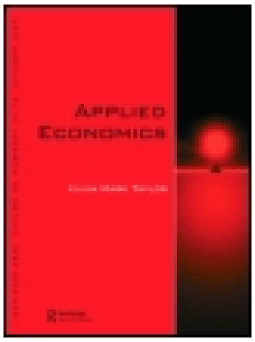

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On the co-movement between coffee and cocoa prices in international markets

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ABSTRACT
In this article, we study the movement between cocoa and coffee prices, two close substitute commodities. Using the ARDL approach developed by Pesaran et al. (2001), we found that the two prices are cointegrated. The long-run elasticity of coffee price with respect to the cocoa one is estimated at 0.88. Also, using the lag-augmented VAR approach of Toda and Yamamoto (1995), which is valid whatever the order of integration of the data, the cocoa price is found to granger cause the coffee price and not vice versa. This finding suggests that models aiming at forecasting coffee prices should incorporate cocoa prices as well.

KEYWORDS
Coffee; cocoa; commodity prices; co-movement

JEL CLASSIFICATION
Q02; Q11; C22

I. Introduction

One of the relevant features of commodity prices is their tendency to co-move. Understanding the correlations between the prices of agricultural products is important because of the welfare implications for both commodity importers and exporters. Borensztein and Reinhart (1994) suggest that a synchronized increase in commodity prices is likely to place commodity import-dependent countries under considerable inflation pressure. However, if covariations are explained by the substitution effects, they favour export concentration in commodity-producing countries.

Excessive or unexplained co-movements among commodity prices can probably be dated back to Pindyck and Rotemberg (1990). These authors test the hypothesis that the prices of raw commodities have a persistent tendency to move together, and they find existence of co-movement between the prices of a set of commodities including wheat, cotton, copper, gold, crude oil, lumber and cocoa. These seven commodities are largely unrelated. Furthermore, the co-movement is well in excess of anything that can be explained by the common effects of inflation, or changes in aggregate demand, interest rates and exchange rates. Pindyck and Rotemberg (1990) conclude that correlation among the commodity prices whose fundamentals are unrelated that cannot be explained by macroeconomic effects is excess co-movement. They argue that, due to herd behaviour, prices tend to move together. By herd behaviour, they mean the bullish or bearish manner of traders on all commodities for no plausible reason.

Deb, Trivedi and Varangis (1996) suggest that the idea of excess co-movement developed by Pindyck and Rotemberg (1990) was based on the assumption of normal and homoscedastic errors. They investigate the co-movement in commodity prices using GARCH framework to account for the non-normality and heteroscedasticnature of commodity price changes. They find minimal evidence of co-movement using the same commodities and the same time interval as in Pindyck and Rotemberg (1990).

Ai, Chatrath and Song (2006) re-examine co-movement between agricultural commodities. They develop a structural model and use five commodities including wheat, barley, oats, corn and soybeans to explain a substantial portion of the co-movements among prices of the commodities. They find that their model explains the correlation between related commodities, but it does not explain the co-movement in commodity prices for fundamentally unrelated commodities.

The multiple commodity price booms in international markets in the early 2000s have prompted a particular interest on fundamentals of co-

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Supplemental data for this article can be accessed here.

movements in commodity prices. Between January 2005 and January 2010, the price of cocoa more than doubled, while the price of coffee and cotton tripled and quadrupled between January 2005 and April 2011, respectively. This simultaneous upward trend in prices was explained through three hypotheses. The first hypothesis emphasizes robust growth in emerging market economies such as China and India and its role in stimulating demand for commodities (see e.g. Caballero, Farhi and Gourinchas 2008). The second hypothesis focuses on the role of financialization of commodities traded on exchanges as futures or in physical form (see e.g. Kilian and Murphy 2014). Finally, the third hypothesis is attributed to commodity price co-movements to monetary growth (see e.g. Frankel 2006). However, reviewing the literature highlights the little attention given to analysis of co-movement among the prices of commodities considered as related products such as coffee and cocoa which are close substitutes.

