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7

The Effect of Monetary Policy on Real Commodity Prices

Jeffrey A. Frankel

7.1 Introduction

Commodity prices are back, with a vengeance.

In the 1970s, macroeconomic discussions were dominated by the oil price shocks and other rises in agricultural and mineral products that were thought to play a big role in the stagflation of that decade.[1] In the early 1980s, any discussion of alternative monetary regimes was not complete without a consideration of the gold standard and proposals for other commodity-based standards.

Yet the topic of commodity prices fell out of favor in the late 1980s and the 1990s. Commodity prices generally declined during that period; perhaps declining commodity prices are not considered as interesting as rising prices. Nobody seemed to notice how many of the victims of emerging market crises in the 1990s were oil producers that were suffering, among other things, from low oil prices (Mexico, Indonesia, Russia) or others suffering from low agricultural prices (Brazil and Argentina). The favor-

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1. A small dissenting minority viewed the increases in prices of oil and other commodities in the 1970s as the *result* of overly expansionary U.S. monetary policy, rather than as an exogenous inflationary supply shock (the result of the 1973 Arab oil embargo and the 1979 fall of the Shah of Iran). After all, was it just a coincidence that other commodity prices had gone up at the same time, or in the case of agricultural products, had actually preceded the oil shocks?

able effect of low commodity prices on macroeconomic performance—helping deliver lower inflation in the United States in the 1990s than had been thought possible at such high rates of growth and employment—was occasionally remarked. But it was not usually described as a favorable supply shock, the mirror image of the adverse supply shocks of the 1970s. It always received far less attention than the influence of other factors, such as the declining prices of semiconductors and other information technology and communication equipment. Indeed, anyone who talked about sectors where the product was as clunky and mundane as copper, crude petroleum, and soy beans was considered behind the times. In Alan Greenspan's phrase, gross domestic product (GDP) had gotten "lighter." Agriculture and mining no longer constituted a large share of the New Economy and did not matter much in an age dominated by ethereal digital communication, evanescent dot-coms, and externally outsourced services.

Now oil prices and many broader indices of commodity prices are again at or near all-time highs in nominal terms and are very high in real terms as well. Copper, platinum, nickel, zinc, and lead, for example, all hit record highs in 2006, in addition to crude oil. As a result, commodities are once again hot. It turns out that mankind has to live in the physical world after all! Still, the initial reaction in 2003 to 2004 was relaxed, on several grounds: (1) oil was no longer a large share of the economy, it was said; (2) futures markets showed that the "spike" in prices was expected to be only temporary; and (3) monetary policy need focus only on the core Consumer Price Index (CPI) inflation rate and can safely ignore the volatile food and energy component, unless or until it starts to get passed through into the core rate. But by 2005 to 2006, the increase in prices had gone far enough to receive much more serious attention. This was especially true with regard to the perceived permanence of oil prices, largely because the futures price had gone from implying that the rise in the spot price was mostly temporary to implying that it is mostly permanent.

Certain lessons of the past are well-remembered, such as the dangers of the Dutch Disease for countries undergoing a commodity export boom. But others have been forgotten, or were never properly absorbed.

With regard to point (3), it is time to examine more carefully the claim that if an increase in energy or agricultural prices does not appear in the core CPI, then monetary policy can ignore it. *The central argument of this chapter is that high real commodity prices can be a signal that monetary policy is loose*. Thus, they can be a useful monetary indicator (among many others). The analysis is both theoretical and empirical. The empirical work includes the determination of real commodity prices in the United States, the determination of prices in other smaller countries, and the determination of inventories. We find that real interest rates are an important determinant of the demand for inventories and, in turn, of the prices of agricultural and mineral commodities.

The current fashion in monetary policy is inflation targeting, by which is standardly meant targeting the CPI.[2] To be sure, the usual emphasis is on the core inflation rate "excluding the volatile food and energy sector." The leadership of the Federal Reserve has indicated that the appropriate response to the oil-shock component of recent inflation upticks is to ignore it, that is, accommodate it. But just because agricultural and mineral product prices are volatile does not mean that there is no useful information in them. The prices of gold and other minerals used to be considered useful leading indicators of inflationary expectations, precisely because they moved faster than the sluggish prices of manufactured goods and services. Nor does the volatility mean that excluding such products from the price index that guides monetary policy is necessarily appropriate.

In the first place, the "core CPI" is not a concept that is especially well understood among the general population. Thus, the public will not necessarily be reassured when the central bank tells them not to worry about big increases in food and energy prices. Attempts to explain away high numbers for headline inflation make it sound like the authorities are granting themselves an ad hoc self-pardon—like a "dog ate my homework" excuse. This can undermine the public credibility of the central bank. But credibility and transparency is the whole point of announcing an observable target in the first place. Thus, targeting the core CPI may not buy as much credibility as targeting something more easily understood (even if with a wider band).

The many proponents of inflation targeting will argue that the regime, if properly instituted, makes clear from the beginning that it excludes volatile commodity prices so that there is no loss in credibility. But, in the second place, let us ask if it is appropriate for the inflation target to exclude commodity prices. They may be important, on terms of trade grounds, especially in smaller countries. Stabilizing the traded-goods sector is itself an important goal in a world where balance of payments deficits can lead to financial crises, in which the previously declared currency regime is often one among many subsequent casualties. Recent oil price increases have also illustrated the necessity to take into account terms of trade shocks that come on the import side as well as the export side. Does there exist a price index to serve as an intermediate target that is more easily understood by the public than the core CPI, but also more robust with respect to terms of trade shocks than the overall CPI? Candidates include a producer price index (PPI) and an export price index.

2. Among many other references, see Bernanke et al (1999), Svensson (1995, 1999), and Truman (2003).

It is a tenet of international economics textbooks that a desirable property of a currency regime is that the exchange rate be allowed to vary with terms of trade shocks: that the currency automatically depreciates when world prices of the import commodity go up (say, oil for the United States or Switzerland, or wheat for Japan or Saudi Arabia) and that it automatically depreciates when world prices of the export commodity go down (say, oil for Saudi Arabia and wheat for Canada). Yet CPI targeting does not have this property. To keep the headline inflation rate constant, one must respond to a rise on world markets in the dollar price of imported oil by tightening monetary policy and *appreciating* the currency against the dollar enough to prevent the domestic price of the importable from rising. This response is the opposite from accommodating the adverse terms of trade shock, which would require a depreciation. It is true that the core inflation rate does not share this unfortunate property with the headline rate (unless the price increase comes in nonenergy commodities like semiconductors that are in the core). But the other half of terms of trade shocks are declines on world markets in the price of a country's export commodity. Theory says that when the dollar price of oil goes down, Saudi Arabia or Norway ought to depreciate against the dollar. But inflation targeting—*either* the headline CPI variety *or* the core CPI variety—does not allow this result. One would need to target a price index that specifically featured prominently the price of the exportable. The fundamental difficulty is that excluding the volatile food and energy components is not sufficient to accommodate the terms of trade, *either* if some imports lie outside those two sectors *or* if some exports lie within those two sectors.

