumer markets is striking. Their IRFs suggest that in both cases, price transmission was considerably faster and more complete prior to liberalisation than afterwards. That is, IRF peaks were earlier pre-liberalisation, decay was faster and cumulative IRFs were closer together. This is an important result, as the factors affecting price transmission from the world market to consumer markets are fundamentally of a private nature, governmental interventions being essentially non-existent. It is therefore highly suggestive of the fact that changes in market structure following liberalisation have had an important effect on the dynamics of price transmission, and not necessarily for the better.

4.4. Direction of Price Transmission

Within the basic VAR framework (levels or first differences), the direction of price transmission can be analysed by testing for Granger causality amongst the price series in question. The null hypotheses are: firstly, that lagged values of producer prices do not enter the world price equation significantly; and secondly that lagged values of world prices do not enter the producer price equation significantly. Or in terms of constraining models (1) and (2), the tests are $H0:_{w}\Pi_{j}^{p}=0,\forall j=1...k$ and $H0':_{p}\Pi_{j}^{w}=0,\forall j=1...k$ (with adjustments as needed in the cases of multiple world price series or inclusion of retail prices). Given that cross-equation restrictions are involved, the system has to be re-estimated by Seemingly Unrelated Regression (SUR) and the hypothesis tested using Sims' (1980) modified likelihood ratio (LR) test, which appears in equation (3). (T is the total number of observations, c is the number of estimated parameters and the two Σs represent the residual covariance matrices of the restricted and unrestricted models respectively.) The LR test statistic is distributed as a chi-square variate with degrees of freedom equal to the number of restrictions imposed.

$$\lambda=(T-c)\left(\log\left|\Sigma_{R}\right|-\log\left|\Sigma_{U}\right|\right)\sim\chi^{2} \qquad (3)$$

Rejection of $H0$ and non-rejection of $H0'$ means that previous producer prices are relevant to determining current world prices, but that past world prices are not relevant to determining current producer prices. Hence, causation runs exclusively from producer to world prices, which is consistent with bottom-up price transmission. Similarly, non-rejection of $H0$ and rejection of $H0'$ is consistent with top-down price transmission. If both null hypotheses are rejected, then causation is bilateral and prices changes are transmitted in both directions. Finally, if neither null hypotheses can be rejected, there is no Granger causality in the system and transmission between world and producer prices must be very weak.

Table 6 shows the results of these tests in summary form across the two model types used, namely lag-augmented VARs in levels and VARs in first differences. The direction of causality is indicated with arrows. When more than one world price is involved, results are reported both for individual Granger causality (e.g., "BNG causes Brazil") and joint causality (e.g., "BNG and RG jointly cause Brazil"); joint causality is indicated with braces. Unless otherwise indicated, all tests are conducted at the 10% level of significance.

As is common, the results of the Granger causality tests in this case display some sensitivity to model specification. To generalise, however, it would appear that bilateral transmission between world and US retail prices was the norm in both sub-periods, but that Germany exhibited bottom up transmission. For producer countries, it seems clear that bottom up price transmission was considerably stronger prior to liberalisation than afterwards; insulating producers from world prices was, indeed, one of the objectives of the ICA and so this is not an unexpected result. In the first period, five of the six producer countries exhibit credible evidence of either bilateral causality or bottom-up price transmission; only Colombia shows no sign whatsoever of this mechanism's having been in operation. After liberalisation, on the other hand, only three countries (Brazil, Colombia and India) seem to be involved in bottom-up price transmission, and in the cases of Brazil and India the evidence is mixed and not at all

robust to model specification. It would therefore seem that top-down price transmission is a more important driving force in producer markets after liberalisation than prior to it, but that no such change is apparent in consumer markets.

4.5. Symmetry of Price Transmission

VARs in first differences are used as the basic model for assessing PTA. However, a slight modification is necessary: system (2) must be decomposed to allow for different coefficients on positive and negative price changes, which can then be tested for equality (implying symmetric price transmission). This is done in system (4), in which Δ^+ is zero for first differences less than or equal to zero and otherwise is equivalent to the first difference operator and Δ^- takes a non-zero value only when first differences are negative. This is a simple adaptation of more traditional, single-equation PTA models and finds an echo in the asymmetric VECM approach. (See the overviews in von Cramon-Taubadel & Meyer (undated), Gonzales et al. (2003) and Gómez & Koerner (2002).)

$$\left.\begin{aligned} \Delta p_t^w &= \mu^w + \Phi^w \Delta DU^{89} + \sum_{j=1}^{k} {}_w\Pi_j^w \Delta p_{t-j}^w + \sum_{j=1}^{k} {}_w^+\Pi_j^p \Delta^+ p_{t-j}^p + \sum_{j=1}^{k} {}_w^-\Pi_j^p \Delta^- p_{t-j}^p + \varepsilon_t^w \\ \Delta p_t^p &= \mu^p + \Phi^p \Delta DU^{89} + \sum_{j=1}^{k} {}_p^+\Pi_j^w \Delta^+ p_{t-j}^w + \sum_{j=1}^{k} {}_p^-\Pi_j^w \Delta^- p_{t-j}^w + \sum_{j=1}^{k} {}_p\Pi_j^p \Delta p_{t-j}^p + \varepsilon_t^p \end{aligned}\right\} \quad (4)$$

