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# Are coffee farmers worse off in the long run?[1]

Atanu Ghoshray
Newcastle University Business School, Newcastle upon Tyne, UK.

**Abstract**
In this study, we aim to determine whether coffee prices received by growers have actually declined over time making coffee growers worse off in the long run. Further short run cycles are examined to see if there is a prevalence of slumps in comparison to booms. This paper exploits a unique data set of coffee prices paid to growers that stretches from 1990 to recent years for selected developing countries and emerging economies. The coffee prices that are received by producers, are adjusted for inflation and robust econometric methods are applied to estimate underlying trend parameters to conclude whether they are statistically significant. As a prelude to the analysis, we search for structural breaks to ascertain whether the plausible underlying trend is subject to a change in the sign and/or magnitude. We find there are no signs of significant structural breaks in the real price of coffee paid to growers over time, and we find very little evidence of significant trends. The volatility in coffee prices varies by country and the quality of coffee and taking this volatility in to consideration, we find mixed results as to whether slumps are more prevalent than booms or whether the slumps or more pronounced than booms.

**JEL Classifications** C22; Q02

## 1. Introduction

A coffee market report published by Oxfam in 2001 painted a bleak picture of the coffee producing developing countries, whose main source of income is through the exports of coffee. The report concluded that international prices of coffee have been declining especially in the recent years since the report was published thereby spelling doom and gloom for coffee farmers. The main reasons cited by Oxfam was that coffee production has been outstripping supply thereby causing stocks of coffee to rise over time leading to a coffee prices becoming depressed. The increase in supply is largely driven by new plantations of coffee, new arrivals of players on the coffee export side, and technological progress. In comparison growth in coffee demand has been sluggish. However, have coffee prices declined in the long run, or is this decline a short run temporary phase? For example, since mid–2000s there have been episodes where real coffee prices received by producers have been seen to increase over time. Alternatively. as most coffee producing and exporting countries had their markets liberalised for both the domestic and export sectors since the early 1990s (Krivonos 2004) causing coffee prices to become more volatile, is it the case that no clear trends are discernible and that variability in coffee prices has overshadowed the trend? This paper aims to determine whether

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real coffee prices received by farmers has gradually declined over time, the extent of the volatility in prices, and whether shocks to prices are short-lived or not. We focus on the period of time when most countries started to liberalise their coffee sector and in that way we aim to find out whether such liberalisation has helped to prevent a sustained long term decline in coffee prices that would make producers worse off.

Coffee is the one of the most widely traded commodities (Borrella et al 2015). Coffee is mainly produced in the tropics and sub-tropics which includes mainly developing countries as well as some middle income emerging economies. For many of the developing countries, coffee accounts for a large share of export earnings making these countries highly reliant on coffee as their major source of income. Almost 70 percent of all coffee grown is by smallholders and an estimated 25 million producers are dependent on coffee production for their livelihoods (Borrella et al 2015; Caswell et al 2012). It has been argued that rural poverty and economic vulnerability is becoming prevalent among coffee growing regions and a declining trend in coffee prices has been listed as one of the main reasons for the declining income and profitability of coffee growers, especially smallholders (Dietz et al 2020). This declining income hampers the achievement of the Sustainable Development Goals (SDGs) which is to raise income in rural areas, create rural employment and alleviate poverty. Since coffee exports can be a major source of income for developing countries, the receipts from the exports these coffee dependent countries receive can be used to finance their imports from the international markets. Apart from short-lived spikes in 2014 and 2016, nominal coffee prices have trended steadily downward since their peak of April 2011 (see Figure 1). Clearly, the substantial drop in coffee prices to growers, threatens the livelihood of millions of smallholder producers and risks reversing any gains in living standards.

These frequent production surpluses have exerted significant downward pressure on prices, further exacerbated by the inherent economic and physical characteristics of the coffee market. The demand for coffee is inelastic, given the taste and preferences of coffee consumers, implying that a significant change in coffee prices are needed to induce a moderate change in consumption. Similarly, supply is also inelastic due to the time lag taken in producing new coffee. For example, it takes approximately at least 3 years for coffee to bear fruit from the point of time when the planting takes place. Therefore in the short term, coffee harvesting is reduced but this can lead to increasing unemployment on coffee farms and encouraging migration out of rural areas. However, there may be government support, where large subsidies are provided for input use or minimum prices guaranteed for coffee farmers.

Therefore, the inelastic nature of demand and supply means that declines in coffee prices tend to be volatile. Volatile prices make it difficult for coffee producers to smooth their consumption. For poorer coffee farmers, a downswing in coffee prices can lead to curtailing expenditure on education and health. For example, Colombia has set up a fund to help coffee farmers deal with the declining prices. Over time, if the government invests in inputs provided to coffee farmers (e.g., providing farmers with technology that can lead to mechanised farming, this can help large farmers. Clearly, the greatest impact on coffee prices would come from actions aimed at controlling production and/or stimulating demand.

Colombia and Ethiopia produce high-end quality Arabica coffee. In Ethiopia, coffee is considered the most important cash crop and the production of coffee is an important source of livelihood for the vast majority of smallholder farmers as coffee production is mainly carried out by them (Kuma et. al. 2019). For Colombia, an internal price support system was in operation, managed by the National Federation of Coffee Growers (NFCG) that set domestic

prices as a function of world prices but prevented extreme variations in world prices to affect domestic prices (Miller and Urdinola 2010). The NFCG partially dismantled this policy in 2001 due to sustained low prices during the period of the coffee crisis. Inspite of managing domestic price distortions, coffee prices in Colombia are still highly volatile (Bastianin et. al. 2018) which is caused by the low price elasticity of supply and demand as well as the low income elasticity of demand (Mehta and Chavas 2008). Two frosts that hit Brazil in late June and early July of 1994 raised coffee prices throughout the mid-1990s, but by the late 1990s Brazilian production had recovered, once again putting downward pressure on prices. Uganda's coffee market reforms, were initiated by the government, and in 1991 the role of the parastatal Coffee Marketing Board (CMB) in marketing coffee began to dissipate. Gradually private firms began to enter the coffee sector and took over almost all coffee exports, with producer prices experiencing significant change since liberalisation. Producer prices increased under a new regime of marketing (Akiyama 2001). India started the liberalisation process of its coffee sector in 1992 and complete liberalisation was put in to force in 1996. While coffee producers were paid more promptly, they are believed to be paid more than they used to prior to liberalisation, except during the early 1990s when producer prices fell due to depressed world prices (Akiyama 2001).

What is needed is mostly cooperation among producers to protect the livelihood of coffee farmers, especially the smallholders. This involves sharing the information, both on the short- and medium-term outlook, as well as on production expansion plans, such as technology. It also means developing and implementing global coordinated promotional activities that have the commitment to enhance the welfare of farmers. As an export commodity, coffee realises important foreign exchange earnings amounting to USD 20 billion globally in 2017/18 (ICO 2019a). Its contribution to the overall economy of producing countries measured, for example by the share of coffee in total merchandise exports varies. Today, Brazil, Colombia – two of the largest coffee-producing countries, show relatively low dependence on coffee with a share in total exports of 3% and 6%, respectively. However, in less diversified economies of medium-sized producing countries such as Honduras and Ethiopia, this share exceeds 20%. Other smaller producers, such as Uganda, are also highly dependent on coffee exports (ICO 2019b).