Throughout this chapter, we will adopt the familiar assumption that all goods can be divided into homogeneous agricultural and mineral commodities, on the one hand, and differentiated manufactured goods and services, on the other hand, and that the key distinction is that prices of the former are perfectly flexible so that their markets are always clear and that prices of the latter are sticky in the short run so that their markets do not.[3] The plan is to look at connections between commodities and monetary policy. We begin with the monetary influences on commodity prices—first for a large country, then for a small one. We conclude with a viewpoint based on reverse causality: the possible influence of commodity prices on monetary policy in a consideration of what price index to use for the nominal anchor. Even if one is wedded to, say, a Taylor rule, the question of what price index to use merits discussion. *The author summarizes a proposal made elsewhere, for countries with volatile terms of trade, to use an export price index (or producer price index) in place of the CPI.* If one is en-

3. For young readers, I will recall that these distinctions were originally due to Arthur Okun (1975), who called the two sectors auction goods versus customer goods.

amored of a simpler price-targeting regime, then the proposal is to Peg the Export Price Index (PEPI) in place of targeting the CPI.

7.2 The Effect of Monetary Policy on Real Commodity Prices

The central purpose of this chapter is to assert the claim that monetary policy, as reflected in real interest rates, is an important—and usually underappreciated—determinant of the real prices of oil and other mineral and agricultural products, while far from the only determinant.

7.2.1 Effect of U.S. Short-Term Real Interest Rates on Real U.S. Commodity Prices

The argument can be stated in an intuitive way that might appeal to practitioners as follows. High interest rates reduce the demand for storable commodities, or increase the supply, through a variety of channels:

- By increasing the incentive for extraction today rather than tomorrow (think of the rates at which oil is pumped, zinc is mined, forests logged, or livestock herds culled)
- By decreasing firms' desire to carry inventories (think of oil inventories held in tanks)
- By encouraging speculators to shift out of commodity contracts (especially spot contracts) and into treasury bills

All three mechanisms work to reduce the market price of commodities, as happened when real interest rates were high in the early 1980s. A decrease in real interest rates has the opposite effect, lowering the cost of carrying inventories and raising commodity prices, as happened during 2002 to 2004. Call it part of the "carry trade."[4]

Theory: The Overshooting Model

The theoretical model can be summarized as follows. A monetary contraction temporarily raises the real interest rate, whether via a rise in the nominal interest rate, a fall in expected inflation, or both. Real commodity prices fall. How far? Until commodities are widely considered "undervalued"—so undervalued that there is an expectation of future appreciation (together with other advantages of holding inventories, namely the "convenience yield") that is sufficient to offset the higher interest rate (and other costs of carrying inventories: storage costs plus any risk premium). Only then, when expected returns are in balance, are firms willing to hold the inventories despite the high carrying cost. In the long run, the general price level adjusts to the change in the money supply. As a result, the real money

4. See Frankel (2005b).

supply, real interest rate, and real commodity price eventually return to where they were.

The theory is the same as Rudiger Dornbusch's (1976) famous theory of exchange rate overshooting, with the price of commodities substituted for the price of foreign exchange—and with convenience yield substituted for the foreign interest rate. The deep reason for the overshooting phenomenon is that prices for agricultural and mineral products adjust rapidly, while most other prices adjust slowly.[5]

The theory can be reduced to its simplest algebraic essence as a claimed relationship between the real interest rate and the spot price of a commodity relative to its expected long-run equilibrium price. This relationship can be derived from two simple assumptions. The first one governs expectations. Let

$s \equiv$ the spot price,
$\bar{s} \equiv$ its long run equilibrium,
$p \equiv$ the economy-wide price index,
$q \equiv s - p$, the real price of the commodity, and
$\bar{q} \equiv$ the long run equilibrium real price of the commodity,

all in log form. Market participants who observe the real price of the commodity today lying above or below its perceived long-run value expect it in the future to regress back to equilibrium over time, at an annual rate that is proportionate to the gap:

$$(1) \qquad E[\Delta(s - p)] \equiv E[\Delta q] = -\theta(q - \bar{q})$$

or

$$(2) \qquad E(\Delta s) = -\theta(q - \bar{q}) + E(\Delta p).$$

Following the classic Dornbusch overshooting paper, we begin by simply asserting the reasonableness of the form of expectations in these equations: a tendency to regress back toward long-run equilibrium. But, as in that paper, it can be shown that regressive expectations are also rational expectations, under certain assumptions regarding the stickiness of other goods prices (manufacturers and services) and certain restrictions on parameter values.[6]

Equation (3) concerns the decision whether to hold the commodity for another period—either leaving it in the ground or on the trees or holding it in inventories—or to sell it at today's price and deposit the proceeds in the bank to earn interest. The arbitrage condition is that the expected rate of return to these two alternative courses of action must be the same:

$$(3) \qquad E\Delta s + c = i,$$

5. See Frankel (1984).
6. See Frankel (1986).

where

$c \equiv cy - sc - rp$
$cy \equiv$ convenience yield from holding the stock (e.g., the insurance value of having an assured supply of some critical input in the event of a disruption, or in the case of gold, the psychic pleasure component of holding it),
$sc \equiv$ storage costs (e.g., costs of security to prevent plundering by others, rental rate on oil tanks or oil tankers, etc.)
$rp \equiv$ risk premium, which is positive if being long in commodities is risky, and
$i \equiv$ the interest rate.[7]

There is no reason why the convenience yield, storage costs, or risk premium should be constant over time. If one is interested in the derivatives markets, the forward discount or slope of the futures curve, $f - s$ in log terms, is given by:

$$f - s = i - cy + sc, \quad \text{or equivalently by} \quad E\Delta s - rp. \tag{4}$$

Parenthetically, the introduction to this chapter noted that conventional wisdom initially regarded the 2003 to 2004 "spike" in oil prices as only temporary, but expectations regarding the long-run oil price were subsequently revised sharply upward. The changes in the perceived transience or permanence of the price increase were standardly based on the futures markets, which did not catch up with the increase in the spot price until after a year or so. It is curious that so many economists and central bankers are ready to accept that the futures price of oil is an unbiased forecast of the future spot price. This proposition, of course, would follow from the two propositions that the futures price is an accurate measure of expectations (no risk premium) and that expectations are rational. Both halves of the joint hypothesis are open to question. Few familiar with the statistics of forward exchange rates claim that they are an unbiased predictor of the future spot exchange rate. Few familiar with the statistics of the interest rate term structure claim that the long-term interest rate contains an unbiased predictor of future short-term interest rates. Why, then, expect the oil futures price to be an unbiased predictor of the future spot price?[8] The convenience yield, storage costs, and risk premium are variable. So the backwardation (forward prices below spot) in oil prices in 2004 was not necessarily a reason to be complacent, and the flattening or contango (for-

7. Working (1949) and Breeden (1980) are classic references on the roles of carrying costs and the risk premium, respectively, in commodity markets. Yang, Bessler, and Leatham (2001) review the literature.