System (4) can be tested for PTA using the following hypotheses. Firstly, the symmetric specification in model (2) can be tested as a nested model within the more general asymmetric specification in model (4). Formally, we test the joint *H0*: $\left.\begin{aligned} {}_w^+\Pi_j^p &= {}_w^-\Pi_j^p \\ {}_p^+\Pi_j^w &= {}_p^-\Pi_j^w \end{aligned}\right\} \forall j = 1...k$. Rejection of the null hypothesis implies that there is some evidence of PTA on a system-wide basis and that further investigation is required to uncover its nature and extent. The second stage of PTA analysis is therefore to test each equation in the system separately, again using the null hypothesis that price transmission is symmetric in that equation, against the alternative that it is asymmetric in that particular equation. In formal terms, we sequentially test null hypotheses

of the form $H0: {}^{+}_{p}\Pi^{w}_{j} = {}^{-}_{p}\Pi^{w}_{j}, \forall j = 1...k$ and $H0: {}^{+}_{w}\Pi^{p}_{j} = {}^{-}_{w}\Pi^{p}_{j}, \forall j = 1...k$. Rejection of either null hypothesis implies that price transmission in the equation concerned is asymmetric. Finally, we test explicitly for short-term PTA—occurring over one period only—by conducting 2*k* independent tests of null hypotheses of the form $H0: {}^{+}_{w}\Pi^{p}_{j} = {}^{-}_{w}\Pi^{p}_{j}$ and $H0: {}^{+}_{p}\Pi^{w}_{j} = {}^{-}_{p}\Pi^{w}_{j}$. Once again, rejection of any one of the null hypotheses is indicative of short-term PTA at a given lag.

Summary results from testing at the 10% level appear in Table 7, in which the conclusion that PTA exists in one direction or another includes the situation where short-term PTA is found to exist (i.e., a null hypothesis of symmetry is rejected even in respect of one lagged price change). On that basis, only one producer country (Guatemala) was not subject to PTA in the pre-liberalisation period. It is notable that except in the case of Brazil, PTA in producer countries prior to liberalisation took the form of asymmetric transmission of world prices to producer prices, while changes in the other direction were transmitted symmetrically. That is, the results in Table 7 are broadly consistent with the price maintenance and stabilisation practices used by producer countries (except notably Guatemala) before liberalisation and which were expressly designed to shelter producers to some extent from changes in world prices.

What is far more surprising in terms of producer countries is that Table 7 discloses significant evidence of PTA *after* liberalisation as well; only Mexico and India exhibit symmetry of price transmission. Moreover, PTA in the post-liberalisation period is (except for Brazil) in *both* directions, that is from world to producer prices—as in the pre-liberalisation period—and from producer to world prices. This is an extremely significant result, as it suggests that far from improving the quality of price transmission, liberalisation has in fact tended to erode it. Given that the costs of adjusting prices at the world and producer levels should now be quite

small—especially in the general absence of government price controls in producer countries post-liberalisation—it is difficult to rely on "menu costs" as an explanation of PTA in this case; that is, menu costs at this level should have decreased substantially following liberalisation, yet PTA has seemingly worsened.

Another interesting result is that consumer countries also display significant evidence of PTA, running both from world to retail prices and from retail to world prices. This is true both before liberalisation and afterwards. While it is possible that menu costs are at least part of the explanation for PTA from world to retail prices, it is more difficult to see their role in the opposite direction, as there is little reason to expect price stickiness at the world market level.

4.6. Changes in the Marketing Margin

To isolate changes in the marketing margin following liberalisation, it is necessary to estimate VAR models over the full sample period, using dummy variables to take account of relevant breakpoints. One approach is to test the null hypothesis H0: $\Phi^w = \Phi^p$, rejection of which would be consistent with a change in the marketing margin following liberalisation, as it would show level jumps of different magnitudes in the two series. Secondly, we make use of the fact that the constant term in a VAR in levels can be interpreted as a "summary" of the condition of genuinely exogenous variables (Greene, 2000). Prior to liberalisation, we would expect these terms to be different for producer and world prices, to take account of the different exogenous policies to which they were subject. After liberalisation, it seems plausible that they might be subject to the same exogenous conditions. Hence, we test $H0: \mu^w = \mu^p$ and compare the result with that obtained under $H0: \mu^w + \Phi^w = \mu^p + \Phi^p$. If the first null is rejected but the second is not, this suggests that the exogenous conditions surrounding price formation at the two levels have come closer together following liberalisation.

Table 8 presents a summary of results from tests of the above hypotheses, again at the 10% level. For four of the six producer countries, the marketing margin decreased as expected following liberalisation. Hypothesis tests suggest that it remained unchanged for Guatemala and India: a plausible result for the former, given the graphical evidence, but very surprising for the latter. The Indian result seems to flow from the fact that none of the dummy variables entered the VAR significantly, perhaps indicating that the hypothesised dates of structural breaks should be rethought.

The Table also shows that for four of the six countries, the combined post-liberalisation exogenous term is indistinguishable as between the producer and world price equations, where it was statistically different prior to liberalisation. As with the apparent generalised reduction in marketing margins, this suggests improved market integration following liberalisation and is essentially what is expected on a standard view of the benefits from liberalisation.

Finally, it must be noted that the marketing margin for Germany has increased according to the hypothesis tests performed. Indeed, even though the result for the USA is "unchanged", it should be noted that the signs and magnitudes of the relevant dummy variables suggest strongly that the margin increased there as well, even if the effect is not statistically apparent. Although there are other possible explanations for such an expansion of the margin—notably related to the share of non-coffee costs in production of the final product—the influence of market structure certainly cannot be excluded.