Colombia is one of the major producers of coffee and is known for producing premium quality coffee which is of the mild washed Arabica coffee variety. The coffee sector plays an important role in the country's economy and is heavily supported the Colombian Coffee Grower's Federation (FNC) alongside other governmental and non-governmental institutions (Dietz et al 2020). The FNC represents both producers and government institutions, and is in charge of implementing regulatory policies for the coffee sector (Vellema et al 2015; World Bank 2002). Besides technical assistance, infrastructure facilities, quality control, sales and marketing, the FNC provides a guarantee of purchase to coffee growers. This ensures that all producers – especially smallholders – can sell their coffee to the FNC and are protected by a price floor. (World Bank, 2002). Brazil is a leader among the global exporters of coffee. However, the country specializes in low quality coffee and is driven by low costs of labour, and in the context of a deregulated market with high level of competition, smallholder end up with low prices and income (Calderelli et al 2020). Costa Rica has favourable natural conditions for the production of high-quality coffee and possesses a strong organizational structure in the production and marketing stages of coffee. In recent years Costa Rica has increased its production of high quality coffee. The marketing system in Costa Rica ensures that certain quality standards are met to ensure such classification of speciality coffee. Coffee farmers have been able to receive higher prices for high-quality coffee (Wollni and Brummer 2012).

In general, measuring trends in commodity prices are difficult given the high variability that exists in these prices. As Angus Deaton notes "What commodity prices lack in trend they make up for in variance (1999; p.27)." Coffee is no exception and has been widely regarded to be volatile. The fluctuations in coffee prices are largely down to the dynamics of demand and supply; and can also be attributed to the weather patterns and production lags in response to sudden increases or decreases in demand. The variability in coffee prices is believed to deter producers from making necessary investments for increasing productivity, which in turn could lead to potential shortages in coffee supply. Therefore, on one hand, we are inclined to conjecture that supply could be outstripping demand thereby leading to a declining trend; and on the other hand, we could conjecture that the volatility in prices leads farmers to be risk averse and cut back on investments that could lead to decreased production, causing an upward pressure on prices. These two opposing arguments make the trend estimation of coffee an empirical question, which we aim to address in this paper.

One might ponder to think that if there is a declining trend in coffee prices paid to growers of coffee that could be due to the possibility that farmers in developing countries are unable to prevent a fall in the prices when times are bad compared to when times are good. When times are good, farmers are unable to raise coffee prices substantially because of a lack of market or organisation power amongst themselves. Coffee production has been high in coffee producing countries, and has been outstripping consumption, and this is because coffee consumption has increased at the lower rate than production. For a considerable period coffee has been, and continues to be a major export commodity in many developing countries. Many countries are heavily reliant on coffee as a source of income. Before liberalisation, the coffee sector was an important source of government revenue and was therefore subject to heavy taxation. Since coffee production is a major contributor to employment in rural areas, the price received by growers of coffee can be considered as a determinant of their welfare. Prior to liberalisation, there was a system of regulation and intervention. During this period, governments aimed to protect coffee growers' incomes from price fluctuations, through price stabilization, which actually turned out to be costly and often inefficient, causing producer prices to fall as a share of world price levels. Since most coffee farmers produce on small holdings, the fall in price had an impact on exacerbating poverty levels. However, when coffee market sectors for various countries started to liberalise, the share of producer prices in the world market price increased, albeit with producers being exposed to the risks of volatile world coffee prices. By the mid-1990s most coffee producing countries had eliminated or reduced state-controlled marketing, such as withdrawing state trading enterprises, and giving way to market-based systems by allowing private agents to be involved in purchasing, marketing and exporting of coffee. Typically, competition was encouraged among traders; guaranteed minimum prices to farmers were withdrawn and export taxes were lowered or eliminated (Krivonos 2004). A drastic decline in international coffee prices took place in 2001/02 for both Arabica and Robusta varieties. Coffee prices fell below production costs due to oversupply, causing severe difficulties for coffee farmers (Lewin et. al. 2004). Since the liberalisation of the coffee sector, it has been argued that volatility has increased; however, McIntyre and Varangis (1999) note that farmers are receiving a higher price with volatile prices than they would have received with administered prices. Stabilisation policies were insignificant and often marketing boards were found to be corrupt (Krivonos 2004). Since liberalisation, with supposedly higher prices and increased volatility, the following questions arise: whether the so-called decline in coffee prices been reversed; whether there is no clear break in the trend and that prices have continued to fall; whether volatility has overshadowed any long run trend; further, whether cycles are long or short in duration and whether the short term slump in prices is more pronounced than the boom phase of the price cycle. These are questions that we plan to address in this paper.

In this study, we aim to determine whether prices have actually declined over time making coffee growers worse off in the long run. For example, Bussolo et. al. (2007) note that non-coffee producers switched to coffee production as the price of coffee boomed, thereby providing an indication that coffee producers perceive the price increase to be permanent. Interestingly, decreasing prices did not seem to affect household income in rural areas of coffee production. In another study Eakin (2006) documents how few small scale coffee producers in Honduras were of the view that the downturn in coffee prices was permanent, in contrast to large scale coffee producers. This is important as small-scale coffee growers would be badly affected if the shocks turn out to be permanent instead of being transitory. To answer these questions, this paper exploits a unique data set of coffee prices paid to growers that stretches from 1990 to recent years for selected developing countries and emerging economies. The coffee prices that are received by producers, are adjusted for inflation and robust econometric methods are applied to estimate underlying trend parameters to conclude whether they are statistically significant. As a prelude to the analysis, we search for structural breaks to ascertain whether the plausible underlying trend is subject to a change in the sign and/or magnitude. We find there are no signs of significant structural breaks in the real price of coffee paid to growers over time. Further, we find very little evidence of significant trends. The volatility in coffee prices varies by country and the quality of coffee and taking this volatility in to consideration, we find mixed results as to whether shocks to coffee prices are short-lived or not. The paper is organised as follows: section 2 describes the econometric framework to be carried out in this study; section 3 describes the data and the empirical analysis; and finally section 4 concludes.

**2. Modelling Framework**

Before estimating the underlying trend in coffee prices, we employ a test for structural breaks in the trend of the data to establish whether we should estimate a secular trend or whether estimation of broken trends would be more appropriate. If we find structural breaks, that would imply the trend is not secular and that either trend estimation would include regimes where the sign and/or magnitude of the trend may be different. The tests we employ allows us to be agnostic as to whether the real coffee price series chosen in this study contain stochastic or deterministic trends, that is whether they are I(1) or I(0). To this end we adopt the test due to Sobriera and Nunes (2016) by using the following specification:

$$P_t = \alpha + \beta t + \sum_{j=1}^{n} \delta_j DU_t(\tau_j^*) + \sum_{j=1}^{n} \gamma_j DT_t(\tau_j^*) + \varepsilon_t, \qquad t = 1, 2, \dots, T \tag{1}$$

where $P_t$ denotes the logged prices and the trend estimate is given by the parameter $\beta$. The specification allows for $n$ structural breaks in the trend function. These breaks may occur at dates $T_1^*, \dots . T_n^*$., and the level dummies $DU_t(\tau_j^*) = 1(t > T_j^*)$ detect the eventual $j$th break and the slope dummies $DT_t(\tau_j^*) = 1(t > T_j^*)(t - T_j^*)$ detect the eventual $j$th break at date $T_j^* = \lfloor \tau_j^* T \rfloor$ for $j = 1, \dots, n$, with the indicator function given by 1(.) and the integer part of the argument given by $\lfloor . \rfloor$. We can write (1) in first differenced form as:

$$\Delta P_t = \beta + \sum_{j=1}^{m} \delta_j D_t(\tau_j^*) + \sum_{j=1}^{m} \gamma_j DU_t(\tau_j^*) + v_t, \quad t = 1, 2, \dots, T \tag{2}$$

where $D_t(\tau_j^*) = 1(t = T_j^* + 1)$.