Coffee and cocoa are agricultural products used mostly as beverages all around the world and represent a major source of income for many developing countries that have strong commodity export dependence. For instance, cocoa crop exports provide a livelihood for 25% of the Cote d'Ivoire's population, while the share of coffee in total exports represents 79% in Burundi and 64% in Ethiopia (FAO 2006).

Coffee is one of the most widely traded commodities. It is also a seasonal crop; seasons vary from country to country which makes supply for the most part unpredictable. For many developing country governments, and the private sector coffee production, trade and consumption is a critical contributor to socio-economic development. Regarding cocoa, it is produced and exported in small volumes and has many similarities with coffee. Cocoa is exclusively produced in developing countries, harvests and productivity levels are highly dependent on prevalent weather conditions.

Figure 1 below shows strong co-movement and considerable volatility of coffee and cocoa prices over the last 30 years. Indeed, the two prices look highly correlated and moving together. The price volatility is provided by the coefficient of variation that is of 0.38 for cocoa and 0.42 for coffee with the monthly data from the World Bank over the period from November 1985 to November 2015. For coffee- and cocoa-exporting countries, price volatility is a major cause of concern, while it is a relatively minor concern for most importing countries. Significant fluctuations in world prices may have dramatic effects both at the national and producer levels as extreme volatility in prices deters producers from making the necessary investments for increasing productivity and production. For most importing countries, changes in coffee or cocoa prices would probably only result in relatively minor changes in consumption habits.

Although cocoa and coffee may have other uses, they are considered economically as substitutes; therefore, consumers' choice or preference depends

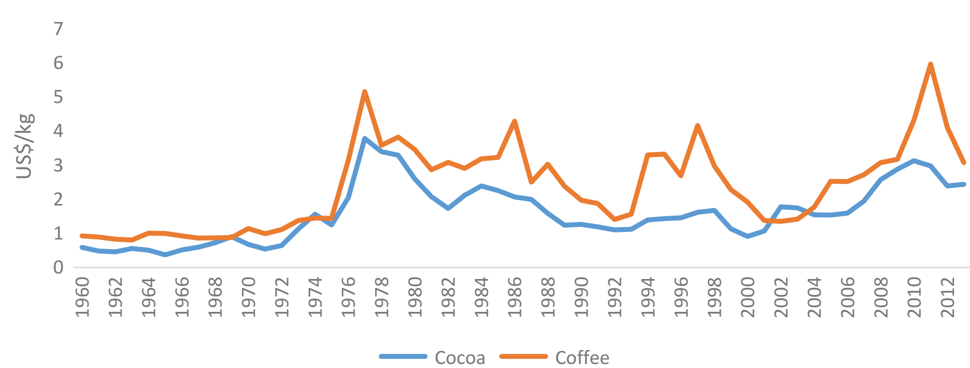

Figure 1. Evolution of world coffee and cocoa prices. Cocoa: International Cocoa Organization daily price, average of the first three positions on the terminal markets of New York and London, nearest three future trading months. Coffee: International Coffee Organization indicator price, other mild Arabicas, average New York and Bremen/Hamburg markets, ex-dock. Source: World Bank

among other factors on the price. The demand for a product depends on consumer preference, taste, income, own price and price of substitutes (see e.g. Nerlove 1958; Gardner 1976). Also in general, both coffee and cocoa are produced in the same countries and traded on the same futures markets by the same trading companies. As a consequence, there is a natural tendency for both prices to move in the same direction on the supply side.[1]

Thus, this article contributes to enrich the understanding of the interdependency of coffee and cocoa prices, to see if they are cointegrated and granger cause each other. As highlighted in Figure 1, the two prices look highly correlated, moving together and exhibiting the same boom and bust cycles. It is also important for modelling issues whether or not one should introduce the price of competing or substitute commodities when making forecasts. Omitting this information may lead to omitted variables biases or poor forecast outcomes. In the presence of granger causality for instance, introducing the information on the past of one price help reduces the variance of the forecast error of the other price.