5. Conclusions and Agenda for Further Research

The results of the present study can be summarised as follows:

- Liberalisation has brought about only limited improvements in the speed and completeness of price transmission among producer countries, the world market and

consumer countries; in some cases, transmission would even appear to have worsened in terms of these criteria.

- There has been a distinct move towards a system of price transmission that is more top-down than bottom-up, a reversal of the situation that existed prior to liberalisation. Bilateral transmission is a substantially less common phenomenon than expected.
- Asymmetric price transmission persists at all levels of the market in spite of liberalisation, and could even said to be more widespread now than it was before.
- Although liberalisation seems to have delivered on its promise of reduced marketing margins in most producer countries, there is some evidence to suggest that margins have increased on the consumer side.

What is striking about these results is the rather sombre picture they paint of the impact of market liberalisation in the 1980s and 1990s. The retreat of the state from the coffee processing chain does not yet appear to have led to the establishment of a particularly well-functioning market. In light of the increased firm concentration identified above, it is certainly possible that market structure and market power have played a role in producing some of the observed results. Although it is far too early to provide a definitive answer to the "profiteering roasters" hypothesis, I would suggest that there is now sufficient evidence to suggest that the firms involved at least have a *prima facie* case to answer and that further, more detailed investigation is called for.

With this in mind, there are a number of directions open to future research, both in terms of the coffee market and other primary commodity markets that exhibit similar characteristics:

- The approach taken here could be rendered more consistent and inclusive by using a panel data VAR, which would enable testing of cross-country hypotheses. This would also facilitate a more detailed comparison of the links between different market

structures across producer and consumer countries and divergences in observed cross-country outcomes.

- More detailed price data could be used to model consumer markets with a number of different processing stages, thereby giving a richer picture of price transmission dynamics and potentially helping to identify more precisely the location of market imperfections in the consumer countries.
- Multivariate volatility (GARCH-type) models could be used to model the transmission of price volatility through the processing chain (cf. Yang et al. (2003) and Weaver & Natcher (2000)).
- Application of similar methodologies to different processing chains would also provide a useful
- Given that commodity processing chains are often international, there are both policy and political implications of this research at the supra-national level. The issue has already been raised in a general way at the WTO (see Kenya et al. (2003) and WTO (2003)) and the trade policy community is starting to come alive to the issues involved: see e.g., Abbott (1998, 2003), Gilbert & Varangis (2003), Josling (1999, 1999a) and MacLaren & Josling (1999). However, this research programme is in its infancy—partly due to the paucity of supporting empirical work. To ensure that the political discourse takes place within an appropriate intellectual framework, it is therefore important for researchers to devote time to both the empirical and theoretical issues involved.

References

Abbott, P. (1998). Competition Policy and Agricultural Trade. *OECD Document COM/AGR/CA/TD/TC/WS(98)106.*

Abbott, P. (2003). Towards More Socially Responsible Cocoa Trade. *IATRC Working Paper 03-03.*

Akiyama, T. (2001). Coffee Market Liberalisation Since 1990. In Akiyama, T., Baffes, J., Larson D. F. & Varangis, P. (eds). *Commodity Market Reforms: Lessons of Two Decades.* Washington D. C.: The World Bank.

Akiyama, T., Baffes, J., Larson, D. & Varangis, P. (2001). Market Reforms: Lessons from Country and Commodity Experiences. In Akiyama, T., Baffes, J., Larson D. F. & Varangis, P. (eds). *Commodity Market Reforms: Lessons of Two Decades.* Washington D. C.: The World Bank.

Baffes, J. & Ajwad, M. I. (1998). Detecting Price Linkages: Methodological Issues and an Application to the World Market of Cotton. *Mimeo.*

Bettendorf, L. & Verboven, F. (1997). How Competitive is the Dutch Coffee Market? *CPB Report, 97(4),* 27-29.

Bettendorf, L. & Verboven, F. (1998). Competition on the Dutch Coffee Market. *Research Memorandum 141.* The Hague: Central Planning Bureau.

Bukenya, J. O. & Labys, W. C. (2002). Price Convergence on World Commodity Markets: Fact or Fiction. *Research Paper 2002-1*, West Virginia University.

Chavas, J.-P. & Mehta, A. (2002). Price Dynamics in a Vertical Sector: The Case of Butter. *Staff Paper 452,* University of Wisconsin-Maddison.

Dolado, J. J. & Lütkepohl, H. (1994). Making Wald Tests Work for Cointegrated VAR Systems. *Mimeo.*

Dolan, C. & Humphrey, J. (2000). Governance and Trade in Fresh Vegetables: The Impact of UK Supermarkets on the African Horticulture Industry. *Journal of Development Studies, 37(2)*, 147-176.

Feuerstein, S. (2002). Do Coffee Roasters Benefit From High Prices of Green Coffee? *International Journal of Industrial Organisation, 20,* 89-118.

Fitter, R. & Kaplinsky, R. (2001). Can an Agricultural "Commodity" be De-Commodified, and if so, Who is to Gain? *Discussion Paper 380.* Brighton: Institute of Development Studies.

Gilbert, C. L. (1996). International Commodity Agreements: An Obituary Notice. *World Development, 24,* 1-19.

Gilbert, C. L. & Varangis, P. (2003). Globalisation and International Commodity Trade with Specific Reference to the West African Cocoa Producers. *Working Paper 9668.* Cambridge, MA: National Bureau of Economic Research.