We estimate (1) and (2) by ordinary least squares (OLS) for all possible break points $\tau^n = (\tau_1, \dots, \tau_n)$ which are obtained from employing the supremum $F$ test given by:

$F_0^*(n|0) = supF_0(\tau^n)$ and $F_1^*(n|0) = supF_1(\tau^n)$

where $F_0(\tau^n)$ and $F_1(\tau^n)$ denote respectively the $F$ statistics for testing $\tau_1 = \tau_2 = \cdots . \tau_n = 0$ from (1) and (2). Sobriera and Nunes (2016) note that the asymptotic distributions of $F_0^*(n|0)$ and $F_1^*(n|0)$ are dependent on whether the underlying price series is I(0) or I(1), and so they work out a weighted statistic that yields the same asymptotic critical values in both I(0) and I(1) cases. This robust weighted statistic $F_\lambda^*(n|0)$ due to Sobriera and Nunes (2016) can be used to test the null hypothesis of no structural breaks against the alternative hypothesis of $n$ breaks and is given by:

$$F_\lambda^*(n|0) = \lambda(\hat{\tau}^n, \tilde{\tau}^n)F_0^*(n|0) + d_\xi^n[1 - \lambda(\hat{\tau}^n, \tilde{\tau}^n)]F_1^*(n|0)$$

where $d_\xi^n$ is a constant that ensures for a given significance level $\xi$, the asymptotic critical values are the same for irrespective of the order of integration of the data.

A further sequential test due to Sobreira and Nunes (2016) is employed which is in the spirit of Bai and Perron (1998) testing the null hypothesis of $m$ against the alternative of $m + 1$ breaks constructed from the maximum value of the $supF$ type statistics. The procedure involves first starting with $m = 0$, and then using $F_\lambda^*(1|0)$ to test for the presence of one break. If the null is rejected, then we set $m = 1$ and perform the $F_\lambda^*(2|1)$ test. If the null is rejected we continue this sequence until we cannot reject the $F_\lambda^*(m + 1|m)$ test.

Noting that this sequential procedure of detecting structural breaks may not work very well if there are two breaks in the slope of opposite sign, Sobriera and Nunes (2016) recommend that if the null hypothesis of no break is not rejected, that is, when $F_\lambda^*(1|0)$ is not rejected, then to use the $F_\lambda^*(2|0)$ or the double maximum test $UDmaxF_\lambda^*$ or $WDmaxF_\lambda^*$. If the $F_\lambda^*(2|0)$ or a double maximum test does not reject the null hypothesis, then we conclude no trend breaks, otherwise we proceed to test for 2 breaks against 3 and the sequential procedure is continues. If there is no evidence of any structural break or multiple breaks in the price series we proceed to test for a secular trend in the price data over the full sample of observations. If we find $m$ breaks then we demarcate $m + 1$ regimes based on the break point locations and estimate broken trends for these selected regimes.

To estimate the trends in the data, we make use of another robust test that allows us to be agnostic to the underlying order of integration in the data. To this end, we make use of the Perron and Yabu (2009) procedure. To implement this procedure we assume the error term in (1) to follow an autoregressive process where the lag is determined according to the modified Akaike Information Criterion (MAIC). A bias corrected version of the autoregressive parameter is created to improve the finite sample properties of the test, from which a quasi-differenced regression is estimated (see Perron and Yabu 2009 for details).

Perron and Yabu (2009) construct a $100(1 - \alpha)\%$ confidence interval for $\beta$; valid for both I(1) and I(0) errors, and is obtained as

$$\hat{\beta} \pm c_{\alpha/2}\sqrt{(\tilde{h}_v)\{(X^{\alpha\prime}X^\alpha)^{-1}\}} \qquad (3)$$

where $c_{\alpha/2}$ is such that $P(x > c_{\alpha/2}) = \alpha/2$ for $x \sim N(0,1)$; $X^\alpha = [x_{L1,1}, (1 - \tilde{\alpha}_{MS})x_{L1,2}, \ldots, (1 - \tilde{\alpha}_{MS})x_{L1,T}]'$, and $\tilde{h}_v$ is an estimate of $2\pi$ times the spectral density function

of $v_t = (1 - \alpha L)u_t$ at frequency zero (see Perron and Yabu 2009 for details). From the estimate $\hat{\beta}$ from (3), we obtain the *t*-statistic and denote it as $t_{PY}$.

In addition to whether a long term secular/broken trend exists, we analyse the short run cycles. Short term price cycles are defined by turning points (peaks and troughs). A local trough in a price series $P_t$ occurs when $P_t \leq P_{t \leq k}$ and a local peak at $P_t \geq P_{t \geq k}$where $k$ varies between a certain time interval. The peaks and troughs separate the boom and slump phases. Boom phases are characterised by the interval when prices are rising and slump phases are characterised by the time intervals when prices are falling. The Bry-Boschan algorithm due to Bry and Boschan (1971) is applied to determine the turning points in the price series. Once the turning points are calculated, the amplitude and duration of the expansion and contraction phases of the cycle are calculated using the procedure of Harding and Pagan (2002). This allows us to obtain the excess index due to Harding and Pagan (2002) which is a measure of the shape of the price path. The price path is constructed in relation to a triangle approximation which is given by:

$$E_i = (C_{Ti} - C_i + 0.5A_i)/D_i \quad (4)$$

where $C_{Ti}$ is the triangle approximation, given by $0.5 * D_i A_i$, and $C_i$ is the best approximation to the actual path. $A_i$ is the amplitude, and $D_i$ is the duration of the cycle. When the price cycle exhibits linear growth/contraction, then the index equals zero. When the price cycle indicates growth/contraction that is greater than it would be under linear growth/contraction, then the index is positive. The more positive the index, the larger is the expansion or contraction phase. Similarly if the index is negative, then the growth/contraction is less than what it would be in a linear growth/contraction scenario.

**3. Data and Empirical Results**

The data employed in this study are coffee prices paid to producers of various coffee growing countries deflated by their consumer price index to obtain the real coffee prices. The source of the data is the *International Coffee Organisation*. The countries we consider are Brazil, Colombia, Costa Rica, Ethiopia, Honduras, India, Indonesia and Uganda. For Brazil, Uganda and India we also analyse both the Arabica and Robusta varieties, and for the remaining countries only the Arabica variety. The start date of the sample is chosen to be in the early 1990s as most countries had started to liberalise their coffee sector. Many developing countries in sub-Saharan Africa and Latin America reformed their coffee sectors as the existing system of marketing was costly and inefficient. The speed of reforms differed across countries, but by the mid-1990s most coffee growing counties had replaced state controlled marketing with private agents. The data is monthly and has varying start and end dates depending on the availability of the data. The details of the sample range and size of each country's coffee prices and the currency unit are given in Table 1 along with the descriptive statistics of each of the prices. The results are contained in Table 1 below.

[Table 1 about here]

The coefficient of variation is a relative measure of dispersion that expresses the sample standard deviation in terms of its mean. This is calculated by taking the ratio of the standard deviation to its mean and thereby provides a unit-less measure of dispersion. The coefficient of variation is the highest for India (Robusta) recording 67% variation. Honduras and Ethiopia have a significantly high level of dispersion recording figures over 40%. Relatively the dispersion of real coffee prices for Brazil (both Robusta and Arabica) along with Colombia and Costa Rica are relatively low with the coefficient of variation being less than 30%. The next

two columns measure skewness and kurtosis. We find in general, significant positive skewness for all coffee prices, except Coast Rica and Uganda (Robusta). This is would imply that there are few or no downward spikes to match the pronounced upward spikes. Except for Uganda (Robusta) none of the coffee prices show significant negative skewness. All coffee prices also display substantial kurtosis, with tails much thicker than those of the normal distribution, a feature that, is not uncommon in agricultural commodities. The skewness and Kurtosis measures are designed to be zero and 3 respectively for a normal distribution. In general, the coffee prices are found to exhibit positive skewness and excess kurtosis, therefore it is not surprising that the test for normality of coffee prices is rejected.

A plot of the different coffee prices considered in this study are shown in Figure 1 below, allowing us to visually inspect the data.

