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Recent Inflationary Trends in World Commodities Markets

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African Department

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Abstract

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Expansionary monetary policies in key industrial countries and sharply depreciating U.S. dollar exchange rate sent commodities prices soaring at unprecedented rates during 2003–2007. Food prices rose to alarming levels threatening malnutrition and food riots. In contrast, consumer price indices, a leading indicator for monetary policy, were showing almost no inflation and posed a price puzzle insofar their evolution was not responsive to record low interest rates, double digit commodities inflation, and sharp exchange rate depreciation. Commodities prices were shown to be driven by one common trend, identified as a monetary shock. Policy makers may have to face a policy dilemma: maintain monetary policy stance with accelerating commodities price inflation, subsequent world recession, and financial disorder; or tighten monetary policy with subsequent world recession followed by recovery and financial and price stability.

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I. INTRODUCTION

World economy featured recently robust real economic growth, averaging about 4.5-5.5 percent per year during 2003–07. However, inflationary pressures re-emerged. Commodities markets experienced highest inflation rates in post-war period with all commodities price index increasing at 23 percent per year during 2003–07.² Crude oil prices hit US\$119/barrel in April 2008 and might accelerate to dramatic levels. Parallel to commodities markets, real estate markets experienced phenomenal speculative price increases. In the same vein, the exchange rate of the U.S. dollar has depreciated considerably during 2002–08, plummeting to US\$1.6 per Euro in April 2008, and might fall further. Financial markets face high uncertainty stemming from rising inflationary expectations, credit risks, and depreciating currencies. Moreover, many vulnerable countries were recently shaken by food riots and may face alarming food crisis arising from exorbitant food prices.

The strong economic growth and accompanying inflationary trends were brought about by overly expansionary monetary policies in leading industrial countries, particularly during 2002–04, with central banks forcing interest rates to record low, and in some instances, nearing the zero bound. Credit to economy has expanded at fast pace in many countries, including major industrial countries, at the expense of creditworthiness and credit quality, contributing to rapid increase in aggregate demand for real assets, goods and services. Credit expansion contributed to high speculation in many assets and commodities markets. While there is no bound to expanding demand for goods and services through credit expansion and unlimited money creation, supply of these goods is, however, constrained by fixed factors, such as cultivable land or existing plants, climatic conditions, availability of oil and other raw materials, entrepreneurship, and may not follow the expansion of demand; excess demand results in high pressure on prices.

Most striking, consumer price indices (CPIs) in many industrial countries, a leading indicator for the conduct of monetary policy, were not sensitive to high increases in commodities or housing prices. In spite of fast rise in housing, energy, and food prices, CPIs continued to show small increase, by about 2–3 percent in industrial countries during 2003–07, indicating puzzling price stability and almost no inflation. Such was not the case during the seventies, when CPIs were highly sensitive to oil shocks and rapid increase in energy prices. Insensitivity of CPIs to commodities prices and to low nominal interest rates may lead policymakers to downplay the risk of inflation while there is ongoing abnormally high asset and commodities price inflation.

² Commodities prices are futures markets' quotations; recognizing that futures markets are also speculative markets, it is assumed here that speculation alone cannot be responsible for persistent trends in commodities prices; only market fundamentals can support such trends. Speculation can only play a short-term role.

With monetary policy remaining accommodative and real interest rates being eroded by inflation, commodities price inflationary trends might not subside. Acceleration of inflation rates will certainly slowdown economic growth, and will aggravate financial instability by eroding rapidly real value of financial assets, and deteriorating the quality of loans. The financial crisis in the subprime market could be easily traced to lax monetary policy and could have serious financial and economic implications. Similar financial crisis can be easily predicted in future as a consequence of overly expansionary monetary policy. Accelerating inflation may disrupt commodities supplies, and, as seen recently, may cause widespread food riots.

To bring inflationary trends under control, central banks will have to strictly reduce money supply as strongly prescribed by Friedman and proponents of the quantity theory of money.³ Such policy will imply significant temporary increase in interest rates and will necessarily cause recession and major debt crisis, owing to monumental outstanding loans accumulated during monetary expansion and low creditworthiness, as reflected recently by the subprime market; its merit, however, would be to extricate inflationary dynamics. Monetary authorities will face political conflicts stemming from debtors' pressure to keep inflating the economy in order to increase their wealth and lower their debt burden, and public pressure to rein inflation, considered as public enemy number one, and avoid its severe economic and financial dislocation.⁴ Commodities prices, along other asset prices, such as exchange rates, are instantly and accurately observed. Their evolution, along other indicators, should be fully taken into account for sound policy making and stable world economy growth. Neglecting information from commodities prices may lead to maintaining unsustainable monetary policies.⁵

This paper is organized as follows. Section II reviews the stance of monetary policy and shows that this policy was overly expansionary during 2000–07. Section III describes the consequences of this policy on commodities markets. Section IV shows that CPIs became less responsive to commodities price indices during 2000–07; moreover, their evolution was not in conformity with the purchasing power parity hypothesis. The time-series properties of commodities price indices were studied in Section V, where it was established that these indices were pulled by a common powerful monetary trend.

³ Friedman (1959, 1969 and 1972) prescribed fixed monetary rule setting a percent growth for money supply in the range of 2–5 percent per year. Alongside with proponents of the quantity theory of money, he criticized the interest rate rule, and strongly argued that inflation, defined as a rising price level, can be controlled only by reducing monetary aggregates. Friedman's prescription agrees fully with early IMF financial programming which consisted of strictly controlling monetary and credit aggregates in order to restore internal and external equilibrium.

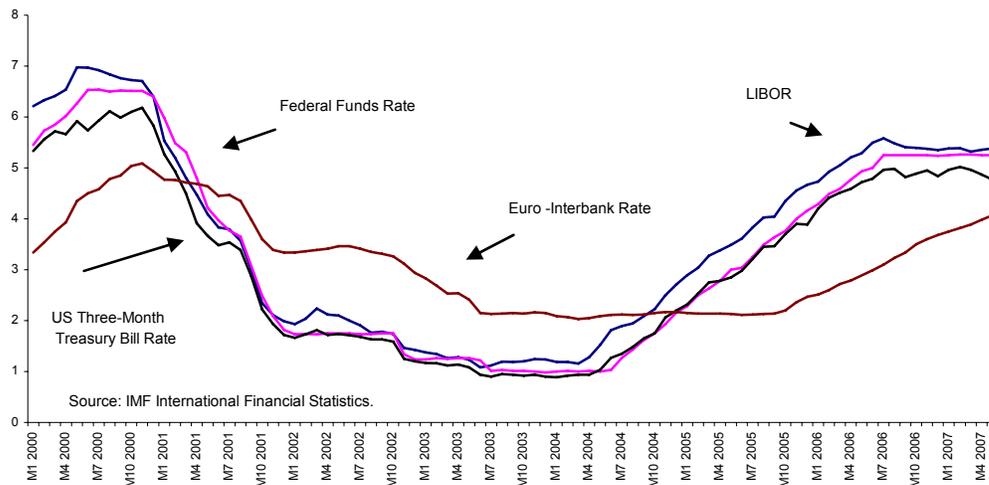
⁴ See Thomas M. Humphrey (1982) "Essays on Inflation", Third Edition, for an excellent treatment of the causes and effects of inflation. According to fiscal theory of the price level (Christiano and Fitzgerald, 2000), inflation is a powerful mean for reducing real debt.

⁵ Classical economists during the nineteenth century measured inflation using readily observable prices such as exchange rates, price of gold and other commodities as price indices were either not available or compiled with delay.

Applying a vector autoregressive (VAR) model, Section VI estimated the effects of monetary policy on commodities prices through variance decomposition, and showed that interest and exchange rates explained large components of commodities price variance. Section VII discusses a forecast of commodities price indices under alternative scenarios for monetary policy and section VIII concludes.