8. Studies of bias in the commodities futures price as a predictor of the spot price include Bessembinder (1993), Brenner and Kroner (1995), Covey and Bessler (1995), Dusak (1973), Fama and French (1987), Fortenbery and Zapata (1997), and Kolb (1992). Most assume that investors' expectations must be unbiased in-sample, and infer a time varying risk premium. The exception, Choe (1990), infers expectations from survey data.

ward prices above spot) in 2005 to 2006 was not necessarily a reason to worry.

Nevertheless, the large increase in the slope of the futures yield curve during the period 2004 to 2006, the same period that the Federal Reserve was steadily raising interest rates, is consistent with the theory that we have just developed: that the slope depends on the interest rate plus storage costs minus convenience yield. Harder to explain is that the move to contango came rather sharply, however, in early April 2005, rather than gradually. Here a rapid revision in expectations may have played a role.

To get our main result, we simply combine equations (2) and (3):

$$-\theta(q - \overline{q}) + E(\Delta p) + c = i \quad \rightarrow \quad q - \overline{q} = -(1/\theta)[i - E(\Delta p) - c]. \tag{5}$$

Equation (5) says that the real price of the commodity (measured relative to its long-run equilibrium) is inversely proportional to the real interest rate (measured relative to a constant term that depends on convenience yield). When the real interest rate is high, as in the 1980s, money flows out of commodities, just as it flows out of foreign currencies, emerging markets, and other securities. Only when the prices of these alternative assets are perceived to lie sufficiently below their future equilibriums will the arbitrage condition be met. Conversely, when the real interest rate is low, as in 2001 to 2005, money flows into commodities, just as it flows into foreign currencies, emerging markets, and other securities. Only when the prices of these alternative assets are perceived to lie sufficiently above their future equilibriums will the arbitrage condition be met.

The Simplest Test

One can imagine a number of ways of testing the theory.

One way of isolating the macroeconomic effects on commodity prices is to look at jumps in financial markets that occur in immediate response to government announcements that change perceptions of monetary policy, as was true of Fed money supply announcements in the early 1980s. Money announcements that caused interest rates to jump up would, on average, cause commodity prices to fall, and vice versa. The experiment is interesting because news regarding supply disruptions and so forth is unlikely to have come out during the short time intervals in question.[9]

The relationship between the real commodity price and the real interest rate, equation (5), can also be tested more directly because variables can be measured fairly easily.[10] This is the test we pursue here.

We begin with a look at some plots. Three major price indexes that have

9. See Frankel and Hardouvelis (1985).

10. One precedent is Barsky and Summers (1988, part III), who established an inverse relationship between the real interest rate and the real prices of gold and nonferrous metals.

been available since 1950—from Dow Jones, Commodity Resources Board, and Moody's—are used in the first three figures. (In addition, two others, which started later than 1950, are illustrated in appendix A). To compute the real commodity price, we take the log of the commodity price index minus the log of the CPI. To compute the real interest rate, we take the one-year interest rate and subtract off the one-year inflation rate observed over the preceding year.

The negative relationship predicted by the theory seems to hold. We next apply ordinary least squares (OLS) regression to these data.

It would not be reasonable to expect the regression relationship to hold precisely in practice. It would be foolish to think that the equation captures everything. In reality, a lot of other things beyond real interest rates influence commodity prices. There are bound to be fluctuations both in $\overline{q}$, the long-run equilibrium real price, and c, which includes convenience yield, storage costs, and risk premium. These fluctuations are not readily measurable.[11] Such factors as weather, political vicissitudes in producing countries, and so forth, are likely to be very important when looking at individual commodities. Indeed, analysts of oil or coffee or copper pay rather little attention to macroeconomic influences and, instead, spend their time looking at microeconomic determinants. Oil prices have been high in 2004 to 2006 in large part due to booming demand from China and feared supply disruptions in the Middle East, Russia, Nigeria, and Venezuela. There may now be a premium built in to the convenience yield arising from the possibilities of supply disruption related to terrorism, uncertainty in the Persian Gulf, and related risks. Yet another factor concerns the proposition that the world supply of oil may be peaking in this decade, as new discoveries lag behind consumption (Hubbert's Peak[12]). This would imply that $\overline{q}$, the world long-run equilibrium real price of oil has shifted upward. Other factors apply to other commodities. In coffee, the large-scale entry of Vietnam into the market lowered prices sharply a few years ago. Corn, sugar, and cotton are heavily influenced by protectionist measures and subsidies in many countries and so on (see figure 7.1).

Such effects in individual commodities partially average out when looking at a basket average of commodity prices. This is one reason to use aggregate indexes in the tests reported in the following.

Table 7.1 reports regressions of real commodity prices over the period 1950 to 2005. The results are statistically significant at the 5 percent level for all three of the major price indexes that have been available since 1950—from Dow Jones, Commodity Resources Board (CRB), and Moody's—and

11. An extension for future research would be to attempt to control for some influences on c by means of measures of economic activity and risk such as those used in the inventories equation in the next section.