In order to perform our empirical analysis, we exploit the information about coffee and cocoa prices from the World Bank observed over the period 1960–2011. We use the autoregressive distributed lag (ARDL) approach of Pesaran, Shin and Smith (2001) to study the relationship between the two prices. The ARDL approach is of particular interest here as it avoids pretesting the underlying time series. Indeed, the approach is valid for either I(1) or I(0) series or a mixture of them. In doing so, it prevents from size distortion and low power issues regarding unit root tests (Schwert 1989; Cochrane 1991). Also, many commodity prices exhibit strong autocorrelation and inertia in their behaviour. It is also suitable for small samples, and this generally is the case in empirical analysis. In addition, we use the lag-augmented VAR approach of Toda and Yamamoto (1995), which is valid whatever the order of integration of the data to study the direction of causality between the two prices. The results suggest that the two prices are cointegrated with causation going from the cocoa price to coffee price.

The remainder of this articleis organized as follows. Section **II** presents an overview of the world coffee and cocoa markets. Section **III** focuses on the methodology used for investigating the co-movement between coffee and cocoa prices. Section **IV** provides empirical analysis. Section V discusses the results. Sections VI and VII focus on two important issues which are the long-run elasticity and Granger causality. Section VIII concludes.

II. Overview of the world coffee and cocoa markets

Coffee and cocoa are both tropical commodities mainly produced in least developed countries and developing countries in Africa, South America and South Asia.

Cocoa is an important cash crop and a critical export commodity for producing countries and is also a key import for consuming countries, which typically do not have suitable climates for cocoa production. Indeed, the ideal climate for growing cocoa is hot, rainy and tropical, with lush vegetation to provide shade for the cocoa trees. Thus, the primary growing regions are Africa, Asia and Latin America. The largest producing country by volume is Côte d'Ivoire, which produces 42% of global supply (Figure 2). The vast majority of cocoa comes from small, family-run farms, which often rely on outdated farming practices.

The total production has increased by 13%, from 4.3 million metric tons in 2008 to 4.8 million metric tons in 2012. This represents an average year-over-year production increase of 3.1%. Once cocoa beans have been harvested, fermented, dried and transported, they are processed into separate components for commercial consumption. The Netherlands is the largest processing country by volume, handling about 13% of global grindings. Overall, the cocoa trade is dominated by the European Union that accounts for over half of global cocoa imports (Table 1). As the primary regions for chocolate manufacturing, Europe and the US are the main importers of post-processing cocoa products (Figure 3). However, from 2008 to 2011, China grew from the 12th to 9th largest importer of cocoa paste and from the 15th to 9th largest importer of cocoa powder and cake. Cocoa beans trade on two world exchanges including London (NYSE LIFFE—GBP) and New York (ICE—USD). Cocoa future contracts are the benchmark global price quote for cocoa. Each contract is 10 metric tons, and prices are quoted in US dollars per metric ton.

[1]Even if the two commodities may not be produced in the same area in a particular country.

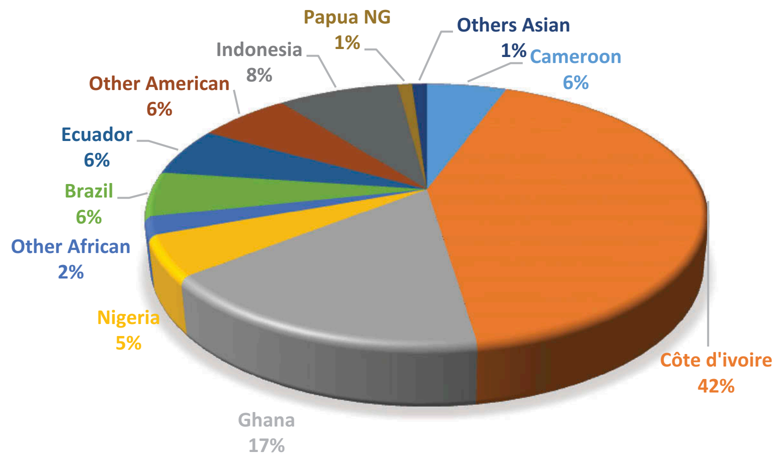

Figure 2. Production of cocoa 2014–2015 estimates. Source: International cocoa organization (ICCO).