II. MONETARY POLICY IN 2000–07

Figure 1. Key Interest Rates, 2000M1–2007M7

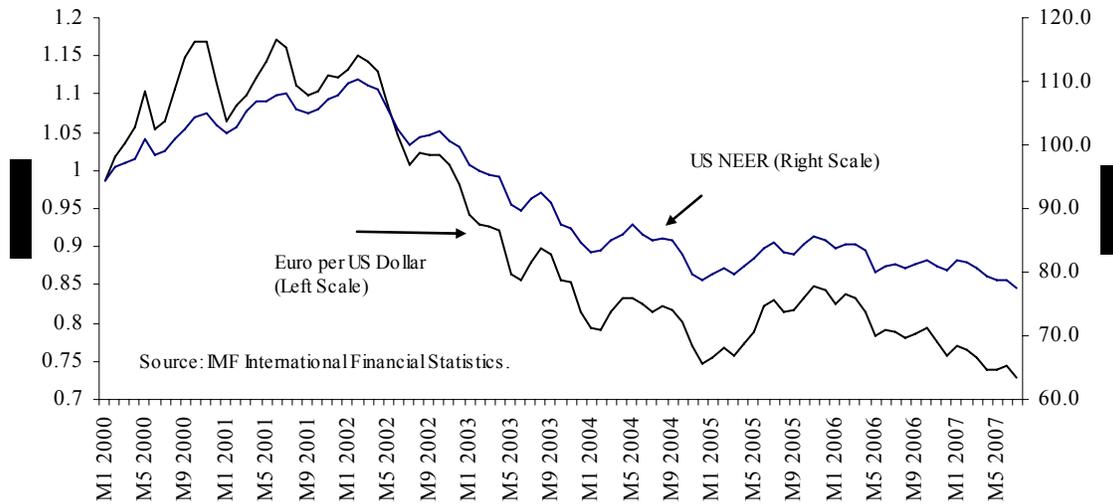


In contrast to oil shocks in the seventies, which were qualified as supply shocks and occurred in financially stable environment, recent oil shocks and fast increase in commodities prices had been fuelled by excessively expansionary policies at the level of major reserve currencies during 2001–07, and could be seen as demand shocks. More specifically, nominal interest rates fell to record low for the post-war period as depicted in Figure 1.⁶ The federal funds rate fell steadily and remained in the range of 1–1.2 percent during 2002M12–2004M7, forcing other world key interest rates to follow the same pattern. Henceforth, LIBOR, six-month U.S. dollar rate, fell drastically and remained within a band of 1.08–1.52 percent during 2002M11–2004M5. The three-month Euro inter-bank rate fell to 2.03 percent in 2004M3 and was kept within a band of 2.03–2.2 percent during 2003M6–2005M10. The three-month U.S. treasury bill rate fell to 0.90–1.27 percent during 2002M11–2004M6. In the same vein, long-term interest rates fell drastically; more specifically, the yield on thirty-year U.S. government bond fell to 4.36 percent in 2003M5. In some key industrial countries, money market rates were near zero bound during 1999–2006.

⁶ The source of data on interest rates, commodity prices, and exchange rates is the IMF International Financial Statistics.

To force interest rates down, central banks strive to inject as much liquidity in the economy as required for achieving lower market interest rate targets, essentially through

Figure 2. Exchange Rates: Euro per U.S. dollar and U.S. NEER, 2000M1–2007M7



open market operations or extended credits to financial institutions.⁷ Banks attempt to increase their credits and reduce their excess reserves by loaning to higher risk and unqualified customers in subprime debt market as demand for credit from prime market cannot absorb all excess liquidity. In such operating mode of interest rate targeting, central banks ignore the quality and nature of loans as well as risk factors in order to achieve lower interest rates.⁸ Most of excess liquidity is loaned up to readily available demand such as housing, consumer durables, and short-term credits. It is also loaned to support speculative activities in assets and commodities markets. It can be extended to foreign borrowers. It rarely finances long-term investment in plants or infrastructure as this type of investment follows a project cycle and is financed through long-term capital from equity, or long-term borrowing. Besides creating unsustainable credit expansion, abnormally low interest rates may cause serious misallocation of resources. They

⁷ In adopting an expansionary stance, central banks may be motivated by the Phillips curve tradeoff which consists of attaining higher output and employment at the cost of higher inflation.

⁸ Interest rate rule was sharply criticized by Thornton (1802), Wicksell (1898), and Friedman (1972). It distorts the interest rates structure and leads to overexpansion of credit and money supply. Under gold standard, central banks were not able to implement this rule because of the risk of losing their gold reserves. Under fiat money, central banks could print costless money in order to peg interest rates at some low levels. If central bank reverts to controlling monetary aggregates, interest rates will suddenly explode to correct for past distortions.

encouraging consumer loans, that have no capital backing and face high default risks, and reduces marginal efficiency of capital by selecting low return investment projects.⁹ The rapidly falling interest rates spread to most of world economies, including major industrial or developing economies, causing fast expansion of credit with attendant pressure on demand for real assets, mainly housing, and goods and services.¹⁰ As implication of monetary expansion, the U.S. dollar exchange rate depreciated significantly in relation to the Euro, by about 63 percent, from US\$0.84 per Euro in 2001M6 to US\$1.37 per Euro in 2007M7(Figure 2); the U.S. dollar nominal effective exchange rate (NEER) depreciated by about 29 percent during 2002M2–2007M7. Such sizeable currency depreciation has contributed to increasing pressure on crude oil and other commodities prices, as these prices are quoted in U.S. dollar and most countries are oil importers.¹¹

With inflation trends accelerating in commodities markets, causing real interest rates to fall, monetary policy could be seen as loosening. Moreover, with recent decline in August 2007–March 2008 in the U.S. discount rate and federal funds rate and injection of large amounts of liquidity to banks with nonperforming portfolio to re-inflate the economy and to reverse steep falls in stocks and housing prices, monetary stance has become highly accommodative and has loosened further. Such loosening will contribute to further pressure on commodities prices and could bring more instability in financial markets, and may cause energy and food crisis.

The combination of low interest rates and double digit commodities inflation could seriously weaken financial institutions by eroding real value of their assets; it will dissipate the value of international reserves and may reduce the volume of international

⁹ Marginal efficiency of capital, or equivalently, internal rate of return, was introduced by J.M. Keynes in *The General Theory of Employment, Interest, and Money*, 1936, page 135. It was defined as the discount rate which sets present value of prospective returns over the life of an investment equal to the cost of the investment.

¹⁰ The transmission of monetary policy is best described by standard IS-LM model. See M. Bailey (1971) for a thorough presentation of this model. Modern version of IS-LM, known as AS-IS-LM, which includes augmented Phillips curve and price expectations, can be found in many references (e.g., Walsh, 2001).

¹¹ Historically, a dollar appreciation (depreciation), due to dollar shortage, has depressed (ignited) commodities prices. Transmission of US dollar movements to commodities prices works through many channels. These include price and real cash balances (Pigou effect) effects for non dollar currencies, and credit channel whereby borrowing in US dollars becomes more (less) attractive in case of US dollar depreciation (appreciation), fueling thus higher (lower) demand and speculation in commodities markets. Moreover, as exchange rate is an asset price, its changes can be related to money supply. Lower (higher) US dollar could be attributed to rising (declining) US money supply or higher (lower) dollar velocity. A form of quantity theory (i.e., long-run proportionality) may therefore prevail between US money supply and commodities prices. If commodities prices were to be priced in gold, and given very slow increase in world gold stock, then commodities prices might turn out to be stable in terms of gold.

trade. It will destroy the value of money, financial savings, and cause a redistribution of wealth in favor of debtors.¹²

III. RECENT TRENDS IN COMMODITIES PRICES

Such powerful monetary stimulus had engineered a substantial increase in aggregate demand for goods and services and had set in vigorous growth for world real GDP, which was reported to have increased at about 4.5–5.5 percent per year during 2003-07.¹³ In contrast to previous economic growth cycles, the one underway was characterized by inflationary commodities prices, with most commodities prices featuring double digit inflation during 2003M5–2007M7 (Table 1 and Figure 3). The inflationary feature becomes clear when recent oil shocks are compared with previous ones. Considering the period 1973M1–1980M12, oil and natural gas prices increased at fast pace, 46.5 percent and 29.8 percent per year, respectively; however, commodities prices, except for gold, featured moderate inflation; the Commodity Research Bureau (CRB) price index moved at 5 percent per year, while food prices increased by 2.7 percent per year. There was therefore a distinct supply shock that hit specifically oil and natural gas markets during 1973M1–1980M12; consequently, the relative price of oil appreciated in relation to other commodities, which strongly encouraged energy substitution and conservation and made it easy to tax oil consumption with a view to contain oil demand.