12. See Deffeyers (2005). Notwithstanding that such predictions have in the past been proven wrong.

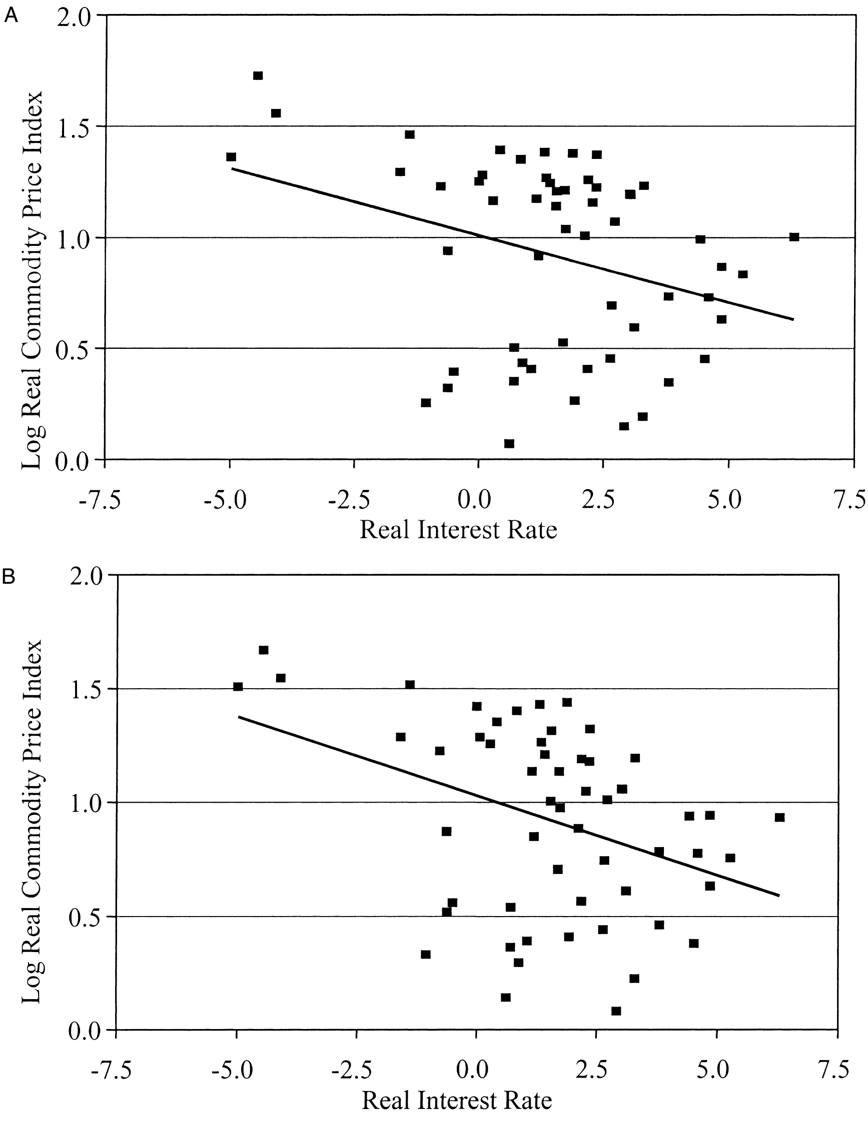

Fig. 7.1 U.S. real commodity prices and real interest rates, annual 1950–2005: *A*, CRB commodity price index versus real interest rate; *B*, Dow Jones commodity price index versus real interest rate; *C*, Moody's commodity price index versus real interest rate

Source: Global Financial Data.

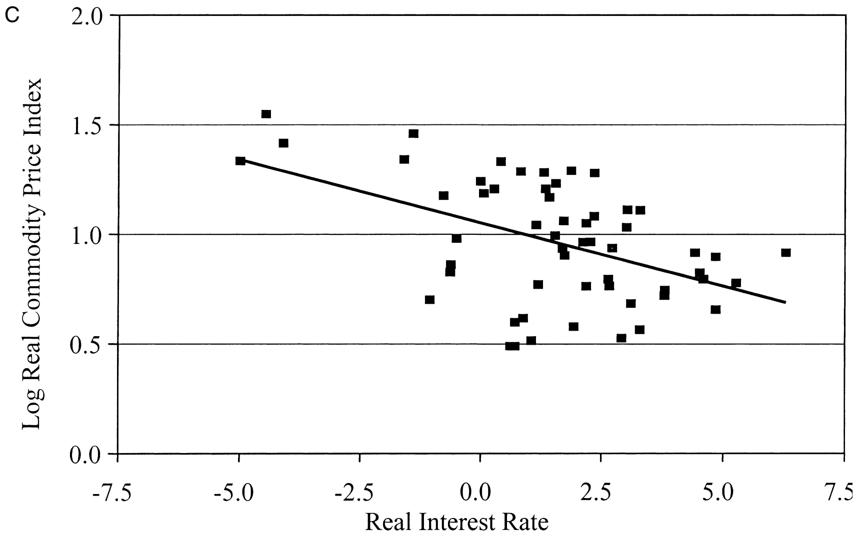

Fig. 7.1 (cont.)

significant for one of the two with a shorter history (Goldman Sachs). All are of the hypothesized negative sign. The estimated coefficient for the CRB, –.06, is typical. It suggests that when the real interest rate goes up 1 percentage point (100 basis points), it lowers the real commodity price by .06, that is, 6 percent. It also suggests that the estimate for $1/\theta = 6$, so $\theta = .16$. In other words, the expected speed of adjustment per year is estimated at 16 percent. The expected half-life is about four years (.84 to the 4th power =.5).

Table 7.1 also reports results for twenty-three individual commodities, presented in order of the size of the estimated coefficient. Despite our fears that sector-specific microeconomic factors swamp the macroeconomic influences for individual commodities, the coefficient is of the hypothesized sign in nineteen out of twenty-three cases and is statistically significant in half (eleven out of twenty-three). Interestingly, oil and gold are the worst of the twenty-three, showing (insignificant) positive coefficients! A fixed effects panel incorporates the information for all the individual commodities with the coefficient constrained to be the same. The coefficient is estimated at –.046 and is highly significant statistically.

The results in table 7.1 suggest that the significant negative relationship between commodity prices and interest rates is reasonably robust across commodity price measures. Is the result as robust over time? It appears that the negative correlation is significant over 1950 to 1979 (see appendix table 7A.1, panel A). However, since 1980, there does not appear to have been a stable relationship between log real commodity prices and the real interest

Table 7.1 **Regression of log real commodity prices on real interest rates, 1950–2005: results by commodity indices, individual commodities, and fixed effects panel of commodities**

	Coefficient	SE
Sample: 1950–2005 (56 annual observations)		
Goldman Sachs (1969–)	–0.080	0.029**
Dow Jones	–0.070	0.023**
CRB	–0.060	0.024**
Moodys	–0.058	0.014**
Reuters (1959–)	–0.009	0.024
Commodities		
Sugar	–0.144	0.035**
Soy bean oil	–0.096	0.030**
Corn	–0.091	0.032**
Rubber	–0.090	0.037**
Wheat	–0.088	0.033**
Lead	–0.071	0.022**
Oats	–0.066	0.029**
Soy beans	–0.064	0.027**
Cocoa	–0.063	0.035
Cotton	–0.061	0.030**
Zinc	–0.050	0.018**
Cattle	–0.048	0.016**
Fixed effects panel	–0.046	0.006**
Nickel	–0.032	0.018
Hogs	–0.031	0.022
Copper	–0.026	0.028
Tin	–0.026	0.032
Aluminium	–0.022	0.017
Coffee	–0.015	0.038
Palladium	–0.012	0.025
Silver	0.002	0.031
Platinum	0.003	0.014
Oil	0.009	0.028
Gold	0.025	0.032

Source: Global Financial Data.

Notes: Real interest rate in percentages and real commodity prices in log units. Commodities are listed by coefficient in ascending order. SE = standard error.

**Significant at the 5 percent level.

rate (see appendix table 7A.1, panel B). The same is true if the sample is divided at 1976 or 1982.

An Effect on Inventories?

Because one of the hypothesized mechanisms of transmission from real interest rates to real commodity prices runs via the demand for inventories, it may be instructive to look at inventory data. Appendixes B and C report regression results for oil inventories (see appendix tables 7B.1 and 7C.1).