Gómez, M. I. & Castillo, M. (2001). Structural Change, Rents Transferring and Market Power in the International Coffee Market: A Time Series Analysis. *Mimeo.*

Gómez, M. I. & Koerner, J. (2002). Do Retail Coffee Prices Increase Faster Than They Fall? Asymmetric Price Transmission in France, Germany and the United States. *Mimeo,* www.fundacion.uc3m.es/earie2002/papers/paper_496_20020329.pdf.

Gonzales, F., Guillotreau, P., Le Grel, L. & Simioni, M. (2003). Asymmetry of Price Transmission Within the French Value Chain of Seafood Products. *Working Paper 2003-02.* Toulouse: Institut National de la Recherche Agronomique.

Greene, W. H. (2000). *Econometric Analysis.* Fourth edition. New Jersey: Prentice-Hall.

Guillotreau, P., Le Grel, L. & Simioni, M. (2003). Price-Cost Margins and Structural Change: Sub-Contracting Within the Salmon Marketing Chain Between France and Norway. *Working Paper in Agricultural Economics 2003-01.* Toulouse: Institut Nationale de la Recherche Agronomique.

Hamilton, J. D. (1994). *Time Series Analysis.* Princeton: Princeton University Press.

Hartmann, J., Jaffry, S. & Asche, F. (undated). Price Relationships along the Value Chain: An Analysis of the Hake Market in France. *Mimeo.*

International Coffee Organisation. (2001). Draft procedures for the collection, transmission, calculation and publication of group and composite prices effective from 1 October 2001. *ICO Document EB 3776(01).*

International Coffee Organisation. (2002). Coffee Market Situation: Coffee Year 2001-2002. *ICO Document ICC 87-1.*

International Coffee Organisation. (2003a). Data Concepts and Variables Used in the Statistics of the Organisation. *ICO Document WP 934-03.*

International Coffee Organisation. (2003b). Share of the Markets in Each Group of Coffee and their Weighting in the Calculation of the ICO Composite Indicator Price. *ICO Document ED 1887-03.*

International Coffee Organisation. (2003c). Coffee Market Report: June 2003. London: ICO.

International Coffee Organisation. (2003d). Ideas and Initiatives Raised at the ICO/World Bank High-Level Round-Table on 19 May 2003 in Search of Solutions to the Coffee Crisis. *ICO Document ICC 88-5.*

International Trade Centre. (2002). *Coffee: An Exporter's Guide.* Geneva: International Trade Centre.

Johansen, S. (1995). *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models.* Oxford: Oxford University Press.

Josling, T. (1999). Globalisation of the Food Industry and its Impact on Agricultural Trade Policy. *Mimeo.* Paper presented at the Conference on Agricultural Globalisation, Trade and the Environment, 7-9 March 1999, UC Berkeley.

Josling, T. (1999a). Trends in Agri-Markets and Trade Policy. *Mimeo.* Paper presented at the Conference on International Plant Protection Policy and Market Development, November 1999.

Kenya, Uganda & Tanzania. (2003). Non Paper on the Need for Urgent Action in WTO to Deal With the Crisis Situation Created by the Long-Term Trend Towards Decline in Prices of Primary Commodities to the Trade and Development of Developing Countries which are Heavily Dependent on their Exports. *WTO Document WT/COMTD/W/113.*

Koerner, J. (2002a). A Good Cup of Joe? Market Power in the German and US Coffee Market. *Mimeo,* www.fundacion.uc3m.es/earie2002/parallel_sessions.asp?sess=VI.

Koerner, J. (2002b). The Dark Side of Coffee. Price War in the German Market for Roasted Coffee. *Working Paper EWP 0204.* University of Kiel: Department of Food Economics and Consumption Studies.

Kwiatkowski, D., Phillips, P. C. B., Schmidt P. & Shin, Y. (1992). Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root. *Journal of Econometrics, 54,* 159-178.

LMC International Ltd. (2000a). Brazil: Coffee Profile. *Mimeo*, www.itf-commrisk.org.

LMC International Ltd. (2000b). Colombia: Coffee Profile. *Mimeo*, www.itf-commrisk.org.

LMC International Ltd. (2000c). Guatemala: Coffee Profile. *Mimeo*, www.itf-commrisk.org.

LMC International Ltd. (2000d). India: Coffee Profile. *Mimeo*, www.itf-commrisk.org.

Lopez, R. A. & You, Z. (1993). Determinants of Oligopsony Power: The Haitian Coffee Case. *Journal of Development Economics, 41,* 275-284.

Lütkepohl, H. (Undated). Vector Autoregressive and Vector Error Correction Models. *Mimeo*.

Lütkepohl, H. & Breitung, J. (1996). Impulse Response Analysis of Vector Autoregressive Processes. *Mimeo.*

MacLaren, D. & Josling, T. (1999). Competition Policy and International Agricultural Trade. *Working Paper 99-7, International Agricultural Trade Research Consortium.*

Monopolies and Mergers Commission. (1991). *Soluble Coffee: A Report on the Supply of Soluble Coffee for Retail Sale in the United Kingdom.* London: Monopolies and Mergers Commission.

Morisset, J. (1997). Unfair Trade? Empirical Evidence in World Commodity Markets Over the Past 25 Years. *Policy Research Working Paper 1815.* Washington D.C.: The World Bank.

Morisset, J. (1998). Unfair Trade? The Increasing Gap Between World and Domestic Prices in Commodity Markets During the Past 25 Years. *World Bank Economic Review, 12(3),* 503-526.

Moss, C. B. & Guerra Galindo, G. A. (2001). Quality Differentiation and Market Power in the Mexican Coffee Market: Theory and Evidence. *Staff Paper 01-5*. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida.