Table 1. Commodities Price Indices, Annual Percent Change, 1973–2007

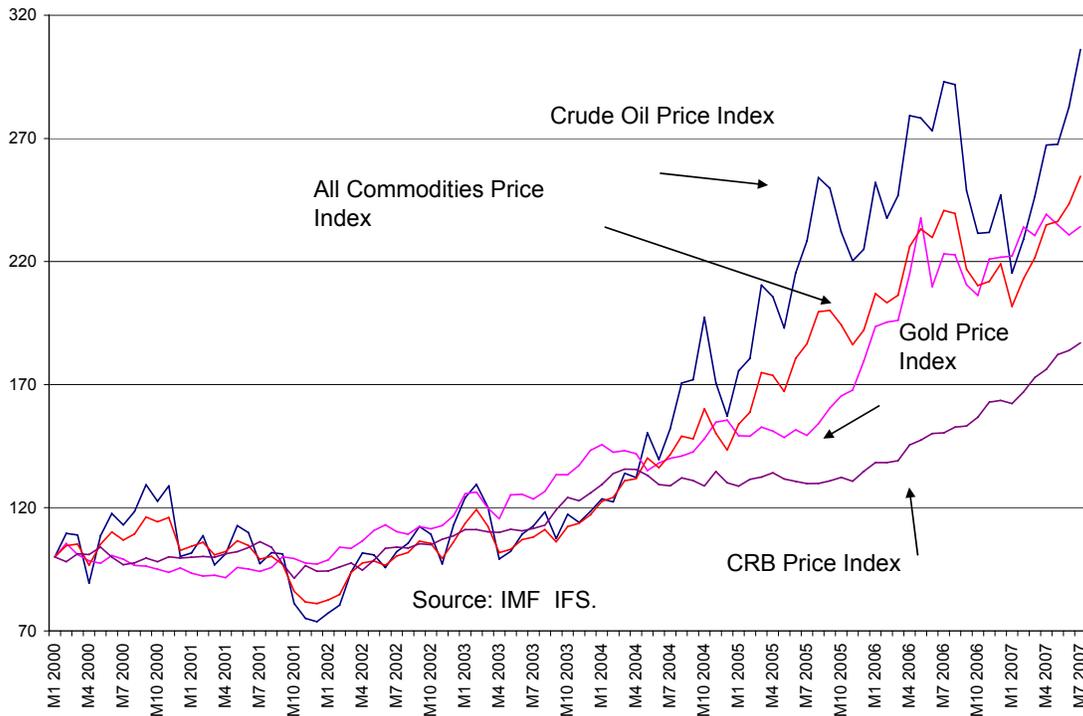
	1973M1 1980M12	1981M1 1999M12	2000M1 2003M4	2003M5 2007M7
Crude oil	46.5	2.0	5.5	30.3
Natural gas	29.8	5.1	41.5	16.7
All commodities	Na	2.5	2.8	23.0
Non fuel commodities	Na	-0.9	0.4	17.9
Gold	31.0	-2.4	4.9	17.7
Metals	6.1	0.6	-2.5	32.9
Agriculture raw materials	2.3	2.0	0.8	6.2
Food	2.7	-2.4	3.4	9.3
Rice	14.0	-1.5	-4.2	13.1
Wheat	11.2	-1.7	10.8	14.1
CRB commodity price index	5.0	-0.9	3.0	12.8

Source: IMF International Financial Statistics.

¹² The effects of inflation and its costs on the economy have been discussed extensively in literature (see Batten, 1981). Inflation, defined as too much money chasing fewer goods, was seen as a heavy tax and could lead to significant income and wealth redistribution at the expense of fixed income recipients and creditors, re-emergence of hedging activities, high distortions in relative prices, high transaction costs, and depreciation of money. The latter becomes like a hot potato and is passed around very quickly until it becomes nonacceptable in trade or as a store of value. Velocity increases and money demand falls. Inflation may also lead to social discontent and frequent labor strikes.

¹³ IMF World Economic Outlook, updated projections, July 2007, IMF website at <http://www.imf.org/external/pubs/ft/weo/2007/update/01/index.htm>.

Figure 3. Commodities Price Indices, 2000M1-2007M7



The periods 1981M1–1999M12 and 2000M1–2003M4 featured commodities price stability. However, with effect of expansionary monetary policy building momentum and demand expanding, commodities prices became almost uniformly under pressure during 2003M5–2007M7, with price increases accelerating to unprecedented double digit rates. Paralleling the increase in oil prices, estimated at 30.3 percent per year during 2003M5–2007M7, all commodities price index rose at 23 percent per year during the same period, with non fuel prices rising at 17.9 percent per year and gold price increasing at 17.7 percent per year. Food prices rose rapidly at 9.3 percent, with staple products such as rice, wheat, maize, and cooking oil exhibiting fast price increases.¹⁴ The CRB commodity price index rose at 12.8 percent per year.¹⁵

¹⁴ Food prices accelerated in early 2008, triggering food riots in many vulnerable countries.

¹⁵ Some widely held views attributed persistently higher commodities prices, including oil, to abnormally high commodities demand from developing countries, or major emerging Asian economies. While distinction of demand by country groupings is irrelevant for world markets, no developing or emerging economy has a reserve currency of its own; therefore, it cannot expand its demand for commodities beyond its international reserves or borrowing capacity. Hence, a developing country cannot buy oil or copper paying with its own currency. Such trade has to be paid in US dollar, Euro, or other reserve currencies. Moreover, elementary textbook demand theory makes a clear distinction between relative, nominal prices, and rate of change of prices. For a fixed nominal income and money stock, change in demand will affect relative prices only. Friedman (1969) showed for prices and exchange rate to sustain a constant or accelerating percent change, money supply has to increase (or decrease) at a rate exceeding (or below) real

(continued...)

Hence, when oil prices are compared with other prices, they appear to be consistent with underlying fundamentals for commodities markets which are characterized by high demand for products, lagging supply capacity, and fast increasing commodities prices. Most striking is the simultaneous rise in all commodities prices starting mid-2003, which points to a strong demand shock affecting all commodities markets. If real interest rates are measured against commodities price increase, then they are certainly largely negative and would contribute to further pressure on commodities prices, and to a significant loss in real value of loans and savings.¹⁶ Similarly, with US NEER depreciating against major currencies, the demand for commodities will be stimulated significantly. These trends are relevant for oil and non-oil commodities markets and indicate that commodities markets will be constantly under pressure unless the underlying fundamentals change. In conjunction with jittery equity markets, and crisis in the housing market, these indicators show a building up of inflationary pressures and growing financial uncertainties. With increasing instability in exchange rates, and loosening monetary conditions following erosion of real interest rates, pressure on oil and commodities markets may increase further in view of severe supply constraints in these markets.¹⁷

IV. RECENT TRENDS IN CONSUMER PRICE INDICES

Despite record low interest rates, sharp depreciation of the U.S. dollar, and simultaneous rise in prices of most commodities, the CPI measure of inflation fails to capture these commodities price increases in both the US and industrial countries during 2003M5-2007M7. Instead, CPIs showed remarkable price stability and almost no inflationary pressure, in sharp contrast with experience during the 1970s, when there was a strong relationship between commodities price increases and CPI inflation (Table 2). Besides this weak relationship between CPIs and commodities prices, CPIs evolution during 2003M5–2007M7 deviated persistently from the purchasing power parity hypothesis (Table 3, and Figure 4), in contradiction with the monetary approach to the balance of payments. The latter predicts that a sharp depreciation of exchange rate,

GDP growth. Inflation is defined as a positive and persistent rate of change in prices. Without accommodative money supply, prices and exchange rate cannot sustain persistent changes. More to the point, recent food riots in many developing countries illustrate clearly the inflationary aspect of food prices with food prices soaring to riot levels and food quantities becoming increasingly scarcer. This dispels the claim that developing countries were responsible for constantly higher energy prices or food prices, as constant increase (or decrease) in prices can only be a monetary phenomena, i.e., consequent to rising money supply and/or higher velocity. Similarly, depreciating currency can only stem from excessive money supply.

¹⁶ A loan of US\$120 made in 2002, would buy 6 barrels of crude oil at 2002 prices. If repaid in April 2008, this loan would buy one barrel of crude oil. The creditor would have lost 84 percent of his real capital. In view of low money interest rate during 2002–2008, crude oil rate of interest (Keynes, 1936, pp. 223) would be largely negative.

¹⁷ For instance, crude oil output cannot exceed in near future 80 million barrels a day (mbd) (approximately 30 mbd from OPEC and 50 mbd from non-OPEC). Some major non-OPEC producers may face prospects of falling oil output. Any oil demand expansion will only exacerbate already high prices.

holding money supply fixed, will enable to redress external disequilibrium, and induce an appreciation of currency and a return, through arbitrage, to long-term purchasing power parity. These two anomalies in CPIs during 2003M5–2007M7 create a price puzzle whose explanation will help in the design of sound macroeconomic policies. More specifically, CPIs may induce policy makers to be wrongly reassured about price stability, while commodities prices were exhibiting double-digit inflation.

A. Relationship between Commodities and Consumer Price Indices

In 1973M12–1980M12, oil prices increased by 46.5 percent per year, causing CPI in the US and the industrial countries to rise by 9 percent and 10.6 percent per year, respectively. World-wide, consumer prices rose by 14 percent per year. However, during 2003M5–2007M7, oil prices rose by 30.3 percent per year and all commodities prices rose by 23 percent per year, causing CPI to rise at 2.2 percent per year in industrial countries, and 3.5 percent per year world-wide. The relationship between consumer and commodities prices seemed to have weakened. In spite of fast increase in oil and non fuel commodity prices, CPIs remained insensitive, indicating price stability and absence of any inflationary pressure. Energy and food prices have increased dramatically at the retail level in many countries, far enough to trigger food riots in vulnerable countries, reflecting money expansion, exchange rates movements, and rise in commodities prices, yet this fast increase in prices did not translate in corresponding increase in CPIs.