The coefficient on the real interest rate is often negative, as hypothesized. It is not always statistically significant, until we control for three other standard determinants of inventory demand, as in table 7.2. The following are the three other determinants:

- Industrial production, representing the transactions demand for inventories. Higher economic activity should have a positive effect on the demand for inventory holdings.
- Risk (political, financial, and economic) among a weighted average of twelve top oil producers. In our measure, a rise in the index represents a decrease in risk, which should have a negative effect on the demand for inventories.
- The spot-futures spread. Intuitively the futures-spot spread reflects the speculative return to holding inventories.[13] A higher spot-futures spread, or lower future-spot spread, signifies a low speculative return and should have a negative effect on inventory demand.

More formally, equation (4) gives us the arbitrage condition relevant for firms deciding whether to incur storage costs:

$$i - cy + sc = E\Delta s - rp.$$

We substitute in the arbitrage condition that comes from the financial speculators,

$$f - s = E\Delta s - rp,$$

and solve for storage costs.

$$sc = f - s + cy - i$$

Storage costs rise with the extent to which inventory holdings strain existing storage capacity:

$$sc = \Phi(inventories).$$

Invert the equation for the supply of inventory storage capacity, and set inventory demand equal to supply:

$$(6) \qquad inventories = \Phi^{-1}(sc)$$
$$= \Phi^{-1}[cy - i - (s - f)].$$

We see from the equation that inventory holdings are positively related to convenience yield (which is, in turn, determined by industrial production and geopolitical risk) and negatively related to the interest rate and the

13. For example, see the discussion of Figure 1.22 in the *World Economic Outlook,* April 2006, Washington, DC, International Monetary Fund; Abosedra and Radchenko (2003); or Balabanoff (1995).

spot-futures spread (two components of the opportunity cost of holding inventories).

Equation (6) is a model of the stock of inventories that firms *desire* to hold. In practice, the actual level of inventories generally deviates from the desired levels. For example, a sudden unexpected acceleration of industrial production will, in the short run, show up as a *fall* in inventories held, even though the desired level of inventories goes up. Only over time are firms able to adjust their actual level of inventories in line with the desired level. This phenomenon is very well known and was the origin of the "stock adjustment" specification in regression equations. For our purposes, it simply means we want to include a lagged endogenous variable and that we should expect its effect on current measured inventories to be very strong.

The results are reported in table 7.2. They show the hypothesized sign on all variables, usually with statistical significance.[14] They, thus, generally support the model.

We have also looked at agricultural inventories, as reported in appendix table 7D.1. Here there is little evidence of an effect of real interest rates. But in this case we were unable to control for risk or other important variables, so perhaps this finding is to be expected.

7.2.2 The Relationship in Other Countries

In the preceding analysis, we have expressed everything—nominal commodity prices, CPI, interest rates—in dollars. But the United States is not the whole world. It is less than 1/3 of Gross World Product, even if its importance in monetary and financial markets is evidently greater than that. In this section, we consider other countries, concentrating on those that currently have floating exchange rates and, thus, are in need of a price target to anchor monetary policy. We will treat them as "small open economies," meaning that they take the world price of commodities as given, even though they range in size up to the United Kingdom.

Adding Exchange Rate Overshooting to Commodity Price Overshooting

We could begin by redoing the previous econometrics with global measures of each of the variables, that is, measuring the commodity price in a GDP-weighted average of the dollar, euro, yen, and so on, measuring the world interest rate as a weighted average of national interest rates and measuring the CPI and inflation rates as the same-weighted average of national CPIs and inflation rates. But we leave this as a possible extension for future research. Instead, we take the U.S. variables to be the global variables, and

14. Indeed, these other determinants are sufficiently successful in the inventory equation as to suggest that one include them in the regression estimates of equation (5), where they would serve as determinants of *c*. Perhaps the addition of such controls would improve the estimates of the macroeconomic influences on the prices of oil and other commodities. This extension is left for future research.

Table 7.2 **Relationship between oil inventories and real interest rates (weekly data; 1,114–1,190 observations depending on data availability)**

Real interest rate	Spot-futures	IP	ΔIP	Risk	Δrisk	Inventories (t – 1)
Nonstationary variables detrended by including quadratic terms in each regression						
–0.394**	–0.821**	0.397**		–0.002**		
(0.089)	(0.041)	(0.062)		(0.001)		
–0.056	–0.079**	0.052**		0.000		0.931**
(0.032)	(0.013)	(0.020)		(0.000)		(0.009)
–0.211**	–0.727**		0.131		–0.005**	
(0.085)	(0.040)		(0.126)		(0.001)	
–0.017	–0.071**		0.009		0.000	0.937**
(0.032)	(0.012)		(0.045)		(0.000)	(0.009)

Note: Standard errors in parenthesis.
**Significant at the 5 percent level.

we proceed directly to look at small countries that by definition take the U.S./global variables as given.

The log spot price of the commodity in terms of currency *j* is given by

$$s_j = s_{(j/\$)} + s_{(\$/c)}, \tag{7}$$

where $s_{(j/\$)}$ is the spot exchange rate in units of currency *j* per $ and $s_{(\$/c)}$ is the spot price of commodity *c* in terms of $, what has hitherto been called simply *s* for the dollar case. The real exchange rate between currency *j* and the dollar is governed by the direct application of the Dornbusch overshooting model.

$$(s_{(j/\$)} - \bar{s}_{(j/\$)}) - (p_j - \bar{p}_j) + (p_\$ - \bar{p}_\$) = -\frac{1}{\upsilon}\{i_j - i_\$ - [E(\Delta p_j) - E(\Delta p_\$)]\} \tag{8}$$

Combining equations (5), (7), and (8),

$$\begin{aligned}(s_{(j/c)} - \bar{s}_{(j/c)}) &= (s_{(j/\$)} - \bar{s}_{(j/\$)}) + (s_{(\$/c)} - \bar{s}_{(\$/c)}) \\ &= (p_j - \bar{p}_j) - \frac{1}{\upsilon}\{i_j - i_\$ - [E(\Delta p_j) - E(\Delta p_\$)]\} \\ &\quad - \frac{1}{\theta}[i_\$ - E(\Delta p_\$) - c] \\ (q_{(j/c)} - \bar{q}_{(j/c)}) &= -\frac{1}{\upsilon}(r_j - r_\$) - (1/\theta)(r_\$ - c),\end{aligned} \tag{9}$$

where $r_\$$ is the U.S. interest rate, and r_j is the interest rate in country *j*.

Equation (9) says the real commodity price observed in country *j* will be high to the extent either that the local real interest rate is low relative to the U.S. real rate or to the extent that the U.S. real interest rate is low. We tested this equation for eight individual countries that currently have independently floating currencies (though they did not all have floating rates throughout the entire sample period).