Murphy, S. (1999). Market Power in Agricultural Markets: Some Issues for Developing Countries. *Trade Working Paper 6.* Geneva: South Centre.

Murphy, S. (2002). *Managing the Invisible Hand: Markets, Farmers and International Trade.* Canada: Institute for Agriculture and Trade Policy.

Otero, J. G. & Milas, C. (1998). Modelling the Behaviour of the Spot Prices of Various Types of Coffee. *Mimeo,* ww2.warwick.ac.uk/fac/soc/economics/research/papers/dpaper.pdf.

Oxfam. (2002). *Mugged: Poverty in Your Coffee Cup.* U.K.: Oxfam.

Perron, P. (1901). The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis. *Econometrica, 57(6),* 1361-1401.

Pesaran, H. H. & Shin, Y. (1998). Generalised Impulse Response Analysis in Linear Multivariate Models. *Economics Letters, 58,* 17-29.

Ponte, S. (2002). The 'Latte Revolution?' Regulation, Markets and Consumption in the Global Coffee Chain. *World Development, 30(7),* 1099-1122.

Sabuhoro, J. B. & Larue, B. (1997). The Market Efficiency Hypothesis: The Case of Coffee and Cocoa Futures. *Agricultural Economics, 16,* 171-184.

Sanjuán, A. I. & Gil, J. M. (undated). Price Transmission Analysis: A Flexible Methodological Approach Applied to European Pork and Lamb Markets. *Mimeo.*

Sexton, R. J. & Lavoie, N. (2002). Food Processing and Distribution : An Industrial Organisation Approach. In Gardner, B. & Rausser, G. (eds). *Handbook of Agricultural Economics, Volume 2.* Amsterdam: Elsevier Science.

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

Talbot, J. M. (2002). Tropical Commodity Chains, Forward Integration Strategies and International Inequality: Coffee, Cocoa and Tea. *Review of International Political Economy, 9(4),* 701-734.

Toda, H. Y. & Yamamoto, T. (1995). Statistical Inference in Vector Autoregressions with Possibly Integrated Processes. *Journal of Econometrics, 66,* 225-250.

UNCTAD. (1999). The World Commodity Economy: Recent Evolution, Financial Crises and Changing Market Structures. *UN Document TD/B/COM.1/27.*

USDA. (1995). Mexico: Coffee – Annual Report. *Report #MX9503A*, Foreign Agriculture Service.

USDA. (1999). Colombia: Coffee – Semi-Annual Report. *GAIN Report #CO9028*, Foreign Agriculture Service.

Varangis, P., Siegel, P., Giovannucci, D. & Lewin, B. (2003). Dealing with the Coffee Crisis in Central America: Impacts and Strategies. *Policy Research Working Paper 2993*. Washington D.C.: The World Bank.

Vogelvang, E. (1992). Hypotheses Testing Concerning Relationships Between Spot Prices of Various Types of Coffee. *Journal of Applied Econometrics, 7(2),* 191-201.

Von Cramon-Taubadel, S. & Meyer, J. (Undated). Asymmetric Price Transmission: Fact or Artefact? *Mimeo.*

Weaver, R.D. & Natcher, W.C. (2000). Competitiveness in Vertical Market Chains: Evidence for Beef Markets. *Mimeo,* presented at the NEC-165 Conference "The American Consumer in the Changing Food System", Washington D.C., 3-5 May 2000.

Winter-Nelson, A. & Temu, A. (2002). Institutional Adjustment and Transaction Costs: Product and Inputs Markets in the Tanzanian Coffee System. *World Development, 30(4),* 561-574.

Yamada, H. & Toda, H. Y. (1998). Inference in Possibly Integrated Vector Autoregressive Models: Some Finite Sample Evidence. *Journal of Econometrics, 86,* 55-95.

Yang, J., Zhang, J. & Leatham, D. J. (2003). Price and Volatility Transmission in International Wheat Futures Markets. *Annals of Economics and Finance, 4,* 37-50.

Zachariasse, V. & Bunte, F. How are Farmers Faring in the Changing Balance of Power Along the Food Chain? *Mimeo*. Paper presented at the Conference on Changing Dimensions of the Food Economy: Exploring the Policy Issues, 6-7 February 2003, The Hague.

Statistics

www.ico.org.

www.unctad.org

www.usitc.gov

Tables

Table 1: Summary of Previous Studies' Stationarity Results

Study	Series Tested	Tests Used	Conclusion
Vogelvang (1992)	CMA, OMA, BNG & RG Quarterly Prices (1960-1982)	Phillips	All series I(1).
Sabuhoro & Larue (1997)	CSCE Daily Spot and Futures Prices (1979-1990)	ADF, Phillips-Perron, KPSS	All series I(1).
Otero & Milas (1998)[19]	BNG, OMA, CMA & RG Quarterly Prices (1960-1998)	ADF, Phillips-Perron	All series I(1).
Gómez & Castillo (2001)	NYSE Monthly Prices & USDA Monthly Consumer Prices (1982-2000)	ADF	Both series I(1).
Gómez & Koerner (2002)	CI Monthly Prices (1990-2000)	ADF, DF-GLS, KPSS & Phillips-Perron.	I(1) with a structural break.
Bukenya & Labys (2002)	CSCE Yearly Prices for Brazilian, Colombian and Ugandan Coffees (1950-1998)	ADF	All series I(1).

Table 2: Results of Stationarity Tests – Monthly ICO Indicator Prices (1982-2001).