[Figure 1 about here]

From the figure it is difficult to discern whether there is an underlying trend in the data. The data appears to be highly variable with several large positive spikes – which are expected given the positive skewness that we find in the data, and again are common features of commodity prices. A common feature for all Arabica coffee prices is the large positive spike around 1997/98 and then a gradual decline albeit with a considerable and varying range of volatility, to reach a low at around 2001/02. Thereafter Arabica prices tend to increase until 2011 before becoming highly volatile. The graphs for Robusta prices seem to follow a different dynamic path to Arabica coffees. One may conclude that the data is characterised by large upswings and downswings which either could be thought of as breaking trends in coffee prices or high volatility. We treat these features of the data with high importance when conducting trend estimates and tests for persistence.

Accordingly, before estimating a secular trend, we test for structural breaks to ascertain the need for estimating broken trends. We employ the robust procedure due to Sobreira and Nunes (2016) to detect structural breaks in the trend of the data series where the number and dates of the breaks are unknown and are robust to the order of integration of the data. The results are shown in Table 2 below.

[Table 2 about here]

The application of the test statistics $F_\lambda(m|0)$ for $m = 1,2,3$ and the double maximum statistics $UDmaxF_\lambda$, along with the $WDmaxF_\lambda$ to the various coffee prices are compared against the 10% critical values. Following the procedure by Sobriera and Nunes (2016) if the null hypothesis of no break is not rejected, that is, when $F_\lambda^*(1|0)$ is not rejected, then we proceed to test $F_\lambda^*(2|0)$ or the double maximum test $UDmaxF_\lambda^*$ or $WDmaxF_\lambda^*$. We allow up to 3 breaks so we also test for $F_\lambda^*(3|0)$. If the $F_\lambda^*(3|0)$ or double maximum tests do not reject the null hypothesis, then we conclude no trend breaks. For all coffee prices, the $F_\lambda(m|0)$ statistic for $m = 1,2,3$ and the double maximum statistics $UDmaxF_\lambda$, along with the $WDmaxF_\lambda$ lead us to conclude no rejection of the null hypothesis of no trend break. For example, in the case of Brazil (Arabica) the null of no break against the alternative of a single break returns a test statistic of 2.26 which is less than the critical value at conventional levels (at least 10%) and therefore we cannot reject the no break null. This implies that the null hypothesis of no trend breaks cannot be rejected for all coffee prices. Given that there is not enough evidence to conclude that coffee prices have any structural break in the trend, we can assume that the evidence favours an estimation of an unbroken trend for these coffee prices. At this juncture,

we can infer that the large upswings and downswings in the data as shown in Figure 1 are not linked to broken trends, but are likely due to the large volatility.

We test for the presence of significant trends in coffee prices for the entire sample considered, since there is no evidence of trend breaks and therefore no need to estimate broken trends at points where structural breaks could have been identified. Accordingly, we first apply the Perron and Yabu (2009) procedure for robust trend estimation. The results of the estimation are shown in Table 3, along with the 95% and 90% confidence intervals. The robust t-statistics are also reported for reference.

[Table 3 about here]

For example, in the case of Brazil (Arabica) the trend estimate is –0.35; however, the associated 95% confidence interval has a lower bound of –1.10 and an upper bound of 0.41. Since the confidence interval contains zero the trend estimate is insignificant. The same can be said when using the 90% confidence interval, where the lower bound is –1.25 and the upper bound is 0.55. The associated insignificant t-statistic confirms the result that the trend estimate is insignificant. Using this robust procedure we find in general, no evidence of a significant trend in any of the real coffee prices, irrespective of the country of origin, or the variety of coffee, except for Honduras and India (Robusta) coffee prices. The parameter estimates for Honduras and India (Robusta) are negative and the t-statistics indicate significance at both the 95% and 90% confidence levels. This implies, that the real prices of coffee for these two coffee prices have been declining over the long run. The trend estimates of India (Robusta) show a fair amount of variability with a lower bound decline of 1.32% and an upper bound decline of 0.28% at the 5% significance level; this increases to a lower bound decline of 1.41% and an upper bound decline of 0.19% at the 10% significance level. The range in both cases exceed 1 percentage point. In contrast the variability in the trend estimates for Honduras are lower, with a lower bound decline of 0.25% and an upper bound decline of 0.07% at the 5% significance level. The estimates hardly change when choosing a higher level of significance, but the trend estimate is smaller in magnitude and the range is smaller (approximately 0.18 percentage points) relative to India (Robusta).

Given that there is very little evidence of significant long term trends we move on to analyse the short run cycles. The first set of results using the Bry-Boschan algorithm is shown in Table 4. In this table we record the statistics of cyclical behaviour in the boom and the slump phases of coffee prices. We find that for Brazilian Arabica prices the total number of months in the slump phase is 135 whereas the number of months in the boom phase is 109. The prevalence of the slump phase is therefore 55% compared to the boom phase where it is approximately 45%. However, for Brazilian Robusta the prevalence of the slump phase is lower at just under 44% compared to the boom phase which is just over 55%. On scrutinising all the other coffee prices we find a similar mixed picture of the prevalence of booms and slumps. Besides, the prevalence of booms and slumps is not too different with each phase accounting for between approximately half to just a little over half of the sample period.

[Table 4 about here]

The minimum and maximum number of months in the slump phase varies widely for the different coffee producing countries and the types of coffee. For example the minimum number of months in the slump phase varies between just 5 months to 11 months. Whereas for the maximum months in the slump phase, the numbers vary from 32 to 71 months. Similar

variations are found for the boom phase as well. The separation of the boom and slump phases is also shown in Figure A in the Appendix for all the coffee prices. The slumps are shown by the shaded portions.

Based on the evidence of short run cycles, we proceed to use the Harding and Pagan (2002) procedure to estimate the duration and amplitude of the cycles for both the boom and slump phases to enable the calculation of the excess index. The results are shown in table 5 below.

[Table 5 about here]

We find mixed results. For example, Brazilian Arabica and Robusta, Colombia Ethiopia and Honduras exhibit a negative excess index in the boom phase indicating that the boom is less than the linear path. Therefore the boom phase is relatively muted. In contrast, Costa Rica, Indian Arabica and Robusta, as well as Ugandan Arabica and Robusta coffee prices show a positive index indicating the boom phases for these coffee prices to be more pronounced. The slump phases depict that the cycles can be asymmetric. For example we found the boom phase to be muted for Brazilian Arabica whereas the slump phase is pronounced (given the positive excess index). Besides Brazilian Arabica, the pronounced slump is found for Colombia, Costa Rica, Indian Arabica and Robusta and Ugandan Arabica.

**4. Concluding Remarks**

From the empirical results we can broadly conclude that there are no significant structural breaks in real coffee prices that growers receive for a range of coffee producing countries since the collapse of the ICA. This suggests that if any trends were to exist, they would be secular and there would be no change in signs and/or magnitude over the sample thereby suggesting that prices might have been affected by policy instruments. Instead, we can proceed to estimate secular trends in all the coffee prices considered in this study, and using robust methods that allow us to be agnostic to the order of integration of the data, we find that the evidence of significant trends is limited to just two coffee prices, thereby showing limited evidence. These two coffee prices are India (Robusta) and Honduras; and so the real prices of coffee for these two countries and the specific variety are declining over time. The rest of the countries (and the different coffee varieties) do not show any significant trend. This leads us to conclude that for most countries real coffee prices do not show any signs of a declining trend and the grim reports of Oxfam at the turn of the century may not apply anymore.

We find short run price cycles that are generally mixed showing no clear pattern for the prices chosen. Nevertheless we can conclude that the price cycles are asymmetric. While the average time spent in boom/slump phases is not that different – the approximate split varies from 50-55% in each phase, the excess index of the slump/boom is generally different for each price. For example, booms could be more pronounced than slumps or vice versa (such as Brazilian Arabica, Colombia, Ugandan Robusta). For some countries both the boom and slump phase is muted (such as Brazilian Robusta, Ethiopia, Honduras) and for some countries botht the boom and slump phase is pronounced (such as Costa Rica, Indian Arabica and Robusta, Ugandan Arabica).