Table 1. Top cocoa exporters and importers.

Top exporters in 2013		Top importers in 2013	
Countries	Value in tonnes	Countries	Value in tonnes
Côte d'Ivoire	813 891	EU(25)	1 336 170
Ghana	526 187	EU(27)	1 336 170
Netherlands	215 717	EU(15)	1 328 931
Indonesia	188 420	EU(12)	1 328 913
Nigeria	182 900	Netherlands	630 800

Source: ICCO.

Table 2. Descriptive statistics.

	Mean	SD	Minimum	Maximum
Coffee price (USD/kg)	2.37	1.24	0.80	5.98
Cocoa price (USD/kg)	1.59	0.85	0.36	3.79

Source: World Bank.

Coffee is a perennial crop that is an agricultural commodity produced from the same root structure for 2 or more years. In 2012, 8.2 million metric tons of coffee was produced in over 50 countries on 0.2%of the world's agricultural area. The top five producers had a total of 67% of the global production (Figure 4) including Brazil (32%), Vietnam (18%), Indonesia (6%), Colombia (6%) and Ethiopia (5%). Over 80% of the world's coffee production was exported, with a total export value of US$23.4 billion. These exports include Brazil (24%), Vietnam (22%), Indonesia (9%), Colombia (6%) and Honduras (5%). The global consumption of coffee has grown by 22.3% over the past 10 seasons (Figure 5). It has been dominated by European Union (31%). Latina America and Asia are increasingly important consumers, notably in producing countries (see Figure 5 below). The main post-processing coffee products are Kraft Foods and Nestle which represent about one-fourth of the world's traded coffee, and top five coffee traders account for 40% of traded volumes in 2012.

III. Modelling and testing procedure

The ARDL approach has been justified in the introduction; we will just describe here the testing procedure, which is suitable here as many commodity prices exhibit strong autocorrelation and inertia in

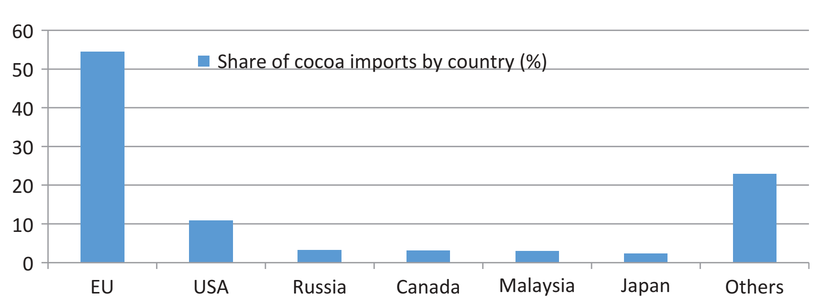

Figure 3. Share of cocoa imports in percentage by country, 2011. Source: Edwards (2013).

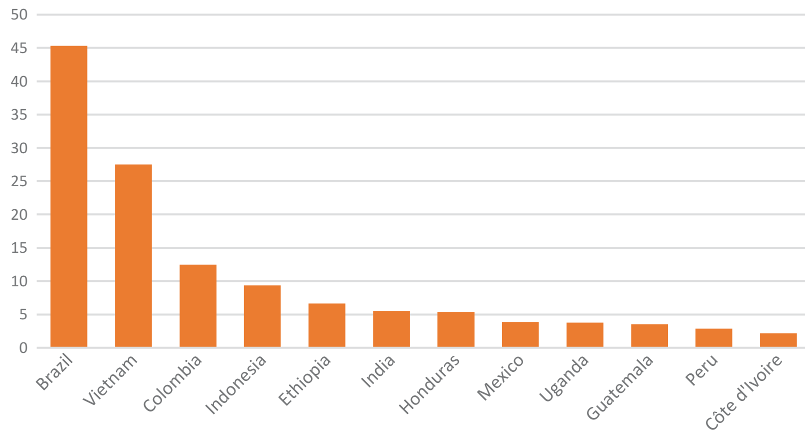

Figure 4. Top coffee producers (in millions 60 kg bags). Source: International Coffee Organization (ICO).