Series	ADF	KPSS	Perron
CI			
Full Period	I(1)	I(1)	I(1)
Pre-Liberalisation	I(0)	I(0)	-
Post-Liberalisation	I(1)	I(1)	-
BNG			
Full Period	I(0)	I(1)	I(1)
Pre-Liberalisation	I(1)	I(0)	-
Post-Liberalisation	I(1)	I(1)	-
CMA			
Full Period	I(0)	I(0)	I(1)
Pre-Liberalisation	I(1)	I(0)	-
Post-Liberalisation	I(1)	I(1)	-
OMA			
Full Period	I(0)	I(1)	I(1)
Pre-Liberalisation	I(0)	I(0)	-
Post-Liberalisation	I(1)	I(1)	-
RG			
Full Period	I(1)	I(1)	I(1)
Pre-Liberalisation	I(1)	I(1)	-
Post-Liberalisation	I(1)	I(1)	-

[19] Sincere thanks to Jesús Otero for providing me with a detailed statistical appendix to Otero & Milas (1998).

Table 3: Results of Stationarity Tests – Monthly ICO Producer Prices (1982-2001).

Series	ADF	KPSS	Perron
BRAZIL			
Full Period	I(1)	I(0)	I(1)
Pre-Liberalisation	I(1)	I(0)	-
Post-Liberalisation	I(1)	I(1)	-
COLOMBIA			
Full Period	I(1)	I(1)	I(1)
Pre-Liberalisation	I(1)	I(0)	-
Post-Liberalisation	I(1)	I(1)	-
GUATEMALA			
Full Period	I(0)	I(1)	I(0)
Pre-Liberalisation	I(0)	I(0)	-
Post-Liberalisation	I(1)	I(1)	-
INDIA			
Full Period	I(0)	I(0)	I(1)
Pre-Liberalisation	I(1)	I(0)	-
Post-Liberalisation	I(1)	I(0)	-
MEXICO			
Full Period	I(0)	I(1)	I(1)
Pre-Liberalisation	I(0)	I(0)	-
Post-Liberalisation	I(1)	I(0)	-
UGANDA			
Full Period	I(1)	I(1)	I(1)
Pre-Liberalisation	I(1)	I(1)	-
Post-Liberalisation	I(1)	I(1)	-

Table 4: Results of Stationarity Tests – Monthly ICO Retail Prices (1982-2001).

Series	ADF	KPSS	Perron
USA			
Full Period	I(0)	I(1)	I(1)
Pre-Liberalisation	I(1)	I(1)	-
Post-Liberalisation	I(1)	I(1)	-
GERMANY			
Full Period	I(1)	I(0)	I(1)
Pre-Liberalisation	I(1)	I(1)	
Post-Liberalisation	I(1)	I(1)	

Table 5: Results of IRF Analysis

Country	Speed	Completeness
Brazil	IRF peaks generally 1-2 periods later post-liberalisation, except for PP_{BNG} which is 3 periods earlier. IRFs decay more slowly post-liberalisation.	Cumulative IRFs are larger and closer together post-liberalisation.
Colombia	IRF peaks generally 1-2 periods earlier post-liberalisation, except for PP_{PP} which is 1 period later. IRFs decay more regularly post-liberalisation.	Cumulative IRFs are larger and closer together post-liberalisation.
Guatemala	IRF peaks generally 1-3 periods later post-liberalisation, except for RG_{PP} which is 4 periods earlier. IRFs generally decay more slowly post-liberalisation.	Cumulative IRFs are generally closer together and larger, except those for innovations to PP: they are smaller and have moved away from the others.
India	IRF peaks generally earlier post-liberalisation and decay at a similar rate.	Cannot compare as cumulative IRFs are explosive post-liberalisation.
Mexico	IRF peaks later and decay slower post-liberalisation.	Cumulative IRFs much larger. Those for OMA are closer together, but those for PP appear to have moved apart.
Uganda	IRF peaks generally earlier post-liberalisation, except for PP. Decay is generally slower post-liberalisation, apart from PP which decays marginally more quickly.	Cannot compare as cumulative IRFs are explosive post-liberalisation.
Germany	IRF peaks generally earlier pre-liberalisation, except for PR_{PR} which is two periods later. Decay is generally substantially slower post-liberalisation.	Cumulative IRFs are significantly larger post-liberalisation, but appear to have moved further apart.
USA	IRF peaks generally earlier pre-liberalisation. Decay is substantially slower post-liberalisation.	Cumulative IRFs are significantly larger post-liberalisation, but appear to have moved further apart.

