Macroeconomic Determinants Of Non-Fuel Primary Commodity Price Movements

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ABSTRACT

This paper uses cointegration and error correction modelling techniques to examine the relationship between non-fuel commodity prices and world macroeconomic and monetary variables. The results show that fluctuations in industrial production of OECD countries, real effective exchange rate of the U.S. dollar and oil prices have significant short- and long- run impact on non-fuel commodity prices. In addition, there is evidence of highly significant positive correlation between the index of non-fuel commodity prices and crude oil price. This implies non-fuel commodity-dependent developing countries that are net importers of oil can derive little benefit from upward movements in commodity prices.

Keywords: Primary commodity, macroeconomic variables, cointegration, error correction model, less developed countries

INTRODUCTION

The importance of macroeconomic linkages to the primary commodity sector has been recognised in a plethora of literature (see 1982; Bond, 1984; Frankel, 1984; Frankel and Hardouvelis, 1985; Batten and Belongia, 1986, Hua, 1998). Batten and Belongia (1984, 1986) for example focussed on the effects of monetary and exchange rate variables on agricultural commodity prices as well as exports and inventories. Bond (1984) and Frankel and Hardouvelis (1985) used structural models to emphasize the role macroeconomic expectations play in the process of price formation in primary commodity markets.

It has been noted that if developed countries had adopted the commodity price index as an "early warning indicator" as suggested by Keynes (1943), they would have tightened monetary policy in 1948 because in the month of June of that year commodity prices rose by 70 percent. This action, the argument goes, "would have led to a gentler recession because central banks would not have had to slam the brakes so hard later.[1] This statement underscores the importance of the relationship between commodity prices and macroeconomic variables of OECD countries.

Production of primary commodities takes place predominantly in developing countries. However, processing and ultimate consumption occurs mainly in highly developed OECD countries. This multinational separation of production from consumption makes primary commodity prices, and subsequently export earnings of LDCs that are heavily dependent on them, highly vulnerable to fluctuations in the business cycles industrialized countries (Hua, 1998, Swaray, 2005a). In his Nobel Price lecture, Lewis (1980) pointed out that the secular slowdown in industrial countries will inevitably reduce the speed of development in developing countries unless an alternative engine of growth is found. This, engine he believed was trade among developing countries. Riedel (1984) challenged Lewis' conclusion and argued that most developing countries face a downward sloping export demand function and could therefore expand their exports despite slowdown in industrial countries, by practising price discrimination. However, Faini et al. (1992) challenged Riedel's reasoning and showed by means empirical evidence that a single country can increase its market share through real devaluation but all countries cannot. The bottom line in the above controversy is that trade in the primary commodity sector and economic growth of developing countries

[1] *The Economist* March, 1994, p.108.

is, to a large extent, influenced by the business cycle conditions in developed countries.

The purpose of this paper is to analyse the aggregate non-fuel primary commodity price behaviour over the last three decades by means of a simple equilibrium models of price determination that may be helpful in giving some answers to some questions.

THE MODEL AND DATA SOURCE

We use a reduced form equation of a competitive market equilibrium model as follows:

$$Y_t = \alpha_0 + \alpha_1 \ln IPD_t + \alpha_2 RER_t + \alpha_3 \ln RIR_t + \alpha_4 OIL_t + \alpha_5 T + \varepsilon_t \quad (1)$$

where Y_t denote aggregate non-fuel commodity prices at time t, IPD_t denotes real industrial production of industrialized countries over time, RER_t is the real effective exchange rate of the U.S. dollar overtime, and RIR_t denotes is the real international interest rate of the 1 year London interbank offered rates overtime, OIL_t denotes the index of oil prices over time.

Primary commodity prices have been shown to exhibit persistent mean-reverting behaviour and long term common deterministic trend (Deaton and Laroque, 1992, Cashin, *et al*., 2000; Swaray, 2005b and 2006). Therefore, a multivariate time series technique, that captures the generic co-dependence prevalent in the relationship between commodity prices and macroeconomic variables is used in this paper.

We can symbolize a fourth-order vector autoregressive representation of Y_t as follows:

$$Y_t = C + \Pi_{t-1} Y_{t-1} + \Pi_{t-2} Y_{t-2} + \Pi_{t-3} Y_{t-3} + \Pi_{t-4} Y_{t-4} + \mu_t \quad (2)$$

Where C is a 4×1 vector of constants (drift) terms μ_t denote white noise error terms.

We can rewrite the VAR as a reduced-form error-correction model of Equation (1) (á la Johansen, 988; Banerjee *et al*, 1993; and Hua, 1998) as follows:

$$\Delta Y_t = C + \sum \lambda_i \Pi_i \Delta Y_{t-i} - \Pi Y_{t-i} + \mu_t \quad (3)$$

Where
$$\lambda_i = -(\Pi_1 + \Pi_2 + \Pi_3)$$
$$\Pi = (\Pi_1 + \Pi_2 + \Pi_3 + \Pi_4) - 1$$

The components of vectors λ_i are short-run parameters depicting disequilibrium features of the data, and the matrix Π hold information on the long-run equilibrium relationships.