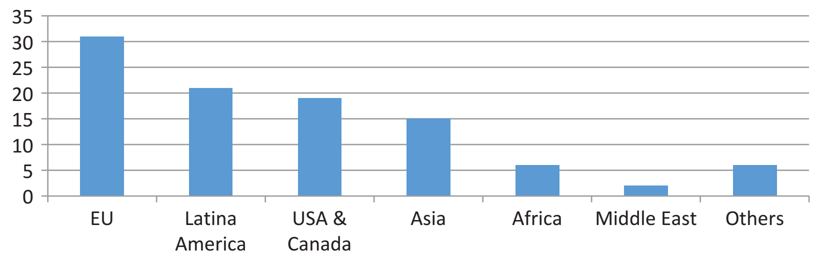

Figure 5. Share of Coffee consumption in percentage by region, 2012–2013. Source: Edwards (2013)

their behaviour. As the ARDL approach has been justified in the introduction (small samples, endogeneity, mixture of I(1) and I(0) variables), we will just describe here the modelling and testing procedure.

We start with the general ARDL (p,q) model to describe the dynamics between coffee and cocoa prices:

$$P_t^{cf} = \alpha_0 + \sum_{i=1}^{p} \alpha_i P_{t-i}^{cf} + \sum_{i=0}^{q} \beta_i P_{t-i}^{co} + \varepsilon_t, \qquad (1)$$

where P_t^{cf} is the world coffee price, P_t^{co} the world cocoa price and α_i and β_i are coefficients to be estimated.

In the ARDL modelling framework, Pesaran, Shin and Smith (2001) have developed a new testing procedure which is much more powerful. These new tests, called 'bounds tests', can be described as follows:

We start with the general unconstrained error correction model of the following form between coffee and cocoa prices.

$$\Delta P_t^{cf} = \pi_0 + \pi_1 P_{t-1}^{cf} + \pi_2 P_{t-1}^{co} + \sum_{i=1}^{p-1} \gamma_i \Delta P_{t-i}^{cf} + \sum_{i=0}^{q} \delta_i \Delta P_{t-i}^{co} + \varepsilon_t. \qquad (2)$$

The null hypothesis of no cointegration between the variables is given by:

$$H_0^{\pi_1} : \pi_1 = 0, H_0^{\pi_2} : \pi_2 = 0$$

and

$$H_0^{\pi_1} : \pi_1 \neq 0, H_0^{\pi_2} : \pi_2 \neq 0,$$

that is, $H_0 : H_0^{\pi_1} \cap H_0^{\pi_2}$ and H_1: $H_1^{\pi_1} \cup H_0^{\pi_2}$.

In this framework, the testing procedure consists of computing the F-statistic under the null hypothesis. This F-statistic has to be compared to the two critical value bounds tabulated by Pesaran, Shin and Smith (2001). The lower bound assumes that all the regressors are I(0), while the upper bound assumes that they are all I(1). If the computed F-statistic falls above the upper bound, cointegration is not rejected; on the other hand, if the statistic is below the lower bound, cointegration is rejected. However, if the

Table 3. Unit root tests.

	Levels			First differences		
	ADF	PP	ERS-DFGLS	ADF	PP	ERS-DFGLS
Cocoa price	−2.54	−2.53	−2.08**	−7.65***	−7.65***	−7.59***
Coffee price	−2.43	−1.96	−1.91*	−5.46***	−5.25***	−5.37***

ADF, Augmented Dickey–Fuller; PP, Phillips–Perron; ERS-DFGLS, Elliot–Rothenberg–Stock-Dickey–Fuller generalized least squares. *: significant at 10% level; **: significant at 5% level; ***: significant at 1% level.

statistic falls within the bound, the test is inconclusive and further investigation is needed.