Table 2. Consumer Price Indices, Annual Percent Change, 1973–2007

	1973M1 1980M12	1981M1 1999M12	2000M1 2003M4	2003M5 2007M7
Consumer price indices				
CPI US	9.0	3.4	2.6	2.9
CPI industrial countries	10.6	3.7	2.0	2.1
CPI Euro zone	Na	Na	2.2	2.1
CPI World	14.0	15.2	3.9	3.5
Memorandum items				
Crude oil price index	46.5	2.0	5.5	30.3
All commodities price index	Na	2.5	2.8	23.0
Food prices index	2.7	-2.4	3.4	9.3
CRB Commodity Price index	5.0	-0.9	3.0	12.8

Source: IMF International Financial Statistics.

Estimation of the relationship between CPIs and commodities price indices for 1973M1–1980M12 and 2003M5–2007M7 (Table 3) showed sharp drop in the elasticity parameter. The elasticity between oil price index and US CPI dropped from 0.28 to 0.11; although highly significant, this elasticity indicated much smaller effect of crude oil prices on CPI. The elasticity between the CRB commodity price index and US CPI fell drastically from 0.94 to 0.27; although remaining significant, this elasticity indicated smaller effect of commodity prices on CPI. The same findings hold with respect to elasticity between crude oil price index and industrial countries CPI. This elasticity fell from 0.32 to 0.08, indicating smaller effect of high oil prices on CPI. The elasticity between the CRB commodities price index and industrial countries CPI fell also from 1.08 to 0.08, showing smaller effect of commodities price inflation on CPI in industrial countries.

These regression results may imply a structural change in the relationship between commodities prices and CPIs, with high oil and commodities prices having a much smaller effect on CPIs. There are a number of possible explanations that can be suggested. First, commodities may account for a much smaller component in the consumer's goods bundle; consequently, an increase in their prices is weighted by a smaller coefficient and has therefore smaller effect on the CPI. Second, as oil and other

Table 3. Elasticities between Commodities and Consumer Price Indices

Sample period 1973M1–1980M12:	
$\text{Log(CPI_US)} = 0.28 \cdot \text{Log(Oil price index)} + 2.80;$	$R^2 = 0.83, \text{DW} = 0.22.$
(t=21.4)	(t=79.2)
$\text{Log(CPI_US)} = 0.94 \cdot \text{Log(CRB price index)} - 1.53;$	$R^2 = 0.69, \text{DW} = 0.10.$
(t=14.6)	(t=-4.4)
$\text{Log(CPI_Industrial)} = 0.32 \cdot \text{Log(Oil price index)} + 2.61;$	$R^2 = 0.81, \text{DW} = 0.18.$
(t=19.8)	(t=58.3)
$\text{Log(CPI_Industrial)} = 1.08 \cdot \text{Log(CRB price index)} - 2.38;$	$R^2 = 0.65, \text{DW} = 0.08.$
(t=13.3)	(t=-5.4)
Sample period 2003M5–2007M7:	
$\text{Log(CPI_US)} = 0.11 \cdot \text{Log(Oil price index)} + 4.29;$	$R^2 = 0.90, \text{DW} = 0.40.$
(t=20.6)	(t=203.1)
$\text{Log(CPI_US)} = 0.27 \cdot \text{Log(CRB price index)} + 3.19;$	$R^2 = 0.78, \text{DW} = 0.11.$
(t=13.3)	(t=27.4)
$\text{Log(CPI_Industrial)} = 0.08 \cdot \text{Log(Oil price index)} + 4.39;$	$R^2 = 0.89, \text{DW} = 0.37.$
(t=19.7)	(t=275.2)
$\text{Log(CPI_Industrial)} = 0.20 \cdot \text{Log(CRB price index)} + 3.58;$	$R^2 = 0.80, \text{DW} = 0.11.$
(t=14.1)	(t=44.9)

commodities may be inputs into the production process, productivity gains may reduce the effect of higher commodities prices. Third, productivity gains may also lower the prices of manufactured products and therefore offsetting the impact of higher commodities prices. Fourth, labor cost, particularly in labor surplus emerging exporters, has remained stable. Fifth, given low interest rates, interest costs may have declined offsetting thus higher energy and other raw materials costs. Sixth, monetary policy operates through a variable and long lag. It may take about five years for expansionary monetary policy to have full impact on prices (Friedman, 1969). This reconciliation is only speculative and lacks statistical backing. Further research on the relationship between commodities and CPIs seems to be warranted in order to explain this structural change.¹⁸

¹⁸ The use of the CPI as a measure of inflation has long been debated in the literature. Asset prices are considered to be an indicator of future inflation, and ought to be included in a price index measure for more accurate estimate of inflation and timely response of monetary policy (See Cecchetti, et al., 2000).

B. Real Exchange Rate and Purchasing Power Parity

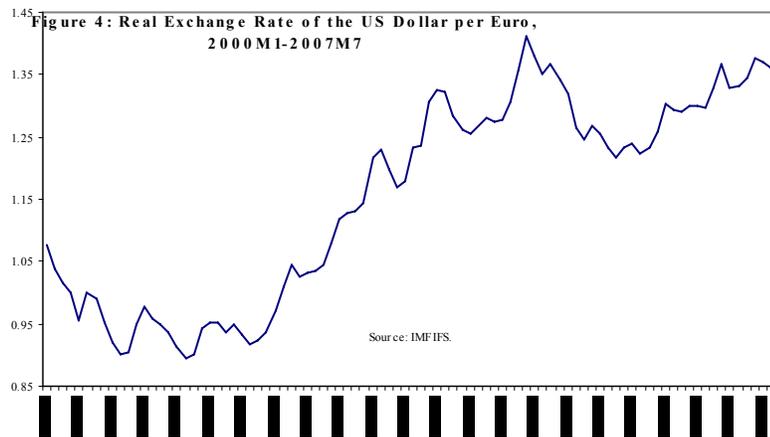
Besides weakening relationship between CPIs and commodities prices, CPIs evolution during 2000M1–2007M7 has been in sharp contrast with long-term purchasing power parity as illustrated by the real exchange rate between the U.S. dollar and the Euro (Figure 4). The latter is defined as the nominal exchange rate of the U.S. dollar per Euro adjusted by the ratio of the CPI in the Euro zone and in the US, namely:

$$Real_Exchange_Rate_US_EC = (US\$/EC).(CPI_EC/CPI_US) \quad (1)$$

Table 4. Unit Root Test for the Real Exchange Rate of the U.S. dollar per Euro, 2000M1–2007M7

Null Hypothesis: Real Exchange Rate has a unit root		
Exogenous: Constant		
Lag Length: 1 (Automatic based on SIC, MAXLAG=12)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-0.59723	0.8651
Test critical values:		
	1% level	-3.50388
	5% level	-2.89359
	10% level	-2.58393

*MacKinnon (1996) one-sided p-values.



The real exchange rate for 2000M1–2007M7 shows considerable deviation from the purchasing power parity hypothesis and a weakening of the arbitrage assumption. Unit root test indicates existence of a unit root in real exchange rate (Table4). This finding is in contrast with the prediction of trade and exchange rate theory. Namely, substantial depreciation of exchange rate, holding money supply constant, would lead to reduce imports and increase exports, assuming Marshall-Lerner elasticities condition to be valid. The adjustment of the external current account will generate a trade surplus and an appreciation of the currency. Furthermore, higher demand for exports and more expensive imports would increase prices in the depreciating country. Therefore, consequent appreciation of the exchange rate and higher prices in the depreciating

country would lead to re-establish the purchasing power parity in the long-run. This prediction of the theory seemed to fail. Instead, the exchange rate continued to depreciate without inducing the expected adjustment in prices and trade balance which would re-establish the purchasing power parity condition. Such failure may result from excessive money supply which keeps exchange rate under pressure and trade balance in deficit.

The weakening relationship between commodities prices and CPIs, in conjunction with the persistent deviation of the real exchange rate from the purchasing power parity assumption, points certainly to a price puzzle at the level of the CPIs which requires further research, as large decline in interest rates and fast increase in commodities prices ought to bring about similar increase in CPIs. Knowing that CPIs are key indicators used by central banks, inability of these indicators to capture rapid increases in prices in assets, commodities, and foreign exchange markets may mislead policy makers and impose high social and economic cost arising from failure to measure inflation and adopt policies to control inflationary pressures.