Some of our results depart from the conclusion made by other studies. While Minten et. al. (2019) document an increasing trend in coffee prices for Ethiopia, we find an insignificant trend. Further, Gong and Sullivan (2017) note that coffee prices have been increasing in Uganda whereas we find no trend for both Arabica and Robusta varieties. The lack of trends could result from producer prices displaying large upswings and downswings which may be in

response to government policy that could indirectly affect production and marketing in the coffee sector. Our results support the contention by Miller and Urdinola (2010) where they suggest the NFCG prevented extreme variations in world prices to affect domestic prices. In Honduras and India (Robusta) where coffee prices show a declining trend, producers have systematically lost purchasing power when exchanging a unit of coffee for a bundle of consumer goods over time. If increases in productivity and efficiency are not sufficient to offset this effect, farmers could be economically worse off today. Over the past two decades productivity has increased in Honduras while broadly stagnated in the Robusta variety of India. Possibly, over the extended sample that we consider that covers almost another 20 years of monthly data, the large swings in prices render such risk management policies to be rather ineffective.

Since 2005 production costs in real terms have increased across all countries at a rate of 3% per annum fuelled by rising costs for inputs such as fertilisers and pesticides as well as labour which represents up to 50% of the overall cost of production in all origins except for Brazil (ICO 2019b). Farm size and terrain has favoured mechanization of cultivating and harvesting of coffee in Brazil, allowing the substitution of increasingly costly hired labour for capital. As a result, Brazil has become alongside Vietnam (not included in the sample) the most efficient producer of coffee globally. However, the trend estimates for coffee prices received by growers in Brazil does not reflect this; there are no signs of a change in the trend sign or magnitude. Hence, it is likely that the growing demand for coffee will be met by further expansion of production in Brazil (and Vietnam), while high-cost origins such as Colombia and Ethiopia will struggle to compete for market share. Efficiency and productivity gains in Brazil have not managed to reduce the variability that we find when measuring the trend in coffee prices; whereas in high end origins such as Colombia and Ethiopia, the variability of the trend estimate of coffee prices is relatively lower. Therefore, while countries such as Colombia and Ethiopia are at a disadvantage competing on production costs, these origins are associated with superior quality that commands a premium in the market. Continuously improving quality (rather than yields) and tapping into the high-value market segment can provide a way out for farmers. Governments in producing countries can support their farmers through provision of targeted extension services as well as the establishment of a strong brand related to the origin (as in the case of Colombia).

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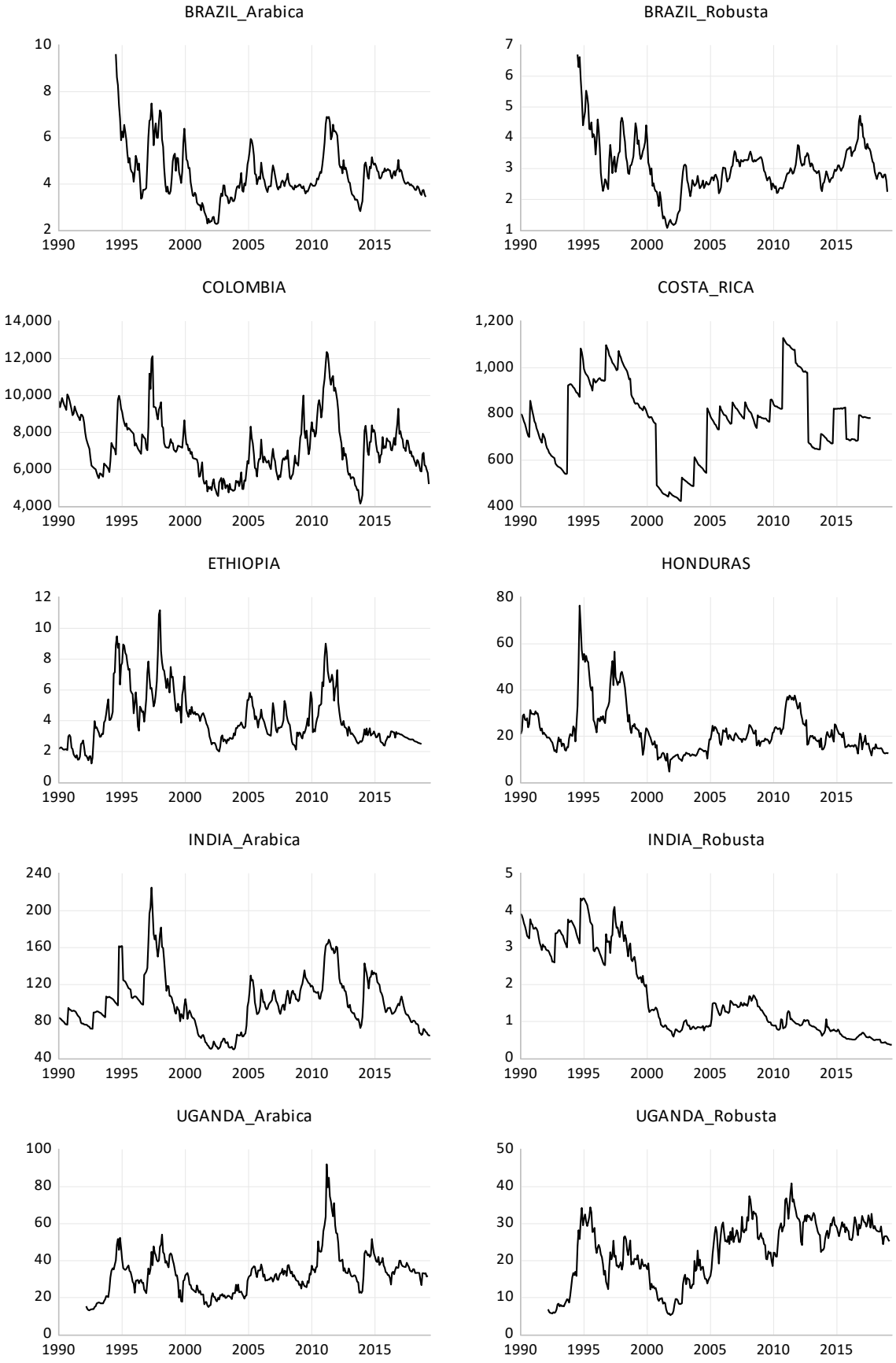
## FIGURES

**Figure 1.** Real coffee prices paid to producers.



## TABLES

**Table 1.** Data and Descriptive Statistics

| | Time period | Currency Unit | C.V. | Skewness | Kurtosis | Normality |
|---|---|---|---|---|---|---|
| Brazil (*Arabica*) | July1994 – January 2019 | BRL/60KG | 0.257 | 1.098*** | 5.036*** | 110.18*** |
| Brazil (*Robusta*) | July1994 – January 2019 | BRL/60KG | 0.280 | 0.816*** | 5.717*** | 123.46*** |
| Colombia | January 1990 – April 2019 | COP/125KG | 0.222 | 0.674*** | 3.256 | 27.61*** |
| Costa Rica | January 1990 – September 2017 | CRC/SQ | 0.220 | -0.143 | 2.470* | 5.03* |
| Ethiopia | January 1990 – September 2018 | ETB/17KG | 0.434 | 1.194*** | 4.246*** | 104.29*** |
| Honduras | January 1990 – June 2019 | HNL/SQ | 0.470 | 1.775*** | 6.937*** | 409.79*** |
| India (*Arabica*) | January 1990 – May 2019 | INR/50KG | 0.303 | 0.880*** | 4.149*** | 64.95*** |
| India (*Robusta*) | January 1990 – May 2019 | INR/50KG | 0.675 | 0.727*** | 2.003*** | 45.69*** |
| Uganda (*Arabica*) | March 1992 – March 2019 | UGX/KG | 0.355 | 1.415*** | 7.285*** | 357.17*** |
| Uganda (*Robusta*) | March 1992 – March 2019 | UGX/KG | 0.370 | -0.491*** | 2.241*** | 20.85*** |

**Notes:** Coefficient of variation (C.V.) is given by the ratio of the standard error to the mean of the data series. The notation, *** and * denote rejection of the null hypothesis at the 1% and 10% significance levels respectively. The significance of skewness is measured against the null hypothesis of zero skewness and the significance of kurtosis is measured against the null of no excess kurtosis. The Jarque-Bera test is used to test for normality with the null being a normal distribution.