Pesaran, Shin and Smith (2001) also extended their approach to the test of Banerjee, Dolado and Mestre (1998), which consists of testing the significance of the error correction term in Equation (2). They developed a t-test version, based on the coefficient of the error correction term (π_1) in Equation (2). The bounds testing procedure remains the same as for the F-test.

However, for the test to work, I(2) variables should not be present. So to avoid this issue, we perform a series of unit root tests, not to distinguish between I(1) and I(0) variables, but to exclude the possibility of I(2) variables.

IV. Empirical analysis

Data

All the data are from the international organizations governing the market of the two commodities and provided by the World Bank (Table 2; see Supplemental data). Cocoa prices are from the International Cocoa Organization. They correspond to annual averages of the daily price average of the first three positions on the terminal markets of New York and London. Coffee prices are from the International Coffee Organization and correspond to the organization indicator price, other mild Arabicas, average New York and Bremen/Hamburg markets. For both prices, we use annual data to smooth too large short-run fluctuations, as integration is essentially a long-run phenomenon and the time span is more important than the sample size per se. The study covers the period 1960–2013.

Cointegration tests

We first test for unit roots to be sure that there are no I(2) variables and the results are shown in Table 3 below:

Table 4. Results of the bounds test.

F-test	*t*-Test
10.60***	−-4.59***

***: Significant at 1% level.

It appears that both variables are stationary after first differencing, whatever test is used. The ERS-DFGLS test even suggests no unit root in the level of the variables. One can then conclude that both variables are at most I(1). As a consequence we can perform the bounds test.

Using the Schwarz information criterion, an ARDL (1, 0) is retained for Equation (1). The F- and t-statistics are provided in the Table below.

Both the F- and t-tests statistics fall outside the upper bound and are significant at 1% level (Table 4). One cannot therefore reject the presence of a long-run equilibrium relationship between Coffee and cocoa prices.

V. Regression results

Table 5 and 6 give the level and short-run impacts of cocoa price on coffee price. The Lagrange multiplier (LM) test suggests that there is no remaining serial correlation in the model, while the Chow forecast tests indicates that there is no structural change in the period. Misspecification could be a serious issue in dynamic models, so the Plosser–Schwert–White differencing test rejects any misspecification in the model.

From Table 5, it appears that there is inertia in the coffee price dynamics. The first lag is positive and significant. The coffee price is positively correlated with cocoa price. One cannot directly draw a causal implication, since there could be a bidirectional link between the two variables: shocks from one market being transmitted to the other one.[2] This can be for instance the supply side shocks that generally affect the two commodities at the same time. The same

[2]The Granger causality analysis will help address this issue (see next section).

Table 5. Level relationship.

	Coefficient
Coffee price (t-1)	0.494***
	(0.089)
Cocoa price	0.446***
	(0.085)
Intercept	0.238***
	(0.052)
Adjusted *R*-squared	0.86
Breusch–Godfrey serial correlation LM test	*T***R*-squared = 0.633
p-value	(0.32)
Plosser–Schwert–White differencing test	*F*-statistic = 0.27
p-value	0.761
Chow forecast test (1990–2013)	*F*-statistic = 1.49
p-value	(0.158)

Standard errors in parentheses.
***: Significant at 1% level.

Table 6. Error correction model.

	Coefficient
D (Coffee price (t-1))	0.586***
	(0.178)
D (Cocoa price)	0.448***
	(0.130)
ECT (-1)	−1.016***
	(0.228)
Intercept	−0.003
	(0.030)
Adjusted *R*-squared	0.36
Breusch–Godfrey serial correlation LM Test	*T***R*-squared = 6.709
p-value	(0.152)
Chow forecast test (1990–2013)	*F*-statistic = 1.39
p-value	(0.209)

Standard errors in parenthesis.
***: Significant at 1% level.

positive link is provided by the error correction model in Table 6, which gives the short-run estimates. The error correction term is negative and highly significant, highlighting the strong equilibrium relationship between the two prices.