We use annual data from the IMF's International Financial Statistics. The base year for all the variables except interest rates was 1995. The variable for economic activities of developed countries is the real industrial production of 22 industrialized countries.[2] This is because developed countries are the greatest importers of non-fuel primary commodities. The real effective exchange rate of the dollar against currencies of other developed countries (Canada, France, Germany, Italy, Japan, and the United Kingdom) is calculated by using these countries' GDP weights to their corresponding nominal dollar exchange rates corrected for the consumer prices in the United

[2] The countries include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

States and other developed countries. The real international interest rate is the nominal interest rate of the 1 year London interbank offered rates (LIBOR) on a U.S dollar deposit, deflated by the change in the consumer prices of the United States.

RESULTS AND DISCUSSION

Table 1 contains descriptive statistics of aggregate non-fuel primary commodity price index from 1970 to 2004. The degree of variability in the indices of commodity prices as measured by the coefficient of variation of prices indices confirms the tendency of high volatility akin to primary commodity prices (see Gilbert, 1993; Claessens and Qian, 1993). The correlation coefficient between aggregate non-oil primary commodity prices and oil is positive and highly significant (i.e 0.63). This positive comovement essentially implies that non-fuel primary commodity-dependent LDCs that are net importers of oil are less likely to realise a significant improvement in their trade balance in periods of high commodity prices.

Table 1: Descriptive statistics of aggregate non-oil commodity price index

Mean	Std. dev.	Skewness	Excess Kurtosis	Coef. Dev	Normality
74.58	17.65	-0.99	0.54	23.66	6.72* (0.0347)
Unit root tests					
	Augmented Dickey- Fuller		**Philips-Perron**		
	Level dada	**1st Diff**	**Level data**	**1st Diff**	
Y_t	-2.31	-3.86**	-1.79	4.15*	
IPD_t	-0.02	-4.78**	-2.83	-4.12*	
RER_t	-1.71	-4.05**	-2.20	-6.03**	
RIR_t	-2.18	-3.76**	-2.07	-3.99*	
OIL_t	-2.54	-4.39**	-1.78	-4.49**	

Notes: ** and * denotes significant at 1 per cent and 5 per cent respectively.

The bottom section of Table 1 contains Augmented Dickey Fuller and Philips-Perron unit root test reports on variables in the model. The results show that all variables are non-stationary in the level data but stationary in first-differenced data.

Table 2: Johansen Cointegration tests

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
LnNOCPI, LnIPD, LnRER, LnRIR, LnOIL				
0.682673	94.76395	87.31	96.58	None *
0.581593	62.62491	62.99	70.05	At most 1
0.496027	38.22851	42.44	48.45	At most 2
0.363288	19.04197	25.32	30.45	At most 3
0.204379	6.401702	12.25	16.26	At most 4
"Equilibrium relation: LnNOCPI = -0.35 +1.15LnIPD -0.33LnRER -0.06LnRIR + 0.21LnOIL				

*(**) denotes rejection of the hypothesis at 5 %(1%) significance level

L.R. test indicates 1 cointegrating equation(s) at 5% significance level

Table 2 contains results of Johansen's cointegration test result which clearly rejects the null hypothesis of no cointegration against the alternative of one cointegration vector at 1 percent significance level. Thus, we can confirm the existence of only one statistically long-run economic relationship between non-fuel primary commodity prices, macroeconomic variables of OECD countries and oil prices. The coefficients for industrial production, real exchange rate of the dollar and oil prices are statistically significant in the equilibrium equation. This result shows that a recession in major OECD countries and an appreciation in the real exchange of the dollar would translate into a decrease in non-fuel commodity prices (see Hua, 1998). The result further show that non-fuel commodity prices and oil prices move directly in tandem.

Table 3 contains the reduced-form error correction model (ECM hereafter) of non-fuel commodity price index that was obtained from the cointegration analysis. The tests and diagnostic statistics reveal a highly robust that explaind approximately 90 percent of the adjusted variances in the explanatory variables. Further tests show that our model is devoid of autocorrelation, conditional heteroskedascity and significant non-normality in its overall specification. Therefore, we can conclude that the error process in the ECM is independent and homoskedastically normal. A further test involving the Ramsey RESET method confirms that the functional form of the model was correctly specified. Therefore, we can conclude that the analysis reached a satisfactorily good model of the relationship between non-fuel primary commodity prices and macroeconomic/ monetary variables. We shall now proceed to examine individual coefficients in the reduced-form error ECM in turn.