**Table 2.** Robust sequential tests for structural breaks

| | $SupF^*(1\|0)$ | $SupF^*(2\|0)$ | $SupF^*(3\|0)$ | $UDmaxF_\lambda^*$ | $WDmaxF_\lambda^*$ |
|---|---|---|---|---|---|
| Brazil (*Arabica*) | 2.26 | 2.51 | 1.99 | 2.41 | 2.54 |
| Brazil (*Robusta*) | 3.85 | 3.30 | 2.39 | 4.01 | 3.76 |
| Colombia | 1.21 | 1.95 | 2.20 | 2.03 | 2.57 |
| Costa Rica | 3.20 | 3.53 | 3.02 | 3.40 | 3.58 |
| Ethiopia | 2.44 | 2.42 | 2.49 | 2.53 | 2.92 |
| Honduras | 1.72 | 4.27 | 3.71 | 4.11 | 4.34 |
| India (*Arabica*) | 2.76 | 3.96 | 4.06 | 3.81 | 4.75 |
| India (*Robusta*) | 2.64 | 3.03 | 2.91 | 2.92 | 3.41 |
| Uganda (*Arabica*) | 2.39 | 3.91 | 4.68 | 4.32 | 5.48 [c] |
| Uganda (*Robusta*) | 2.46 | 2.89 | 3.55 | 3.27 | 4.15 |

**Notes:** none of the estimated statistics can reject the null hypothesis of no break (all the estimated test statistics are less than the critical values at the 10% significance level). Whether it be the sequential trend break statistics such as $F_\lambda^*(m|0)$ or the break tests statistics such as the *Dmax* tests, or the modified sequential test statistics – all due to the procedures by Sobriera and Nunes (2016). The only exception is Uganda, where one of the *Dmax*

tests is rejected; (the notation, [c] denotes rejection of the null hypothesis at the 10% significance level) but this is only a borderline case, and is not supported by the sequential tests.

**Table 3.** Robust tests for trend estimation

| | Trend est. $\hat{\beta}$ (%) | Conf. Int. $\hat{\beta}$ | Lag | *t*-stat |
|---|---|---|---|---|
| Brazil (*Arabica*) | –0.35 | (–1.10, 0.41)[b]<br>(–1.25, 0.55)[c] | 6 | –0.764 |
| Brazil (*Robusta*) | –0.37 | (–1.24, 0.49)[b]<br>(–1.40, 0.65)[c] | 3 | –0.711 |
| Colombia | –0.11 | (–0.50, 0.27)[b]<br>(–0.57, 0.34)[c] | 6 | –0.487 |
| Costa Rica | –0.08 | (–0.65, 0.49)[b]<br>(–0.76, 0.60)[c] | 1 | –0.230 |
| Ethiopia | –0.14 | (–0.71, 0.42)[b]<br>(–0.81, 0.52)[c] | 17 | –0.423 |
| Honduras | –0.16 [a] | (–0.25, –0.07)[b]<br>(–0.26, –0.06)[c] | 3 | –3.08 [a] |
| India (*Arabica*) | –0.08 | (–0.65, 0.49)[b]<br>(–0.76, 0.60)[c] | 2 | –0.230 |
| India (*Robusta*) | –0.80 [b] | (–1.32, –0.28)[b]<br>(–1.41, –0.19)[c] | 5 | –2.55 [b] |
| Uganda (*Arabica*) | 0.22 | (–0.69, 1.14)[b]<br>(–0.86, 1.31)[c] | 1 | 0.403 |
| Uganda (*Robusta*) | 0.40 | (–0.54, 1.35)[b]<br>(–0.72, 1.52)[c] | 1 | 0.707 |

**Notes:** The notation, [a] and [b] denote rejection of the null hypothesis at the 1%, and 5% significance levels respectively. The confidence intervals shown in parentheses with superscript [b] and [c] are the 95% confidence level followed by the 90% confidence level. The lag length is chosen according to the modified Akaike Information Criterion (MAIC).

**Table 4.** Short run price cycles

| | Slump Phase | | | | Boom phase | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | Average | Min | Max | Total | Average | Min | Max |
| Brazil (*Ara*) | 135 | 22.5 | 8 | 32 | 109 | 15.57 | 5 | 32 |
| Brazil (*Rob*) | 120 | 24 | 5 | 43 | 148 | 29.6 | 18 | 57 |
| Colombia | 170 | 24.28 | 7 | 32 | 144 | 20.57 | 8 | 46 |
| Costa Rica | 151 | 30.2 | 11 | 71 | 125 | 25 | 13 | 49 |
| Ethiopia | 174 | 24.85 | 11 | 56 | 131 | 18.71 | 6 | 29 |
| Honduras | 155 | 22.14 | 8 | 52 | 158 | 22.57 | 7 | 41 |
| India (*Ara*) | 185 | 20.55 | 6 | 56 | 131 | 14.55 | 8 | 28 |
| India (*Rob*) | 158 | 26.33 | 5 | 56 | 137 | 19.57 | 7 | 39 |
| Uganda(*Ara*) | 138 | 19.71 | 11 | 33 | 128 | 18.28 | 5 | 43 |
| Uganda(*Rob*) | 131 | 16.37 | 6 | 43 | 136 | 17 | 11 | 26 |

Table 5. Duration, Amplitude and Excess Index

| | Duration | | Amplitude | | Excess Index | |
|---|---|---|---|---|---|---|
| | Boom phase | Slump phase | Boom phase | Slump phase | Boom phase | Slump phase |
| Brazil (*Ara*) | 18.83 | 20.80 | 0.52 | -0.56 | -4.34 | 12.06 |
| Brazil (*Rob*) | 21.20 | 34.50 | 0.71 | -0.70 | -14.32 | -18.52 |
| Colombia | 20.57 | 23.33 | 0.55 | -0.56 | -23.27 | 11.42 |
| Costa Rica | 37.00 | 32.00 | 0.52 | -0.46 | 12.91 | 11.64 |
| Ethiopia | 18.71 | 25.50 | 0.99 | -0.99 | -1.71 | -1.21 |
| Honduras | 21.83 | 28.00 | 1.06 | -1.02 | -12.93 | -4.92 |
| India (*Ara*) | 16.00 | 23.57 | 0.53 | -0.55 | 8.21 | 11.74 |
| India (*Rob*) | 23.66 | 30.60 | 0.64 | -0.68 | 0.12 | 6.38 |
| Uganda(*Ara*) | 20.50 | 23.60 | 0.76 | -0.80 | 8.58 | 11.58 |
| Uganda(*Rob*) | 28.00 | 25.40 | 0.82 | -0.83 | 18.01 | -6.98 |