We computed the real commodity price by converting the commodity price to the currency of the small open economy in question and dividing by the country's price level. We then regressed the log of the real commodity price on the two variables on the right-hand side of equation (9), the U.S. real interest rate and the differential in real interest rates between the small open economy and the United States:

$$\log \frac{CP^{US} \cdot S^{j/\$}}{P^{j}} = \alpha + \beta_1[(i^j - \pi^j) - (i^{US} - \pi^{US})] + \beta_2(i^{US} - \pi^{US}) + \varepsilon.$$

The results for the eight floating countries are reported in table 7.3, which uses six different commodity price indexes: CRB, Dow Jones, The Economist, Goldman Sachs, Moody's, and Reuters. Monthly data were generally available for the developed countries from 1950.[15] To take full advantage of what data were available, the regressions were estimated separately for the three-month interest rate (three-month Treasury notes or equivalent) and the long-term interest rate with the largest sample (Australia: ten-year bond; Brazil: thirty-year bond; Canada: ten+ year bond; Chile: twenty-year bond; Mexico: three-year bond; New Zealand: ten-year bond; Switzerland: thirty-year bond; United Kingdom: twenty-year bond). The U.S. interest rate for each regression was chosen to match the maturity of the bond from the small open economy.

In general, the evidence appears to support the hypothesis regarding the determination of the log real local-currency index of commodity prices. The estimates show a significant negative coefficient on the real U.S. interest rate, representing global monetary policy, as well as on the real interest differential between the national economy and the United States, representing local variations in monetary stance. Often, significance levels are high. In the case of the three major English-speaking countries, Australia, Canada, and the United Kingdom, both the coefficient on the U.S. real interest rate and the coefficient on the real interest differential are statistically significant and of the hypothesized negative sign in almost every one of the twelve cases, regardless of which of the six commodity price indexes are used and regardless of whether short-term or long-term interest rates are used. The results for New Zealand and Switzerland are almost as strong but for the effect of the short-term U.S. rate, as are the results for Brazil and Chile, except that the coefficient on the long-term real interest differential is not always significant. The only disappointing country is Mexico, where even though the short-term real interest differential always

15. For the three Latin American countries, however, it was difficult to find interest rate data preceding their hyperinflations.

Table 7.3 **Regressions of log real commodity prices in local currency on real interest rates: monthly observations (over largest possible sample of data since 1950)**

	Short rate			Long rate		
	Sample	Real U.S. rate	Real interest differential	Sample	Real U.S. rate	Real interest differential
	A. Log real CRB commodity price index in local currency and real interest rates					
Australia	1/1950–8/2005	–0.023**	–0.076**	1/1950–8/2005	–0.057**	–0.067**
		(0.006)	(0.003)		(0.005)	(0.004)
Brazil	7/1965–12/1989, 1/1995–8/2005	–0.024**	–0.006**	5/1994–9/2005	–0.161**	–0.001
		(0.007)	(0.002)		(0.019)	(0.001)
Canada	1/1950–9/2005	–0.047**	–0.065**	1/1950–9/2005	–0.073**	–0.076**
		(0.005)	(0.005)		(0.004)	(0.006)
Chile	7/1997–9/2005	–0.063**	–0.021**	2/1993–2/2004	–0.092**	–0.018**
		(0.006)	(0.004)		(0.014)	(0.003)
Mexico	1/1978–9/2005	0.055**	–0.017**	1/1995–9/2005	0.047**	0.000
		(0.013)	(0.002)		(0.011)	(0.003)
New Zealand	3/1978–8/2005	0.001	–0.067**	1/1950–8/2005	–0.081**	–0.075**
		(0.009)	(0.004)		(0.006)	(0.004)
Switzerland	1/1980–9/2005	0.034**	–0.054**	5/1953–9/2005	–0.171**	–0.095**
		(0.016)	(0.009)		(0.013)	(0.012)
United Kingdom	1/1950–9/2005	–0.053**	–0.086**	1/1950–9/2005	–0.106**	–0.023**
		(0.010)	(0.007)		(0.007)	(0.006)
	B. Log real Dow Jones commodity price index in local currency and real interest rates					
Australia	1/1950–8/2005	–0.035**	–0.071**	1/1950–8/2005	–0.061**	–0.064**
		(0.005)	(0.003)		(0.004)	(0.004)
Brazil	7/1965–12/1989, 1/1995–8/2005	–0.036**	–0.005**	5/1994–9/2005	–0.197**	0.000
		(0.007)	(0.002)		(0.021)	(0.001)
Canada	1/1950–9/2005	–0.056**	–0.059**	1/1950–9/2005	–0.076**	–0.074**
		(0.004)	(0.005)		(0.004)	(0.006)

(*continued*)

Table 7.3 (continued)

	Short rate			Long rate		
	Sample	Real U.S. rate	Real interest differential	Sample	Real U.S. rate	Real interest differential
Chile	7/1997–9/2005	–0.084**	–0.027**	2/1993–2/2004	–0.106**	–0.004
		(0.009)	(0.006)		(0.017)	(0.004)
Mexico	1/1978–9/2005	0.036**	–0.017**	1/1995–9/2005	0.015	–0.003
		(0.012)	(0.002)		(0.012)	(0.003)
New Zealand	3/1978–8/2005	–0.015	–0.063**	1/1950–8/2005	–0.085**	–0.071**
		(0.008)	(0.004)		(0.005)	(0.004)
Switzerland	1/1980–9/2005	0.004	–0.065**	5/1953–9/2005	–0.160**	–0.076**
		(0.015)	(0.009)		(0.012)	(0.012)
United Kingdom	1/1950–9/2005	–0.063**	–0.081**	1/1950–9/2005	–0.108**	–0.027**
		(0.009)	(0.007)		(0.007)	(0.006)
C. Log real Economist commodity price index in local currency and real interest rates						
Australia	1/1950–8/2005	–0.010**	–0.027**	1/1950–8/2005	–0.018**	–0.031**
		(0.005)	(0.002)		(0.004)	(0.002)
Brazil	7/1965–12/1989, 1/1995–8/2005	0.005	–0.006**	5/1994–9/2005	–0.095**	–0.002**
		(0.007)	(0.001)		(0.018)	(0.001)
Canada	1/1950–9/2005	–0.012**	0.004	1/1950–9/2005	–0.018**	–0.020**
		(0.005)	(0.005)		(0.004)	(0.006)
Chile	7/1997–9/2005	–0.049**	–0.011**	2/1993–2/2004	–0.020	–0.022**
		(0.006)	(0.004)		(0.014)	(0.003)
Mexico	1/1978–9/2005	0.056**	–0.013**	1/1995–9/2005	0.093**	0.001
		(0.012)	(0.002)		(0.013)	(0.004)
New Zealand	3/1978–8/2005	0.011	–0.042**	1/1950–8/2005	–0.031**	–0.042**
		(0.008)	(0.003)		(0.005)	(0.002)
Switzerland	1/1980–9/2005	0.061**	–0.014	5/1953–9/2005	–0.086**	–0.051**
		(0.013)	(0.008)		(0.006)	(0.006)
United Kingdom	1/1950–9/2005	–0.024**	–0.045**	1/1950–9/2005	–0.049**	–0.021**
		(0.007)	(0.004)		(0.005)	(0.004)