Recently a growing literature on price transmission and co-movement has emerged, particularly pointing out nonlinearities.[3] These nonlineraities could concern either the long-run equilibrium or the short-run adjustment, yielding threshold and regime switching Error Correction models (Serra and Goodwin 2003; Goodwin, Holt, and Prestemon 2011; Götz Glauben and Brummer 2013). Regarding our study, the short-run nonlinearity could be due to conversion costs from coffee to cocoa and vice versa.

We perform two tests to take into account the above mentioned potential nonlinearities. The results are shown in Table 7. The first one (Hansen 1996) tests for nonlineraities (threshholds) and is performed on the long-run model. The

Table 7. Tests for thresholds and regime shifts.

	Test statistic	*P*-value
Hansen (1996)	LM test for no threshold: 4.604	0.4189
Hansen and Seo (2002)	SupLM statistic: 20.223	0.068

second one (Hansen and Seo 2002) tests the null of linear cointegration against threshold cointegration (ECM) and is applied to the ECM. As shown in table, the null hypothesis is rejected for both tests at the usual significance levels. These results are not particularly surprising as we are working with an ARDL model. Indeed the lagged values of the prices implicitly take into account the partial adjustment process.

VI. Long-run elasticity

The following subsection has illustrated the short-run impacts. In a traditional ARDL framework, the coefficients of Equation 1 are short-run or medium-term elasticities and the long-run (or equilibrium) value of the elasticity of the coffee price with respect to the cocoa one is given by[4]:

$$\theta = \frac{\beta_0}{1-\alpha_1} \tag{3}$$

To estimate this long-run elasticity, one can use the formula (3) above. But in order to get the standard error of the long-run elasticity, it is necessary to use either the so called 'delta method' by approximating the variance of θ by a linear function or Bewley (1979) transformation and Wickens and Breusch (1988) instrumental variables approach. For computational convenience, the later approach is adopted here. Let us set:

$$\lambda = \frac{1}{1-\alpha_1} \tag{4}$$

The long-run elasticity is then given by:

$$\theta = \frac{\beta_0}{1-\alpha_1} = \lambda\beta_0 \tag{5}$$

By subtracting $\alpha_1 P_t^{cf}$ from both sides of Equation (1) we get:

[3]We are grateful to an anonymous referee for pointing this out.
[4]Here we have an ARDL (1,0) model.

Table 8. Long-run elasticity of coffee price.

Long-run elasticity	Standard error
0.883***	0.098

***: Significant at 1% level.

$$(1-\alpha_1)P_t^{cf} = \alpha_0 - \alpha_1 \Delta P_t^{cf} + \beta_0 P_t^{co} + \varepsilon_t \quad (6)$$

Now let us multiply each side of Equation 5 by λ. This yields:

$$P_t^{cf} = \lambda\alpha_0 - \lambda\alpha_1 \Delta P_t^{cf} + \lambda\beta_0 P_t^{co} + \varepsilon_t \quad (7)$$

Or

$$P_t^{cf} = \lambda\alpha_0 - \lambda\alpha_1 \Delta P_t^{cf} + \theta P_t^{co} + \varepsilon_t \quad (8)$$

This gives the long-run coefficients.

It is worth noting that the presence of P_t^{cf} in the right hand side of Equation (8) makes its estimation by OLS impossible because of an obvious endogeneity issue. So we have to use instrumental variables techniques. Wickens and Breusch (1988) has shown that the estimate of θ we get by applying 2SLS on Equation (7) is exactly the same we will get by applying Equation (5) provided that we use exactly the explanatory variables of Equation (1) as instruments for Equation(8), that is, P_{t-1}^{cf} as an instrument for ΔP_t^{cf}. Applying this estimation procedure to compute the long-run elasticity yields the following estimate given in Table 8 below.