V. COMMON TREND IN COMMODITIES PRICE INDICES

Findings reported in Table 1 suggest that commodities price indices may be driven by common stochastic trends or common factors during 2000M1–2007M7.¹⁹ A brief presentation is provided here for the framework for estimating common trends, followed by an application to commodities prices.

A. Models for Extracting Common Trends

Let X_t be a $(n,1)$ time series vector, composed of n variables, integrated of order one $I(1)$. In order to decompose X_t into a permanent component, representing the common trends part, and a transitory component, a unrestricted vector autoregressive (UVAR) model is assumed for X_t namely:

$$X_t = \mu + A_1 X_{t-1} + \dots + A_p X_{t-p} + \varepsilon_t \quad (2)$$

where ε_t is a vector of random shocks assumed to be independently and identically distributed with $E(\varepsilon_t) = 0$ and $E(\varepsilon_t' \varepsilon_t) = \Sigma$, μ is a constant, and A_1, \dots, A_p are (n, n) coefficient matrices with p denoting the lag length. The UVAR can be reformulated in a vector error correction (VEC) form as:

$$\Delta X_t = \mu + \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_p \Delta X_{t-p} + \Pi(1) X_{t-1} + \varepsilon_t \quad (3)$$

where $\Gamma_p = -A_p$, $\Gamma_{p-1} = -(A_p + A_{p-1})$, ..., $\Gamma_1 = -(A_p + A_{p-1} + \dots + A_1)$, $\Pi(1)$ is a (n, n) matrix defined as $\Pi(1) = (A_1 + \dots + A_p - I)$. If the system X_t is co-integrated with

¹⁹ The common trends representation is a multivariate Beveridge-Nelson decomposition (1981). For univariate models, Beveridge and Nelson (1981) showed that any single integrated ARIMA process has an exactly identified trend plus a transitory component representation, in which the trend is a random walk and the transitory component is covariance stationary.

k unit roots and r stationary long-run co-integrating relationships, then $\Pi(1)$ is a reduced rank matrix and can be decomposed into two matrices $\alpha_{n \times r}$ and $\beta_{n \times r}$ as follows $\Pi(1) = \alpha\beta'$, where β denotes a matrix of co-integrating vectors and α is a matrix of adjustment coefficients. By Engle-Granger representation theorem (1987), the VEC admits a reduced form Wold vector moving-average representation (VMA) in terms of the shocks ε_t :

$$\Delta X_t = \mu_w + C(L)\varepsilon_t \quad (4)$$

where $C(L) = \sum_{i=0}^{\infty} C_i L^i$ is a (n, n) lag polynomial matrix, $C_0 = I_n$, $C(1)$ is a reduced-rank (n, n) matrix with rank $k < n$ satisfying $\mu_w = C(1)\mu$, $\beta' C(1) = 0$, and $C(1)\alpha = 0$. Let α_{\perp} and β_{\perp} with dimensions (n, k) denote the orthogonal complements of α and β defined as $\alpha'\alpha_{\perp} = 0$ and $\beta'\beta_{\perp} = 0$,²⁰ then $C(1)$ can be written as $C(1) = \beta_{\perp}(\alpha'_{\perp}\Gamma\beta_{\perp})^{-1}\alpha'_{\perp}$ where $\Gamma = (\Gamma_1 + \dots + \Gamma_{p-1} - I)$. Let $C(L) = C(1) + (1-L)C^*(L)$, $C_i^* = -\sum_{j=i+1}^{\infty} C_j$, the solution to the difference equation (4) can be written in levels as a function of ε_t :

$$X_t = X_0 + C(1)\mu_w t + C(1)\sum_{i=1}^t \varepsilon_i + C^*(L)\varepsilon_t = X_0 + C(1)\zeta_t + C^*(L)\varepsilon_t \quad (5)$$

Where ζ_t is a n -dimensional random walk with drift μ_w , given by $\zeta_t = \mu_w + \zeta_{t-1} + \varepsilon_t$. The permanent and transitory components of X_t are, respectively, $X_t^P = X_0 + C(1)\zeta_t$ which is made of a deterministic and stochastic trend, and $X_t^T = C^*(L)\varepsilon_t$. Noting that $C(1)$ has rank $k < n$ and is written as $C(1) = \beta_{\perp}(\alpha'_{\perp}\Gamma\beta_{\perp})^{-1}\alpha'_{\perp}$, the common trends driving X_t are defined by k combinations of the vector ζ_t , given by $\alpha'_{\perp}\zeta_t$.

Note that ε_t are reduced form errors and are combinations of structural shocks denoted by η_t , which can be identified with the help of a structural VAR, expressed as

$$B_0 X_t = \rho + B_1 X_{t-1} + \dots + B_p X_{t-p} + \eta_t \quad (6)$$

Where B_0, B_1, \dots, B_p are (n, n) coefficient matrices, η_t is an $(n, 1)$ vector of independent structural shocks with $E(\eta_t) = 0$, $E(\eta_t \eta_t') = I_n$, and $\eta_t = B_0 \varepsilon_t$. The MVA representation for structural VAR is given by:

²⁰ Consider the orthogonal projection of α denoted as $\alpha_{\perp}^P = I_{n \times n} - \alpha(\alpha'\alpha)^{-1}\alpha'$ satisfying $\alpha'\alpha_{\perp}^P = 0$, then α_{\perp} with dimension (n, k) can be obtained as any linear combination of the columns of α_{\perp}^P . Similarly for β_{\perp} .

$$\Delta X_t = \rho_w + R(L)\eta_t \quad (7)$$

In view of the cointegration relations, the structural shocks η_t are partitioned into φ_t , a $(k, 1)$ vector of permanent shocks, and ψ_t , a $(r, 1)$ vector of temporary shocks, i.e.

$\eta_t' = (\varphi_t', \psi_t')$. After expressing the MVA in terms of structural shocks, King et al. (1991) proposed the following common trends representation:

$$X_t = X_0 + R(1)\tau_t + R^\square(L)\eta_t = X_0 + A\tau_t + R^\square(L)\eta_t \quad (8)$$

where τ_t is a $(k, 1)$ vector of common stochastic trends, expressed as a random walk with drift given by $\tau_t = a + \tau_{t-1} + \varphi_t$; A is an (n, k) matrix called the loading matrix, or the long-run multiplier matrix given by $R(1) = (A_{n \times k}, 0_{n \times r})$, and $R^*(L) = C^*(L)B_0^{-1}$.²¹

Hence, common trends are defined as k combinations of either reduced form shocks ε_t or structural permanent shocks φ_t , where the combination matrix is α'_\perp or A , respectively. Both ε_t and η_t are unobserved variables. Consequently, Gonzalo and Granger (1995) preferred to construct common trends using observed statistical data X_t , instead of estimated shocks $\hat{\varepsilon}_t$ or $\hat{\eta}_t$. Noting the identity $\beta'_\perp (\alpha'_\perp \beta'_\perp)^{-1} \alpha'_\perp + \alpha (\beta' \alpha)^{-1} \beta' = I$, they expressed X_t as:

$$X_t = \omega_1 \alpha'_\perp X_t + \omega_2 \beta' X_t \quad (9)$$

where $\omega_1 = \beta'_\perp (\alpha'_\perp \beta'_\perp)^{-1}$ and $\omega_2 = \alpha (\beta' \alpha)^{-1}$. Their common trends are k linear combinations of X_t , given by $\alpha'_\perp X_t$; whereas their transitory components are given by the co-integrating relations $\beta' X_t$. By ignoring shocks, Gonzalo and Granger (1995)'s approach does not enable to simulate the impact of policy shocks on X_t , a major drawback which explains its limited use in VAR literature.

B. Estimating Common Trends in Commodities Price Indices

A vector of four commodities price indices is considered, comprising oil price index, gold price index, nonfuel commodities price index, and CRB price index. Unit root tests show that these price indices were integrated of order one, $I(1)$, during the sample

²¹ King et al. (1991) suggested that the matrix A be written as: $A = A_0 \pi$, where A_0

is a (n, k) matrix with parameters chosen so that $\beta' A_0 = 0$, and where the free parameters of A are lumped into the (k, k) matrix π given by: $\pi \pi' = (A'_0 A_0)^{-1} A'_0 C(1) \Sigma C(1)' A_0 (A'_0 A_0)^{-1}$. The matrix π can be determined from a Choleski decomposition of $\pi \pi'$. Given the estimate $\hat{\pi}$, A is fully identified as: $\hat{A} = \hat{A}_0 \hat{\pi}$.

2000M1–2007M7. Cointegration analyses were performed showing the existence of three cointegrating vectors and one common trend (Table 5).