The first noticeable feature of the dynamic equation of non-fuel commodity price model is that the once-lagged error correction term (ECT hereafter) is statistically significant. The ECT in this model, carrying the usual negative sign, indicates a feedback in excess of 90 per cent of the previous year's disequilibrium from long-run macroeconomic/monetary variables. This result implies that changes in macroeconomic/monetary variables of OECD countries had a significant effect on non-fuel primary commodity prices; and that over 90 percent of the discrepancy between actual and the long-run (or equilibrium) value of the non-fuel commodity prices is eliminated or corrected each year. The highly significant coefficient of the lagged ECT indeed supports the conclusion that commodity prices are cointegtated with macroeconomic/monetary variables of industrialized countries.

Table 3: Error correction model for aggregate non-oil commodity prices

Explanatory variables	**Coefficient**	**t-value**	**Diagnostic statistics**	
Constant	0.010	0.32	$R^2 = 0.89$	DW = 1.65
$\Delta \ln Y_{t-1}$	0.469	3.20	F = 18.67**	
$\Delta \ln IPDC_t$	2.709	7.63	Tests	F-value
$\Delta \ln IPD_{t-1}$	-0.543	-1.24	AR 1-2	0.98628 [0.3945]
$\Delta \ln RER_t$	-0.491	-4.72	ARCH(1)	0.26073 [0.6166]
$\Delta \ln RIR_t$	-0.029	-0.45	Normality $\chi^2(2)$	1.7874 [0.4091]
$\Delta \ln OIL_t$	0.112	2.79	RESET	1.0619 [0.3172]
Trend	-0.001	-0.906		
ECT_{t-1}	-0.934	-5.23		

Notes: AR1-2 is the first- to second-order Lagrange multiplier test for serial correlation. ARCH (1) is test for first-order autoregressive conditional heteroskedasticity. RESET is the Ramsey's first-order test for functional form misspecification. ECT_{-1} denotes the once-lagged error correction term

The second variable that we proceeded to examine is the direction of response of changes in the growth rate of commodity prices to changes in the growth rate of industrial production of OECD countries. This variable entered the ECM in Table 3 in un-lagged and once-lagged forms. The t-value shows that the un-lagged form is highly significant, but the coefficient of the one-period lagged form is statistically insignificant. This result confirms, inter alia, that a recession in industrial production in developed countries can lead to a decrease in primary commodity prices. The lagged form of this variable indicates a fairly sluggish response of non-fuel commodity prices to changes in economic variables in developed countries.

The third is changes in the growth rate of real exchange rate of the U.S. dollar on the growth rate of non-fuel primary commodities. The negative sign of the coefficient of this confirms a priori view that an appreciation of the U.S. dollar would lead to a decrease in foreign demand for primary commodities which will, in the short-run, lead to a decrease in the price of primary commodities (see Dornbusch, 1985). The magnitude of the coefficient of this variable suggests that a 10 percent change in the real exchange rate of the dollar would result to an immediate short-run impact of about 5 percent on non-fuel commodity prices. In effect, an appreciation of the U.S. dollar would have an adverse effect on the terms of trade of commodity dependent countries which will subsequently increase their debt burden.

The fourth explanatory variable, changes in the growth rate of real international interest rate, has a positive coefficient and a magnitude that suggests that a 10 per cent change in real international interest rates would in the short-run lead to approximately 0.3 per cent change in non-fuel commodity prices. It should be noted that the coefficient of the exchange rate term is statistically insignificant.

The coefficient of the fifth explanatory variable, oil price, is positive and significantly related to non-fuel commodity prices. The result shows that a 10 percent increase oil prices lead to approximately 1 percent increase in non-oil commodity prices.

Finally, we examine the time trend explanatory variable. The coefficient of this variable is negative and statistically insignificant. This may indicate a weak impact of technological innovations and other changes on the non-fuel commodity sector over the years.

CONCLUDING REMARKS

In this paper we have used the cointegration and error correction modelling technique to evaluate the relationships between non fuel primary commodity prices and world macroeconomic and monetary variables. We proceeded to specify the ECMs that captured the equilibrium and disequilibrium effects of shocks to macroeconomic and monetary of OECD countries on commodity prices.

We found that fluctuations in business cycles and macroeconomic and monetary variables of highly industrialized OECD countries and oil prices have significant impact on non-fuel primary commodity prices in both the short- and long-run. These findings imply that shocks visited upon the business cycles of industrialized nations as a result of, or because of, macroeconomic and monetary policy changes can be transmitted to the economies of commodity-dependent LDCs via commodity prices.

We approach the concept in such a way that the study benefited from the advantages between using a simple equilibrium market model, that provided some answers to the questions posed, as well as a relatively sophisticated disequilibrium models, which are in practice limited in applicability but suitable for a single commodity framework. Therefore, the empirical results in this paper yielded results that are quite robust to justify the effort made.

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