Table 6: Summary Results of Granger Causality Tests

Country	VAR in Levels		VAR in First Differences	
	Pre-Liberalisation	Post-Liberalisation	Pre-Liberalisation	Post-Liberalisation
Brazil	$p^p \rightarrow$ BNG $p^p \leftrightarrow$ RG BNG$\leftrightarrow$RG	BNG$\rightarrow p^p$ RG$\rightarrow p^p$ $\{RG, BNG\} \rightarrow p^p$	$p^p \leftrightarrow$ BNG $p^p \leftrightarrow$ RG BNG$\leftrightarrow$RG	$p^p \leftrightarrow$ BNG RG$\rightarrow p^p$ $\{RG, BNG\} \rightarrow p^p$ RG$\rightarrow$BNG
Colombia	CMA$\rightarrow p^p$	CMA$\leftrightarrow p^p$	CMA$\rightarrow p^p$	CMA$\leftrightarrow p^p$
Guatemala	$p^p \rightarrow$ OMA $p^p \rightarrow$ RG $\{RG, OMA\} \rightarrow p^p$ OMA$\leftrightarrow$RG	OMA$\rightarrow p^p$ $\{RG, OMA\} \rightarrow p^p$	$\{RG, OMA\} \rightarrow p^p$	OMA$\rightarrow p^p$ $\{RG, OMA\} \rightarrow p^p$
India	$p^p \leftrightarrow$ OMA RG$\rightarrow p^p$ $\{RG, OMA\} \rightarrow p^p$	$p^p \rightarrow$ OMA $p^p \rightarrow$ RG RG$\rightarrow$OMA	$p^p \leftrightarrow$ OMA RG$\rightarrow p^p$ $\{RG, OMA\} \rightarrow p^p$	OMA$\rightarrow p^p$ RG$\rightarrow p^p$ $\{RG, OMA\} \rightarrow p^p$ RG$\rightarrow$OMA
Mexico	$p^p \leftrightarrow$ OMA	OMA$\rightarrow p^p$	$p^p \leftrightarrow$ OMA	OMA$\rightarrow p^p$
Uganda	$\{RG, OMA\} \rightarrow p^p$	OMA$\rightarrow p^p$ $\{RG, OMA\} \rightarrow p^p$	$p^p \rightarrow$ OMA RG$\rightarrow p^p$ $\{RG, OMA\} \rightarrow p^p$	OMA$\rightarrow p^p$ $\{RG, OMA\} \rightarrow p^p$ RG$\rightarrow$OMA
Germany	CI$\rightarrow p^r$	CI$\rightarrow p^r$	None	CI$\rightarrow p^r$
USA	CI$\leftrightarrow p^r$	CI$\leftrightarrow p^r$	CI$\leftrightarrow p^r$	CI$\leftrightarrow p^r$

Table 7: Results of PTA tests

Country	Pre-Liberalisation	Post-Liberalisation
Brazil	PTA from p^p to BNG only	PTA from p^p to BNG & RG only
Colombia	PTA from p^w to p^p only	PTA in both directions
Guatemala	No PTA	PTA in both directions
India	PTA from RG to p^p only	No PTA
Mexico	PTA from p^w to p^p only	No PTA
Uganda	PTA from RG to p^p and from p^p to OMA only	PTA in both directions (RG only)
Germany	PTA from p^w to p^r only	PTA in both directions
USA	PTA in both directions	PTA in both directions

Table 8: Changes in the Marketing Margin Following Liberalisation

Country	ΔMarketing Margin	Exogenous Term
Brazil	Decreased w.r.t. BNG Unchanged w.r.t RG	Same as BNG post-liberalisation only[20] Same as RG both periods
Colombia	Decreased	Same post-liberalisation only
Guatemala	Unchanged	Same both periods
India	Unchanged	Same as OMA both periods Same as RG pre-liberalisation only
Mexico	Decreased	Same post-liberalisation only[32]
Uganda	Decreased	Same as RG post-liberalisation only Different from OMA both periods
Germany	Increased	Same both periods
USA	Unchanged	Same both periods

[20] This conclusion is based on a 5% level of significance.

Figures

Figure 1: ICO Indicator Prices (1982-2001)