The VMA model described by equation (5) was applied to estimate a common trend. Cointegration estimation based on Johansen method yielded the following vector

Table 5. Commodities Price Indices—Johansen Cointegration Test

Hypothesized Number of CE(s)	Eigenvalue	Trace test			Max-Eigenvalue test		
		Statistics	Critical Value	Prob.***	Statistic	Critical Value	Prob.**
None *	0.475	87.71	47.86	0.00	50.11	27.58	0.00
At most 1 *	0.24	37.61	29.79	0.0052	21.53	21.13	0.044
At most 2 *	0.18	16.08	15.49	0.0408	15.81	14.26	0.00283
At most 3	0.003	0.28	3.84	0.5999	0.27	3.84	0.5999

Trace test indicates 3 cointegrating equations at the 0.05 level; Max-eigenvalue test indicates 3 cointegrating equations at the 0.05 level.

* denotes rejection of the hypothesis at the 0.05 level.

** MacKinnon-Haug-Michelis (1999) p-values

$\alpha'_1 = (0.424135, 0.340266, -0.90279, 1.418373)$. A common trend was computed as $\alpha'_1 \zeta_t$, and displayed in Figure 5. Hence, a powerful common trend seemed to drive all four price indices, demonstrating that there was no separate shock hitting in isolation specific markets.²² The long-run multiplier matrix A in structural VMA (8) was estimated as: $A = (10.47, 6.40, 5.82, 3.07)$ ²³ Therefore, a unit positive permanent shock will increase, in the long run, the oil price by 10.47 units, gold price by 6.40 units, nonfuel commodities prices by 5.82 units, and CRB commodities price index by 3.07 units, respectively.

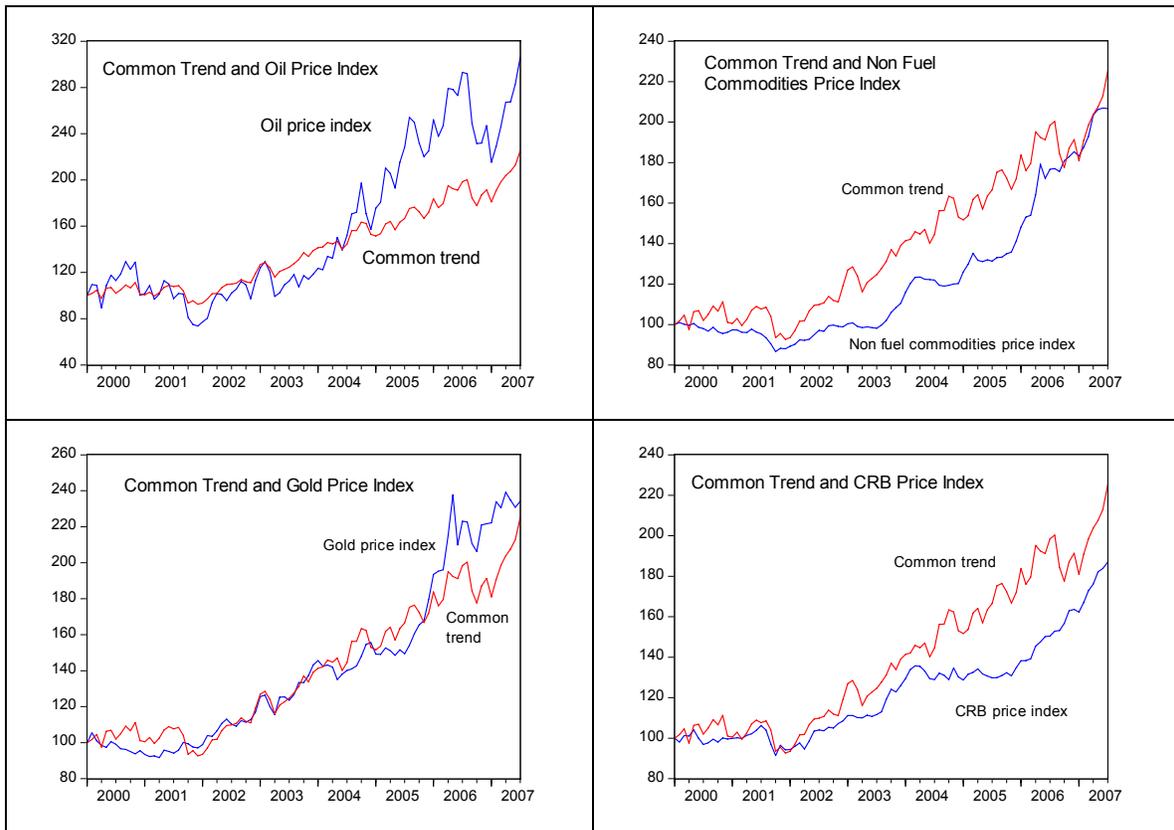
In view of stability of supply conditions in most commodities markets, the common trend driving commodity price indices during 2000M1–2007M7 can be attributed to lag effect of expansionary monetary policy and can be characterized as a demand shock. With real interest declining when measured in terms of commodities prices and with expansion of credit, and depreciating currencies, real aggregate demand for goods and services has been constantly pushed upward, creating tensions in commodities markets and pushing prices constantly upward. As mentioned above, world economic growth was boosted to

²² Co-integration analysis for the period 1970M1–1980M12, not reported here, showed the existence of at least two common trends driving commodities prices, which can be qualified as an oil supply shock spreading to commodities markets, and a nominal inflationary shock arising from accommodative monetary policy.

²³ Estimated using RATS code written by Henrik Hansen (See Warne, 1993).

about 4.5–5.5 percent per year, in real terms, in 2003–2007, creating higher demand for commodities. In view of short-term supply constraints, most of the market clearing was born by prices. Higher prices act to reduce real cash balances and to depress temporarily demand. Higher prices would also act to increase commodities supply. However, as monetary policy remained expansionary or accommodative, more credit expansion and

Figure 5. Common Trend in Commodities Price Indices, 2000M1–2007M7



higher money supply supported further demand expansion, which seemed to dominate the price and supply effects and to push constantly commodities prices upward.