The long-run elasticity of coffee price to cocoa price is 0.88 and significantly different from zero. This is higher than the short-run estimates, due to the inertia mentioned previously (the positive and significant effect of the first lag of the coffee price in the level relationship). This long-run elasticity higher than the short-run one also reflects the rigidities in the supply and demand sides. Particularly on the supply side, it takes some time to adjust the production levels to price changes. There are typically partial adjustment processes, due to land, credit and input constraints but also due to the perennial nature of the commodities.

VII. Granger causality

One important issue when studying the co-movement between coffee and cocoa prices is the direction of causality. It could be the case that the causality goes in both directions, so that what we need is a VAR model, where all the variables are endogenous. The easy and formal way to test this feature is to run a granger causality test on a VAR model. Our estimated model will be valid if and only if coffee prices do not granger cause cocoa prices.

Given the nature of our data (unit roots) we estimate a lag-augmented VAR model of Toda and Yamamoto (1995) since the distribution of the test statistics is nonstandard when the underlying time series are nonstationary. More precisely, if the true lag order of the model is p, the method consists of estimating a VAR of order $p + dmax$, where $dmax$ is the maximum order of integration of the data. This will fix up the asymptotics and one ends up with a standard chi-square distribution for the Wald test statistic under the null hypothesis. However the test should be applied only to the first p lags.

Formally, we estimate the following VAR model:

$$\begin{cases} P_t^{cf} = \alpha_0 + \sum_{i=1}^{p} \alpha_i P_{t-i}^{cf} + \sum_{i=p+1}^{dmax} \alpha_i P_{t-i}^{cf} + \sum_{i=1}^{p} \beta_i P_{t-i}^{co} \sum_{i=p+1}^{dmax} \beta_i P_{t-i}^{co} + \varepsilon_t \\ \hline P_t^{co} = \gamma_0 + \sum_{i=1}^{p} \gamma_i P_{t-i}^{co} + \sum_{i=p+1}^{dmax} \gamma_i P_{t-i}^{co} + \sum_{i=1}^{p} \pi_i P_{t-i}^{cf} \sum_{i=1}^{p} \pi_i P_{t-i}^{cf} + \varepsilon_t \end{cases}.$$

And the absence of granger causality is tested by:

cocoa does not cause coffee: $H_0 : \sum_{i=1}^{p} \beta_i = 0$

coffee does not cause cocoa: $H_0 : \sum_{i=1}^{p} \pi_i = 0.$

The optimal lag length given by the Schwarz information criterion is 1 and the maximum order of integration is also 1 (see unit root tests), so a VAR of order 2 is estimated and the test is run only with the first lags. As one can notice in

Table 9. Granger causality tests.

	^{2}statistic	P-value
Cocoa does not Granger cause coffee	3.87**	0.049
Coffee does not Granger cause cocoa	0.43	0.512

**: Significant at 5% level.

Table 9, we reject the null hypothesis that cocoa price does not Granger cause coffee price. The opposite is true for coffee price. So we can rely on our previous results.

VIII. Conclusion

This article highlighted the positive correlation between coffee and cocoa prices, two close commodities. This relationship is significant both in the short and long run. The long-run elasticity between the two prices is near unity. Following the Granger causality analysis, it appears that the causality goes from the cocoa price to the coffee price and not vice versa. This is important for forecasting as it means that one can make better forecasts by incorporating the cocoa price in a model describing the coffee market for instance.

This study could be extended to a structural model of coffee and cocoa markets in order to better identify the causal effects. However, as long as one is only concerned about forecasting, which could be as important as identifying the causal effect, the results found here remain valid and fall on what is called 'predictive causality'. They help better design these models and are to this extent a useful starting point.

Disclosure statement

No potential conflict of interest was reported by the authors. The opinions expressed here belong to the authors, and do not necessarily reflect those of PIM, IFPRI, or CGIAR.

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