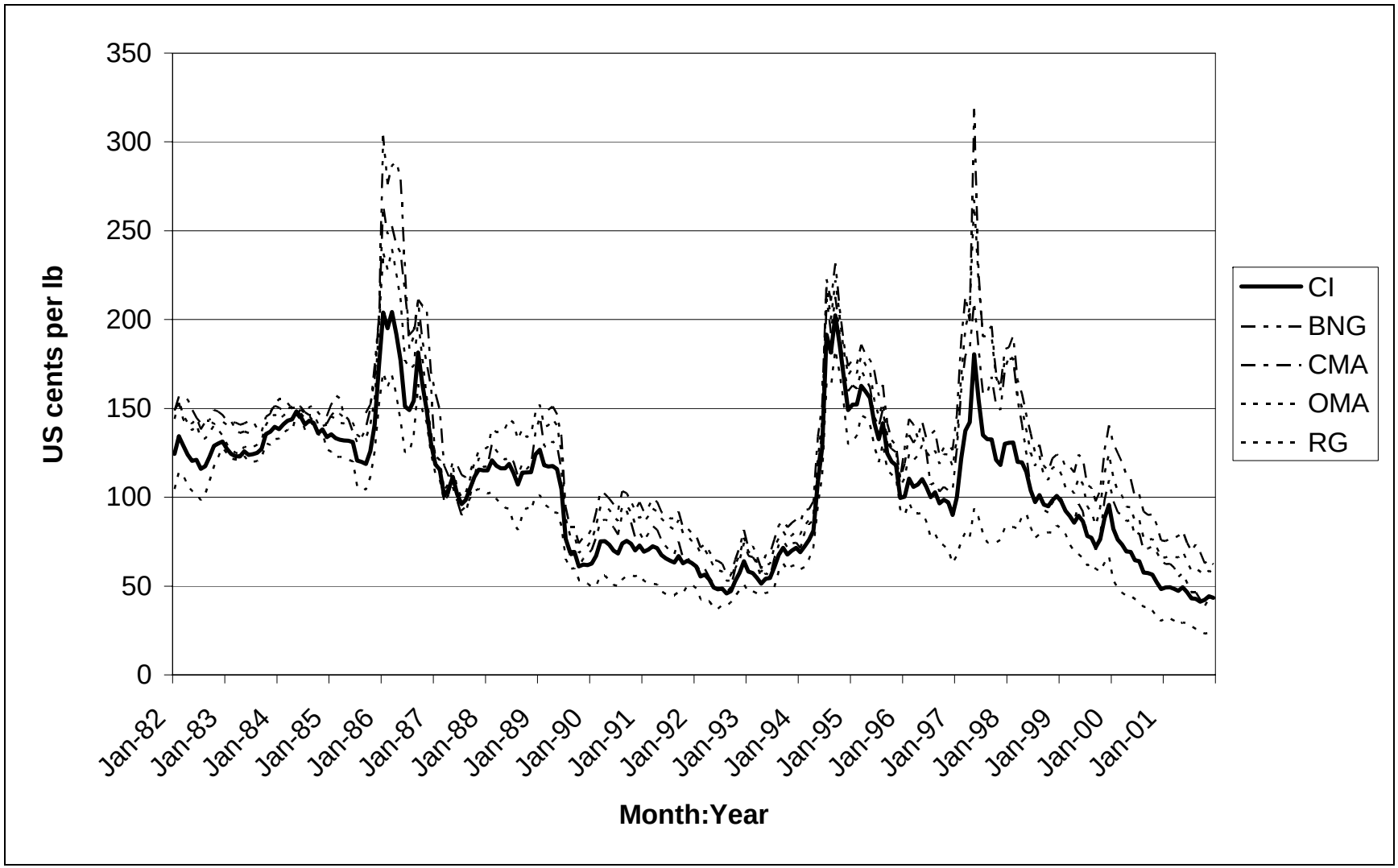


Figure 2: ICO Producer Prices (1982-2001)

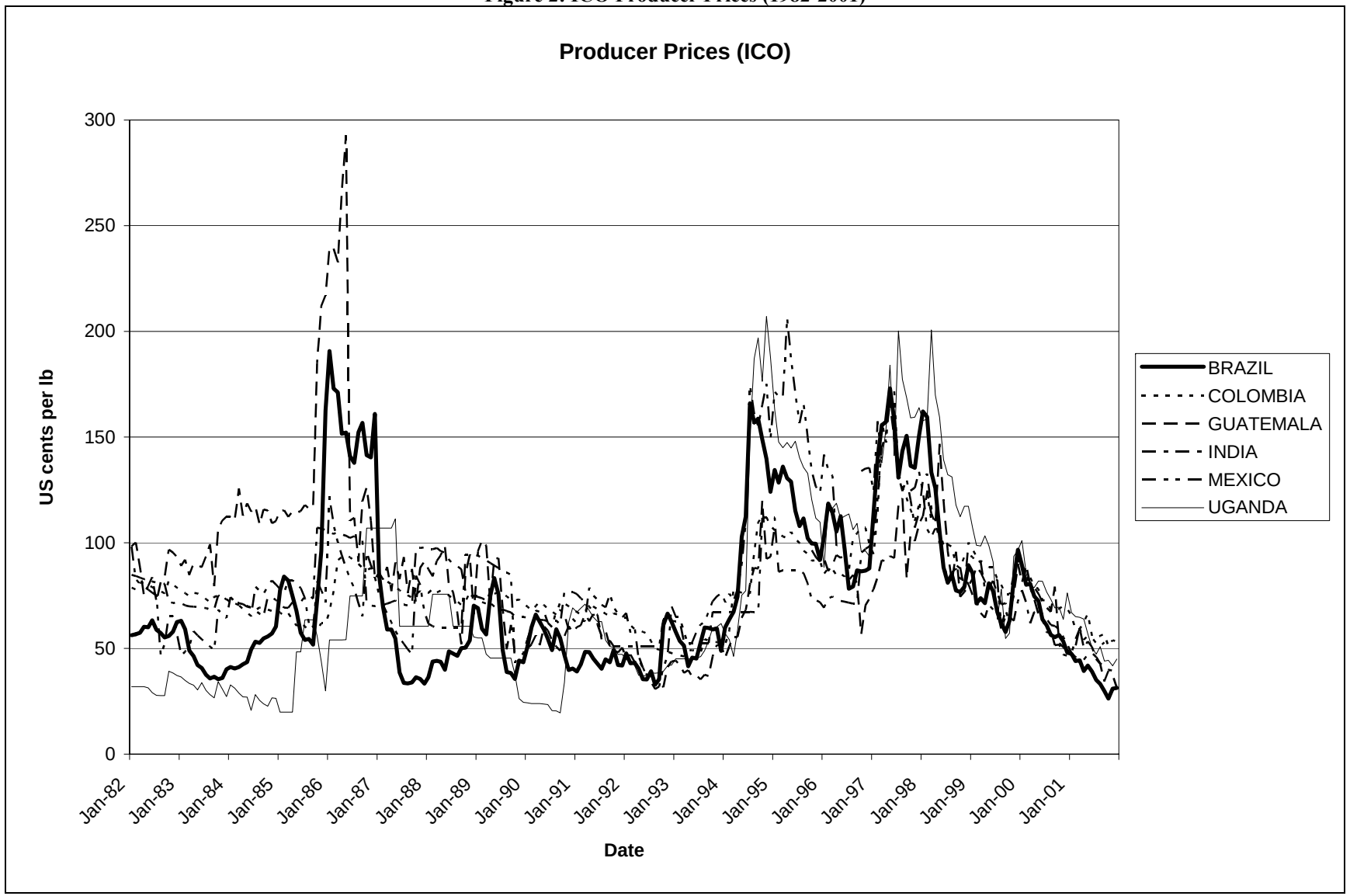


Figure 3: ICO Retail Prices (1982-2001)