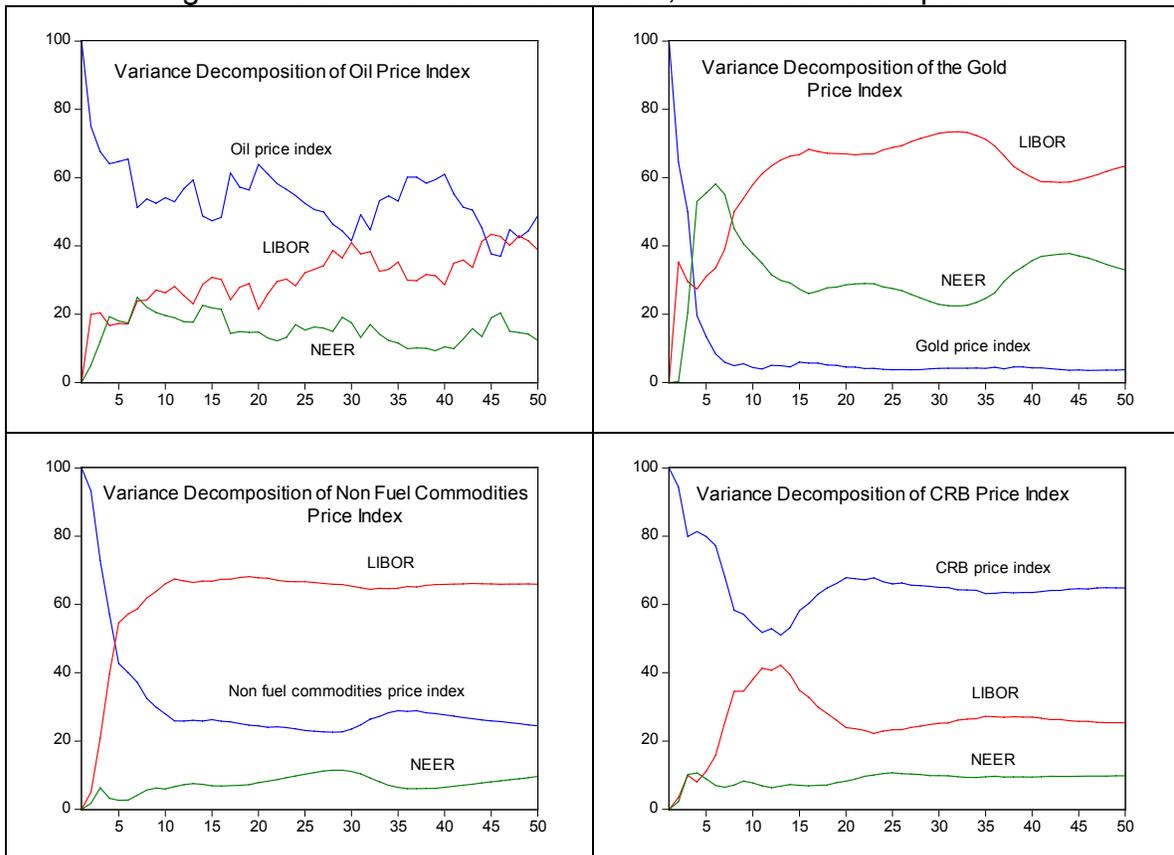
VI. ROLE OF MONETARY POLICY IN COMMODITIES MARKETS

In this section, the role of monetary policy in commodities markets was examined using a VAR approach. Four VARs were considered to study the impact of interest and exchange rates on commodity prices. VAR 1 comprised oil price index, LIBOR, and NEER; VAR 2 comprised gold price index, LIBOR, and NEER; VAR 3 comprised nonfuel commodities price index, LIBOR, and NEER; and VAR 4 comprised CRB price index, LIBOR, and NEER. In each VAR, the transmission channel from LIBOR and NEER to commodities prices was through changes in demand and supply for the respective commodity induced by changes in LIBOR and NEER; the market clearing commodity price would depend on the extent of excess demand and demand and supply price elasticities characterizing each commodity market. In each VAR, the effect of LIBOR

and NEER on each commodity price was analyzed in terms of variance decomposition (Figure 6).

In VAR 1, the optimal lag using Akaike information criterion was found to be 20 months. Variance decomposition shows that the effect of interest rates builds up quickly and could explain up to 20 percent of the oil price variance at a horizon of 3 months and

Figure 6. Commodities Price Indices, Variance Decomposition



about 41 percent at a horizon of 30 months. Similarly, the NEER effect builds up quickly and could explain up to 25 percent of the oil price variance at a horizon of 7 months, and remains an important component at later horizons, explaining about 10 to 20 percent of the oil price variance. In VAR 2, the optimal lag was chosen at 20 months. Variance decomposition shows a predominant role for interest and exchange rates in gold price movements. The impact of LIBOR on gold price builds up very quickly and could explain up to 35 percent of the gold price variation within a horizon of 2 months and up to 50 percent at a horizon of 8 months. LIBOR remains a determinant variable at later horizons explaining between 60 to 70 percent of the gold price variance. The exchange rate turns out to be a dominant factor in gold price change, with its effect building up rapidly to explain about 58 percent of the gold price variance at a horizon of 6 months. NEER remains an important component of the change in the gold price at later horizons accounting between 22 to 37 percent of this variance.

In VAR 3, the optimal lag was chosen at 20 months. Variance decomposition shows that LIBOR explains up to 70 percent of the variation of the nonfuel commodities price index and remains a main component in this price variation. NEER, however, explains a small portion of the nonfuel commodities price change, about 7 to 9 percent of this price change. In VAR 4, the optimal lag was chosen at 20 months. Variance decomposition shows that LIBOR can explain about 41 percent of the CRB price index variance at a horizon of 11 months, and remains an important component at later horizons, explaining about 22 to 27 percent of this variance. The NEER plays a small role in CRB price index variance, explaining only about 8 to 10 percent of this variance.

Variance decomposition shows that monetary policy was influential in commodities price movements and explains a large portion of these movements. LIBOR accounted for a large part of the variance of the four commodity price indices. The exchange rate had an influential role in gold price variance; its role remained important in oil price changes; however, its effect became small in the case of nonfuel commodity and CRB price indices.

VII. FORECASTING COMMODITIES PRICE TRENDS

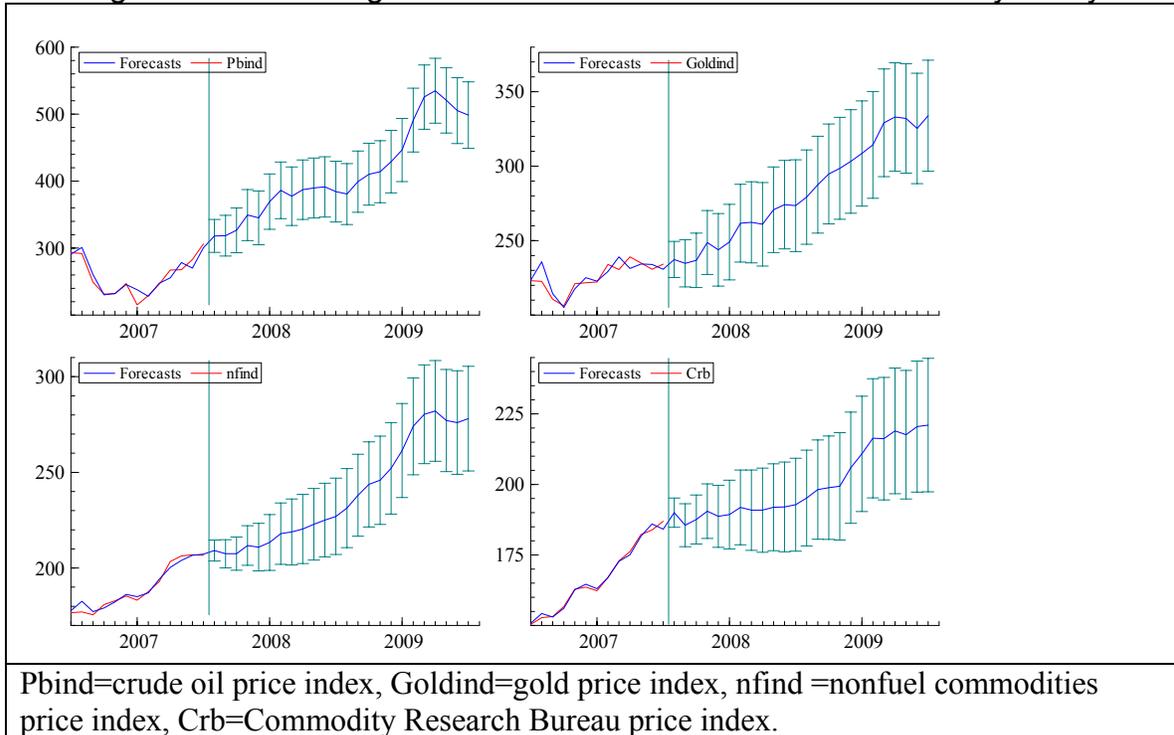
Based on observed recent commodities prices, this section discusses hypothetical scenarios for commodities price indices under alternative monetary policy stances: a baseline scenario where present monetary stance is maintained and an alternative scenario which assumes monetary tightening.

If loose monetary policy continues its unwinding trend, key interest rates will continue to fall, in real terms, thus boosting aggregate demand for commodities further. Economic activity will depend heavily on credit expansion, as becoming debtor will increase one's wealth, and will become sensitive to any small credit squeeze. The sale of assets, such as housing, will depend, not on savings, but on loans. Money demand will be reduced significantly to avoid inflation cost and velocity could increase. Under this scenario, inflationary pressures are bound to increase as illustrated by Figure 7, which is obtained from a forecast based on persistence of common trend analyzed in Section V. Exchange rate instability caused by expansionary monetary policy will erode real value of international reserves, and may weaken international trade. Commodities supplies could become regressive, as producers start to fear fast depreciation of their earnings and realize that they can increase considerably revenues by curtailing supplies. World economy may enter an inflationary-recessionary cycle, with real output growth decelerating and commodities prices continue to spiraling. This outcome can be illustrated by the cuts in the federal funds rate in August 2007—March 2008; Consequently, commodities prices and exchange rates were seriously exacerbated; oil prices jumped by 77 percent to cross US\$119/barrel in April 2008, gold prices bounced by 46 percent to US\$980 in February 2008 per Troy oz., and the U.S. dollar fell to US\$1.60/euro.

An alternative scenario would be tightening monetary policy and jerking up interest rates to rein in inflation. If this scenario materializes, the world economy would witness a cooling off in commodities prices. Such scenario would require major central banks to

change operating procedures by strictly controlling monetary aggregates instead of controlling money market interest rates. If central banks decide to rein vigorously money supply in order to halt inflation, as was the case during 1979–82, then nominal interest rates will jump to high levels. As real aggregate demand decelerates under the influence of higher real interest rates, a recessionary cycle will take place. In turn, demand for commodities will be checked and brought in line with supply. Individual commodities prices will adjust downward according to demand price and income elasticities as well as supply elasticities characterizing each market. Under this scenario, inflationary pressure may be subdued.