D. Log real Goldman Sachs commodity price index in local currency and real interest rates						
Australia	12/1969–8/2005	–0.054**	–0.063**	12/1969–8/2005	–0.064**	–0.074**
		(0.006)	(0.004)		(0.005)	(0.004)
Brazil	12/1969–12/1989, 1/1995–8/2005	–0.058**	–0.004**	5/1994–9/2005	–0.296**	–0.001
		(0.009)	(0.002)		(0.025)	(0.001)
Canada	12/1969–9/2005	–0.077**	–0.060**	12/1969–9/2005	–0.096**	–0.091**
		(0.007)	(0.007)		(0.006)	(0.006)
Chile	7/1997–9/2005	–0.098**	–0.048**	2/1993–2/2004	–0.178**	–0.007
		(0.014)	(0.009)		(0.021)	(0.005)
Mexico	1/1978–9/2005	0.026**	–0.015**	1/1995–9/2005	–0.035**	–0.002
		(0.011)	(0.002)		(0.013)	(0.004)
New Zealand	3/1978–8/2005	–0.030**	–0.067**	12/1969–8/2005	–0.076**	–0.080**
		(0.008)	(0.003)		(0.007)	(0.003)
Switzerland	1/1980–9/2005	–0.025	–0.077**	12/1969–9/2005	–0.219**	–0.172**
		(0.015)	(0.009)		(0.009)	(0.012)
United Kingdom	12/1969–9/2005	–0.051**	–0.089**	12/1969–9/2005	–0.094**	–0.039**
		(0.009)	(0.005)		(0.009)	(0.007)
E. Log real Moody's commodity price index in local currency and real interest rates						
Australia	1/1950–8/2005	–0.031**	–0.052**	1/1950–8/2005	–0.050**	–0.045**
		(0.004)	(0.002)		(0.003)	(0.003)
Brazil	7/1965–12/1989, 1/1995–8/2005	–0.022**	–0.001	5/1994–9/2005	–0.180**	–0.001
		(0.006)	(0.001)		(0.023)	(0.001)
Canada	1/1950–9/2005	–0.044**	–0.040**	1/1950–9/2005	–0.056**	–0.040**
		(0.003)	(0.004)		(0.003)	(0.004)
Chile	7/1997–9/2005	–0.096**	–0.021**	2/1993–2/2004	–0.055**	0.004
		(0.007)	(0.005)		(0.020)	(0.004)
Mexico	1/1978–9/2005	0.029**	–0.011**	1/1995–9/2005	0.017	0.000
		(0.008)	(0.002)		(0.012)	(0.004)
New Zealand	3/1978–8/2005	–0.021**	–0.044**	1/1950–8/2005	–0.067**	–0.045**
		(0.005)	(0.002)		(0.004)	(0.003)

(*continued*)

Table 7.3 (continued)

	Short rate			Long rate		
	Sample	Real U.S. rate	Real interest differential	Sample	Real U.S. rate	Real interest differential
Switzerland	1/1980–9/2005	–0.030**	–0.071**	5/1953–9/2005	–0.117**	–0.046**
		(0.010)	(0.006)		(0.009)	(0.009)
United Kingdom	1/1950–9/2005	–0.054**	–0.059**	1/1950–9/2005	–0.084**	–0.017**
		(0.007)	(0.005)		(0.005)	(0.005)
F. Log real Reuters commodity price index in local currency and real interest rates						
Australia	11/1959–8/2005	0.009	–0.042**	11/1959–8/2005	–0.008	–0.045**
		(0.006)	(0.004)		(0.005)	(0.004)
Brazil	7/1965–12/1989, 1/1995–8/2005	0.003	–0.007**	5/1994–9/2005	–0.060**	–0.003**
		(0.008)	(0.001)		(0.015)	(0.000)
Canada	11/1959–9/2005	–0.004	–0.004	11/1959–9/2005	–0.024**	–0.041**
		(0.007)	(0.006)		(0.006)	(0.007)
Chile	7/1997–9/2005	–0.029**	–0.007	2/1993–2/2004	–0.029**	–0.043**
		(0.007)	(0.004)		(0.013)	(0.003)
Mexico	1/1978–9/2005	0.088**	–0.014**	1/1995–9/2005	0.128**	0.002
		(0.014)	(0.002)		(0.014)	(0.005)
New Zealand	3/1978–8/2005	0.041**	–0.048**	11/1959–8/2005	–0.020**	–0.064**
		(0.011)	(0.004)		(0.006)	(0.003)
Switzerland	1/1980–9/2005	0.102**	–0.011	11/1959–9/2005	–0.125**	–0.107**
		(0.015)	(0.009)		(0.008)	(0.009)
United Kingdom	11/1959–9/2005	0.010	–0.070**	11/1959–9/2005	–0.037**	–0.018**
		(0.009)	(0.005)		(0.008)	(0.006)

Note: Robust standard errors in parenthesis.
**Significant at the 5 percent level.

appears significantly less than zero, the U.S. interest rate appears significantly greater than zero rather than less.

This seems impressive evidence for what has been the central theme of this chapter so far. The hypothesized effect of the real interest rate on real commodity prices works not only at the U.S. level, but also at the level of local variation among open economies above and beyond the global phenomenon.

7.3 Implications for Monetary Policy

We conclude the chapter with a consideration of some implications for monetary policymakers. The first implication is a reason to add commodity prices to the list of variables that central banks monitor, regardless of their regime—that is, regardless of whether they use discretion or some rule or intermediate target and, in the latter case, regardless of the rule or target that is officially declared. The second implication concerns the possibility, in the case of countries where fluctuations in the terms of trade are important, of giving export prices a larger role in the price index that enters the rule or target than does the CPI (whether headline CPI or core CPI).

7.3.1 Commodity Prices Belong on the List of Monetary Conditions Indicators

The advice that monetary policymakers should "look at everything" sounds easy to give and hard to reject. But not everyone would consider it obvious that an index of agricultural and mineral commodity prices belongs on a useful list of variables to reveal current monetary conditions, alongside short- and long-term interest rates, the exchange rate, housing prices, and the stock market. The conventional practice is to throw the volatile "food and energy" sector out of the price indexes, concentrating instead on the core CPI if one wants a good indicator of likely future inflation. It is certainly true that if one is looking for the single standard statistic that best predicts future inflation, the core CPI will do better than the headline CPI. But that is not the question. The question is, rather, if one is free to look at lots of information, are agricultural and mineral prices on the list of variables worth paying attention to? This perspective places this chapter on a plane with other chapters that consider the possibility of central banks paying attention to housing prices or the stock market.