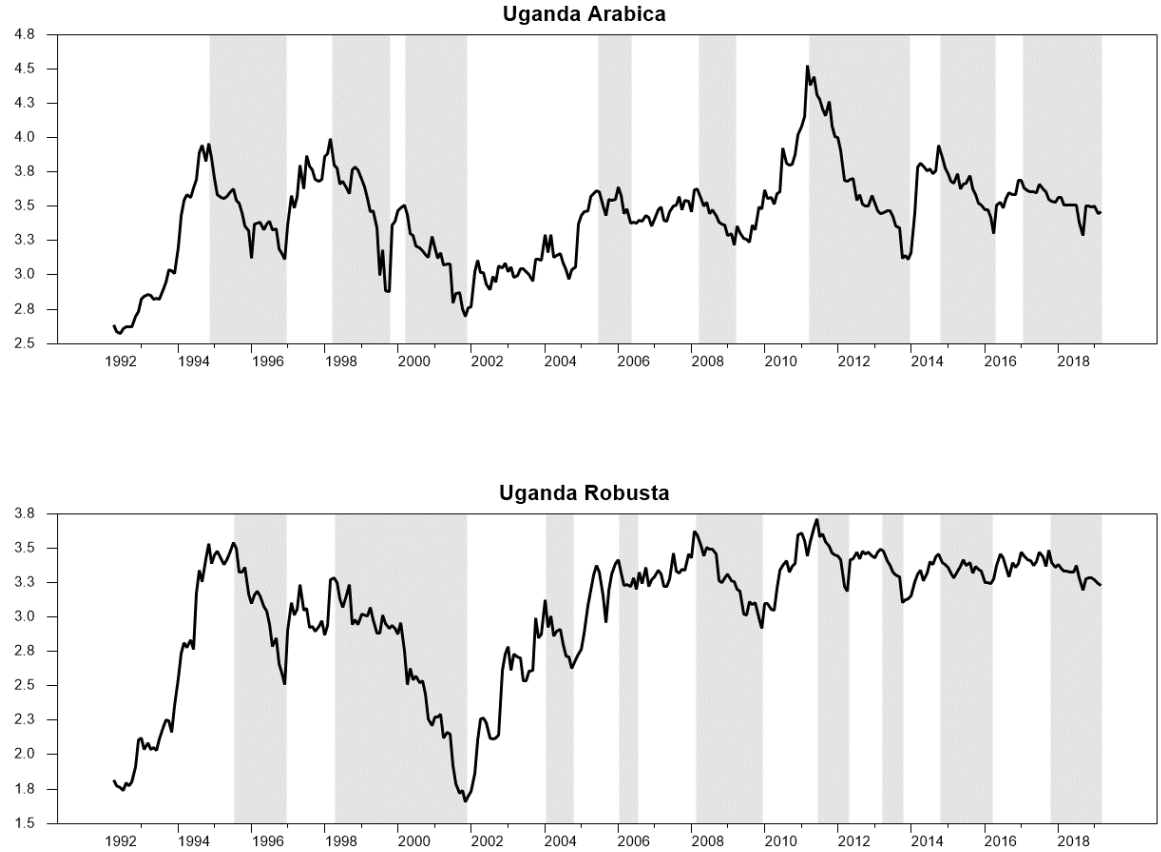
## Appendix

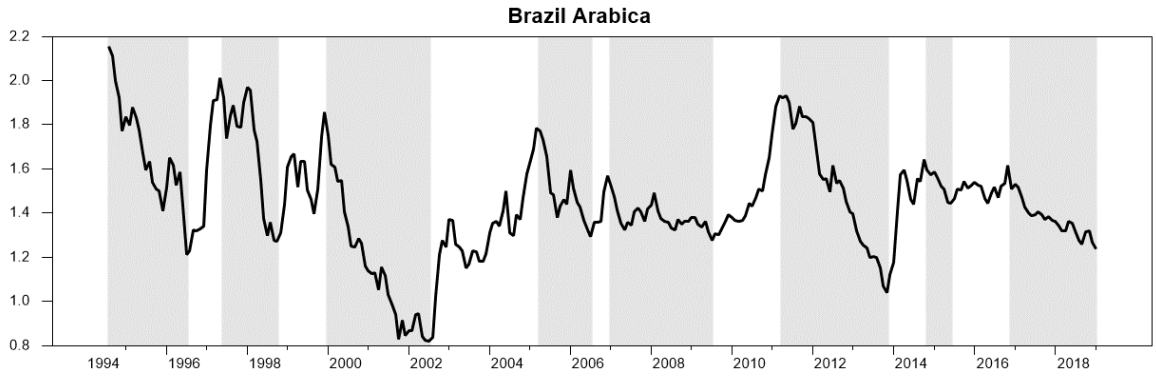
**Table A.** Description of Data

| Country | Time period | No. of obs. | Currency Unit |
|---|---|---|---|
| Brazil (*Arabica*) | July1994 – January 2019 | 295 | BRL/60KG |
| Brazil (*Robusta*) | July1994 – January 2019 | 295 | BRL/60KG |
| Colombia | January 1990 – April 2019 | 352 | COP/125KG |
| Costa Rica | January 1990 – September 2017 | 333 | CRC/SQ |
| Ethiopia | January 1990 – September 2018 | 345 | ETB/17KG |
| Honduras | January 1990 – June 2019 | 350 | HNL/SQ |
| India (*Arabica*) | January 1990 – May 2019 | 353 | INR/50KG |
| India (*Robusta*) | October 1990 – May 2019 | 353 | INR/50KG |
| Uganda (*Arabica*) | March 1992 – March 2019 | 325 | UGX/KG |
| Uganda (*Robusta*) | March 1992 – March 2019 | 325 | UGX/KG |