Figure 7. Forecasting Commodities Prices Under Loose Monetary Policy



This scenario is best illustrated by looking at Figure 8, particularly at the period 1979–82 when major central banks decided to control monetary aggregates and renounced to control interest rates. Such a decisive tightening of monetary policy brought interest rates

Figure 8. Federal Funds Rate, LIBOR, and NEER, 1970–2007

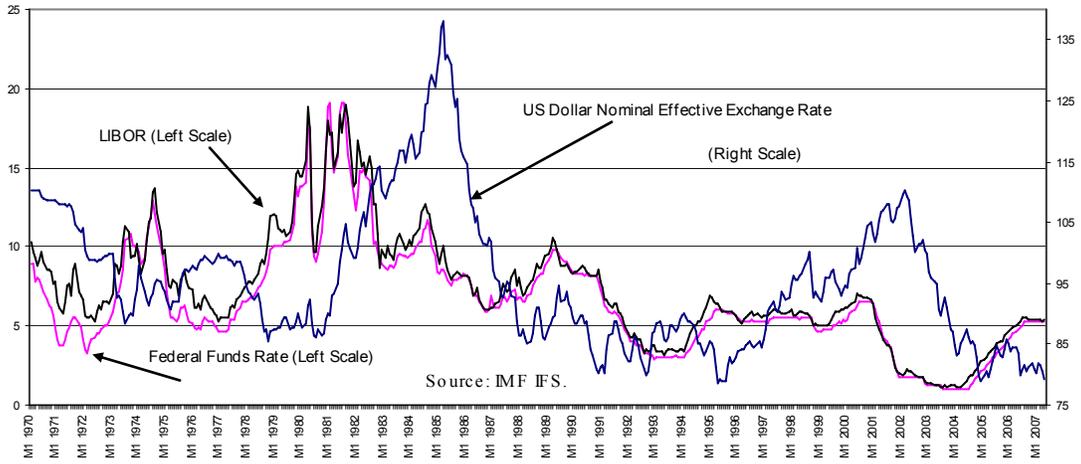
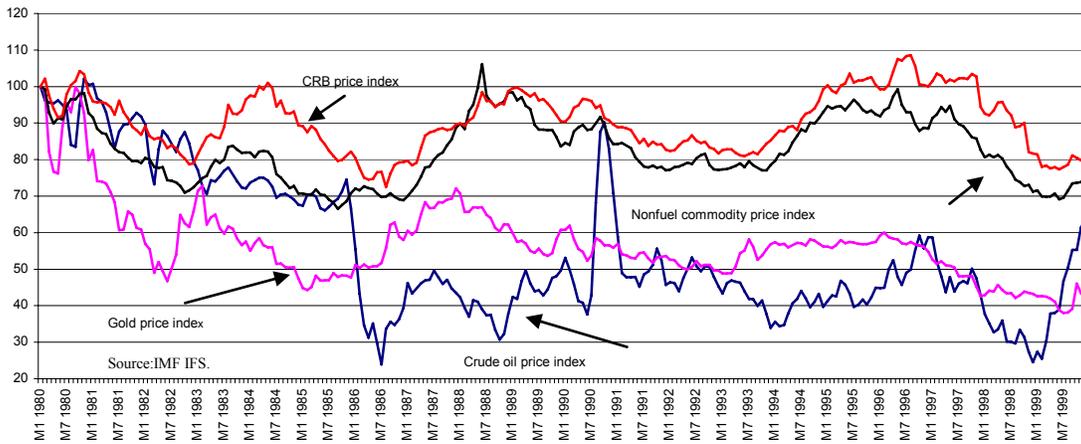


Figure 9. Actual Commodities Price Indices under Tight Monetary Policy, 1980–99



to high levels, with federal funds rate and LIBOR reaching 19 percent and 18 percent in 1981M7, respectively. U.S. dollar exchange rate appreciated considerably, with U.S. NEER reaching historical peak of 138 in 1985M3. Following this strong tightening, inflation rates came down quickly to an average of 3.5–4 percent a year during 1981–99 in both the US and industrial countries.

Implications of a tight monetary scenario for commodities can be examined by considering actual data for 1980M1–1999M12 (Figure 9). Under such scenario, oil prices were forced to trend down persistently and lost about 50 to 60 percent of their appreciation during 1982–85. Similarly, gold prices were most sensitive to monetary policy tightening and fell steeply by about 50 percent during 1981–82. Nonfuel commodities prices trended downward persistently and fell by about 30 percent during

1981–83. The CRB price index also trended down progressively and fell by about 20 percent during 1981–83. The pace and extent of commodities prices decline will depend on the degree of monetary policy tightness.

As indicated by Table 1 and Figure 9, tight monetary policy was effective in reducing commodities inflation and preserving durable price stability during 1981M1–1999M12. More specifically, Figure 9 illustrates that commodities prices could be stabilized by tight monetary policy, with demand brought in line with supply of these commodities. Figure 9 indicates only expected trends under a tight monetary policy scenario and cannot be applied systematically to forecast commodities prices under a tight money scenario as the nature of shocks were different and the number of common trends was also different from those in the seventies. More important, the degree of erosion in real interest rates could be substantial during 2003–07 compared with real interest rates in late seventies when commodities inflation was moderate. During the seventies, the dominant shock was an oil supply shock; whereas during 2003–07, the dominant shock was a monetary shock. The degree of adjustment in prices will depend on the ability of monetary policy to turn real interest rates positive.

A scenario of tight monetary policy could be simulated with equation (8) by assigning negative values to permanent shock over a forecast period. Such scenario indicates only the direction of adjustment. The degree of monetary tightness will be determined gradually until commodities prices start responding persistently to new economic fundamentals, as illustrated by the 1980–82 monetary policy episode when the federal funds rate and LIBOR kept increasing until downward persistence in commodities prices became noticeable and price stability was achieved. Based on long-run multiplier matrix, $A=(10.47, 6.40, 5.82, 3.07)$, a negative impulse of one unit would bring down oil prices over the long-run by 10.47 units, gold prices by 6.40 units, nonfuel commodities prices by 5.82 units, and CRB commodities price index by 3.07 units, respectively. A bigger negative shock would bring down commodities prices by a multiple of the long-run coefficients.

The conduct of tight monetary policy will be opposed by debtors and investors as the economy has become heavily dependent on borrowing and money creation. Any small credit squeeze, under these conditions of heavy dependence on credit expansion and inflation, will stifle speculative activities, increase debt burden, and reduce sharply demand for assets, such as housing, and durable goods. The conduct of tight money policy would require central banks to be independent vis-à-vis any kind of pressure and aim at safeguarding the safety and stability of the financial system and the value of money as a medium of exchange and store of value. Such was the legitimate mandate of any central bank. If a central bank extends its role, then it may face conflicting objectives and create many distortions in the economy.

VIII. CONCLUSIONS

Recent trends in commodities prices were certainly worrisome. Energy and food prices rose far enough to trigger food riots in several vulnerable countries. By sustaining an increase at 23 percent per year during 2003M5–2007M7, commodities prices became

inflationary and caused prices to increase rapidly in most countries. Accelerating commodities inflation may heighten uncertainties, encourages speculation, could disrupt commodities supplies, destabilize many sectors (e.g., transport sector), and may lead to rationing, with serious social and economic implications. This paper argued that the simultaneous increase in all prices during 2003M5–2007M7 was the delayed effect of an overly expansionary monetary policy which led to a fast expansion of all types of credits, irrespective of creditworthiness, and to a worldwide strong expansion of demand for real assets, goods, and services. In view of supply constraints, commodities prices moved rapidly in response to large excess demand. In particular, there was no specific shock confined to a single commodity market, such as an oil shock; instead, all commodities markets were under the same shock, which was identified as a common monetary shock.

The paper argued that monetary conditions kept loosening, mainly as real interest rates were eroded by inflation, and inflationary expectations became self-fulfilling. Maintaining present monetary stance would cause further inflammation of commodities prices, could disrupt supplies, and could cause significant world recession and disorderly financial markets. In order to rein in inflation and bring back a measure of stability in commodities and financial markets, monetary policy has to be tightened considerably and be directed to strictly controlling credit and money supply. The distinction between demand pull-cost push inflation becomes irrelevant, and the only way out of inflation is to restrain money supply and credit. A tightened monetary policy would necessarily cause a tremendous temporary increase in interest rates, a debt crisis given the low quality and high volume of loans, and a temporary recession; however, its merit would be to uproot inflation and stabilize markets. In sum, world economy faces a dilemma: maintaining present course of monetary policy would ruin real value of financial assets, international reserves, and would cause a drawn-out recession. If the course of monetary policy is to be corrected, through controlling money supply, interest rates will go up sharply, exchange rates will appreciate, a debt crisis may erupt, and a temporary recession may set in as was the experience in 1979-82. The merit of prudent monetary policy would be to bring back price stability and durable economic growth, as illustrated by episodes during 1980–99.

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