Source: International Coffee Organisation

**Figure A.** Boom and slump phases




Brazil Arabica
2.2
2.0
1.8
1.6
1.4
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1.0
0.8
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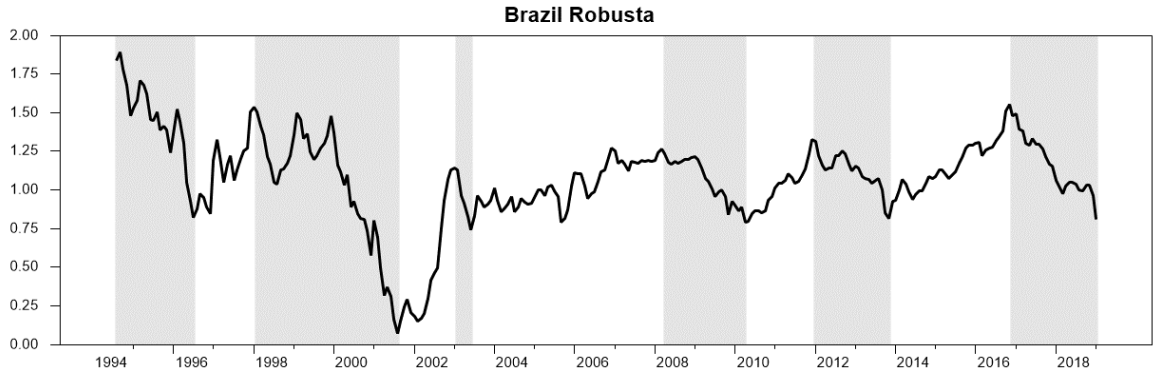
Brazil Robusta
2.00
1.75
1.50
1.25
1.00
0.75
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0.00
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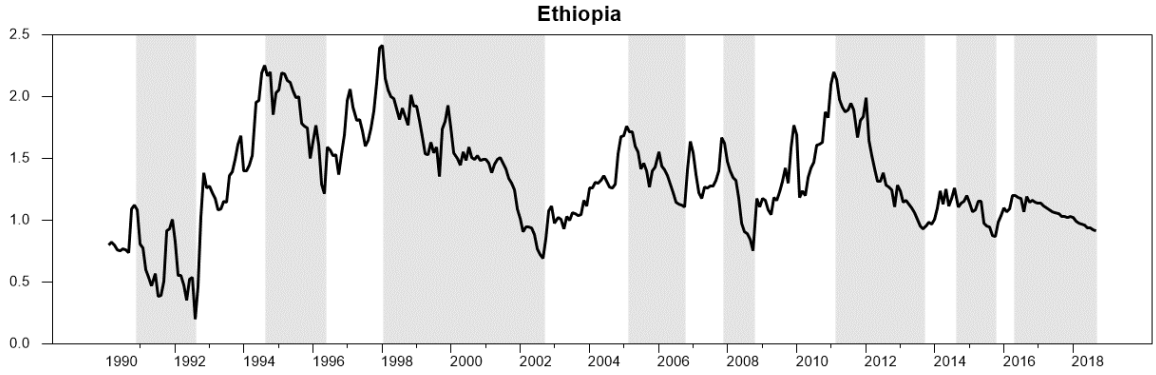
Ethiopia
2.5
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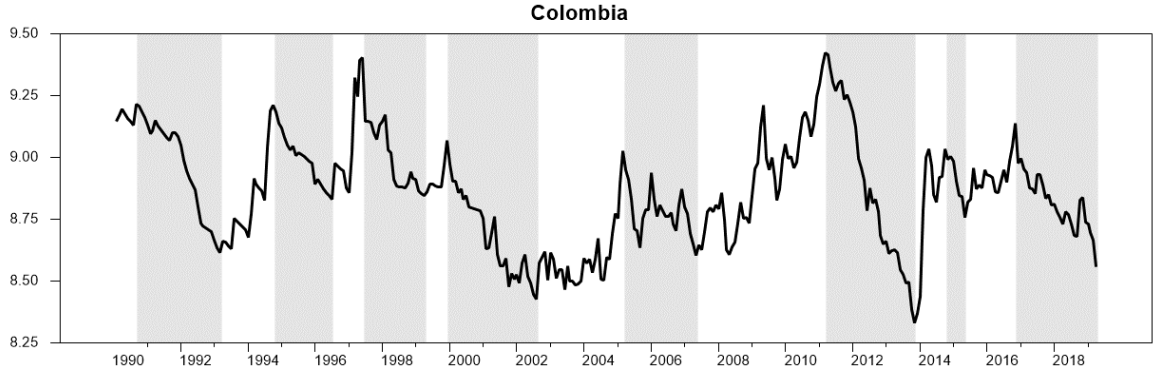
Colombia
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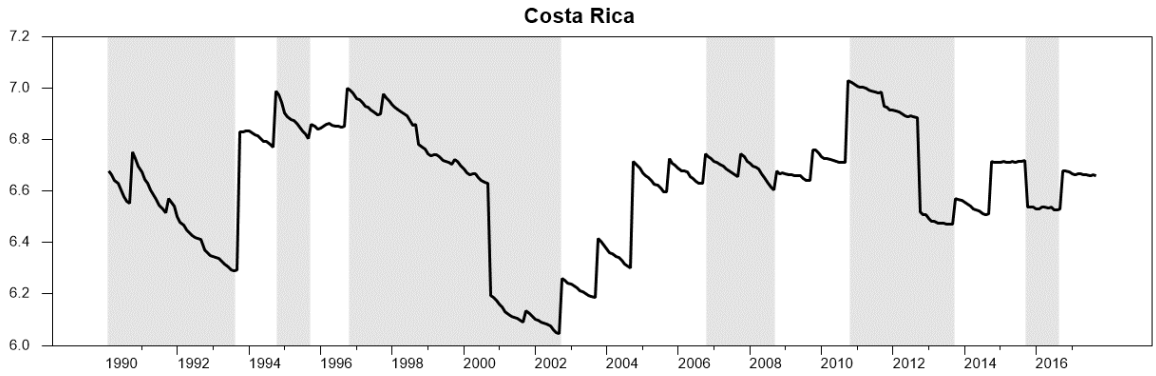
Costa Rica
7.2
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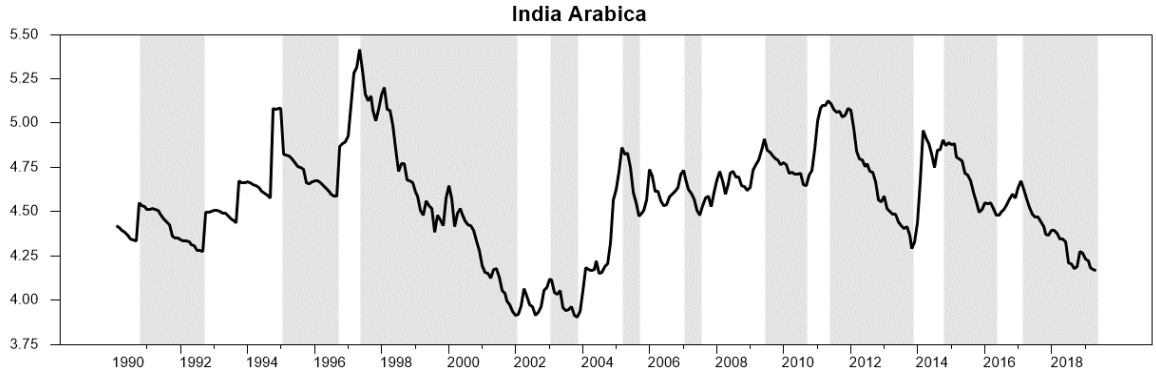
India Arabica
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4.50
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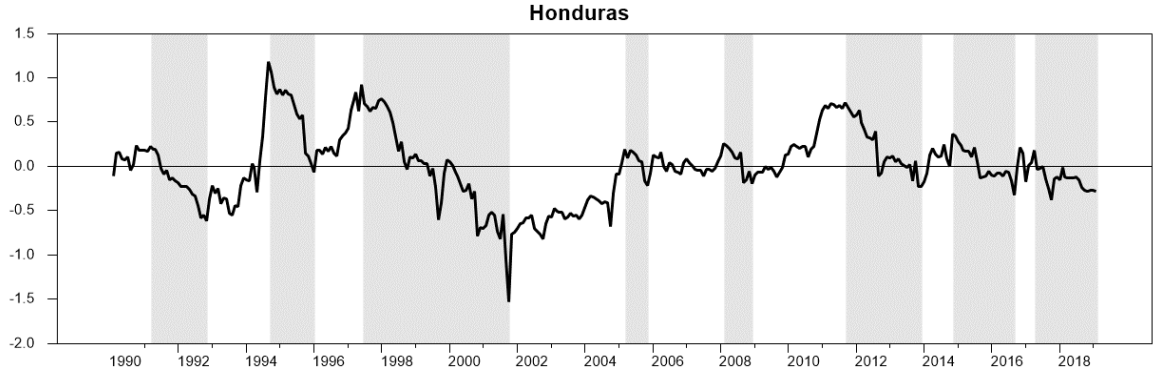
Honduras
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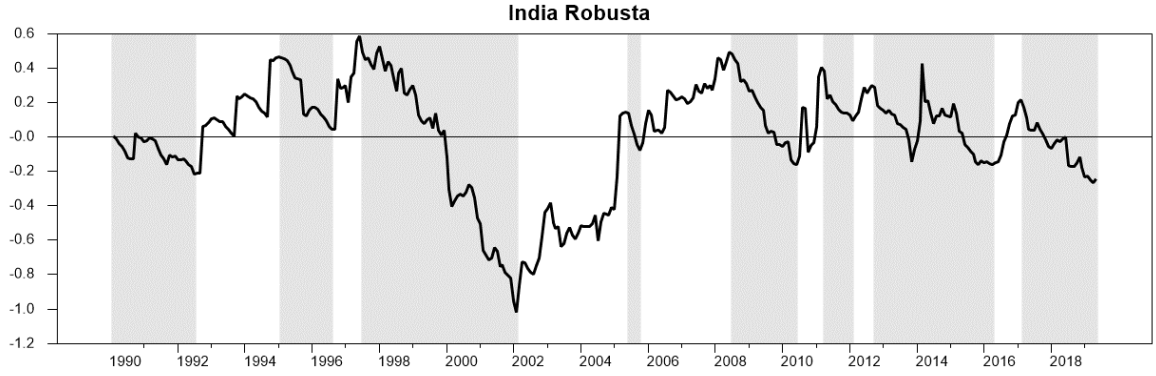
India Robusta
0.6
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-0.2
-0.4
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