The theory and empirical results reported in this chapter suggest that the answer is yes. Real commodity prices reflect monetary ease, more specifically real interest rates, among other factors. We can never be sure what the real interest rate is because we do not directly observe expected inflation. Thus, it is useful to have additional data that are thought to reflect real interest rates.

7.3.2 What Prices Belong in the Inflation Targeters' Target?

The current fashion in monetary policy regimes is inflation targeting. Such countries as the United Kingdom, Sweden, Canada, New Zealand, Australia, Chile, Brazil, Norway, Korea, and South Africa have adopted it, and many monetary economists approve. In part, this is a consequence of the disillusionment with exchange rate targets that arose in the course of ten years of currency crises (from the speculative attack that forced the United Kingdom to drop out of the European Exchange Rate Mechanism in 1992 to the Argentina crisis of 2001). Proponents of inflation targeting point out that if the exchange rate is not to be the anchor for monetary policy, then the ultimate objective of price stability requires that some new nominal variable must be chosen as the anchor. Two old favorite candidates for nominal anchor, the price of gold and the money supply, have long since been discredited in the eyes of many. So that seems to leave inflation targeting. One version of a generalized approach to inflation targeting is a Taylor rule, which puts weight on output in addition to inflation.

But whether it is simple inflation targeting or a Taylor rule, what price index is appropriate? Of the possible price indexes that a central bank could target, the CPI is the usual choice. Indeed, the CPI (whether core or overall CPI) seems to be virtually the only choice that central banks and economists have even considered. But this is not the only possible choice. A proposal made elsewhere is to target an index of export prices.

7.3.3 The Proposal to Peg the Export Price (PEP)

This idea is a more moderate version of an exotic-sounding proposed monetary regime called Peg the Export Price (PEP). The author originally proposed PEP explicitly for those countries that happen to be heavily specialized in the production of a particular mineral or agricultural export commodity. The proposal was to fix the price of that commodity in terms of domestic currency, or, equivalently, set the value of domestic currency in terms of that commodity. For example, African gold producers would peg their currency to gold—in effect returning to the long-abandoned gold standard. Canada and Australia would peg to wheat. Norway would peg to oil. Chile would peg to copper, and so forth. One can even think of exporters of manufactured goods that qualify: standardized semiconductors (that is, commodity chips) are sufficiently important exports in Korea that one could imagine it pegging the won to the price of chips.

How would this work operationally? Conceptually, one can imagine the government holding reserves of gold or oil and intervening whenever necessary to keep the price fixed in terms of local currency. Operationally, a more practical method would be for the central bank each day to announce an exchange rate vis-à-vis the dollar, following the rule that the day's exchange rate target (dollars per local currency unit) moves precisely in proportion to the day's price of gold or oil on the London market or New York market (dollars per commodity). Then the central bank could intervene via the foreign exchange market to achieve the day's target. Either way, the effect would be to stabilize the price of the commodity in terms of local currency. Or perhaps, because these commodity prices are determined on world markets, a better way to express the same policy is "stabilizing the price of local currency in terms of the commodity."[16]

The PEP proposal can be made more moderate and more appropriate for diversified economies, in a number of ways, as explained in the next subsection.[17] One way is to interpret it as targeting a broad index of all export prices, rather than the price of only one or a few export commodities. This moderate form of the proposal is abbreviated PEPI, for Peg the Export Price *Index*.[18]

The argument for the export price targeting proposal, in any of its forms, is stated succinctly: it delivers one of the main advantages that a simple exchange rate peg promises, namely a nominal anchor, while simultaneously delivering one of the main advantages that a floating regime promises, namely automatic adjustment in the face of fluctuations in the prices of the countries' exports on world markets. Textbook theory says that when there is an adverse movement in the terms of trade, it is desirable to accommodate it via a depreciation of the currency. When the dollar price of exports rises, under PEP or PEPI, the currency *per force* appreciates in terms of dollars. When the dollar price of exports falls, the currency depreciates in terms of dollars. Such accommodation of terms of trade shocks is precisely what is wanted. In recent currency crises, countries that suffered a sharp deterioration in their export markets were often eventually forced to give up their exchange rate targets and devalue anyway, but the adjustment was far more painful—in terms of lost reserves, lost credibility, and lost output—than if the depreciation had happened automatically.

But the proposal is not just for countries with volatile commodity exports. The desirability of accommodating terms of trade shocks is a good way to summarize the attractiveness of export price targeting relative to the reigning champion, CPI targeting.[19] Consider the two categories of adverse terms of trade shocks: a fall in the dollar price of the export in world markets and a rise in the dollar price of the import on world markets. In the first case, a fall in the export price, you want the local currency to depreciate against the dollar. As already noted, PEP or PEPI deliver that result automatically; CPI targeting does not. In the second case, a rise in the import price, the terms-of-trade criterion suggests that you again want the local

16. Frankel (2002, 2003) and Frankel and Saiki (2002).

17. Another way to go is to define as the parity a basket that includes the export commodity as well as a weighted average of currencies of major trading partners—for example, 1/3 dollars, 1/3 euros, and 1/3 oil, as the author has proposed for Persian Gulf states.

18. See Frankel (2005a).

19. Among many possible references are Bernanke et al. (1999), Mankiw and Reis (2003), Svensson (1995, 1999), Svennson and Woodford (2005), and Truman (2003).

currency to depreciate.[20] Consumer Price Index targeting actually has the implication that you tighten monetary policy so as to *appreciate* the currency against the dollar, by enough to prevent the local currency price of imports from rising. This implication—reacting to an adverse terms of trade shock by appreciating the currency—seems perverse. It could be expected to exacerbate swings in the trade balance and output.

Few believe that the proper response for an oil-importing country in the event of a large increase in world oil prices is to tighten monetary policy and thereby appreciate the currency sufficiently to prevent an increase in the price of oil in terms of domestic currency. The usual defense of inflation targeting offered by its many proponents is that in the event of such a shock, the central bank can easily deviate from the CPI target and explain the circumstances to the public. But what can be the argument for making such derogations on an ad hoc basis, when it is possible to build them into a simple target rule in the first place? Certainly not a gain in transparency and credibility.

This is not to suggest that this regime would be appropriate for all countries, only that it might have advantages for countries that experience large volatility in their terms of trade. But it has become apparent in this decade that terms of trade volatility is a more serious issue than was believed in the 1980s and 1990s.

To summarize, the argument for PEPI over CPI targeting is twofold. First, CPI targeting requires tightening in the face of an increase in the world price of import commodities, such as oil for an oil importer, while PEPI does not. Second, PEPI allows accommodation of fluctuations in the world price of the export commodities, while CPI targeting does not.

7.3.4 Moderate Version: Peg the Export Price *Index*

The second of the two arguments for the PEPI proposal just given is to eliminate export price variability. The stability in export prices, in turn, would help stabilize the balance of payments. It would, for example, have allowed the Korean won to depreciate automatically in the late 1990s, without the need for a costly failed attempt to defend an exchange rate target before the devaluation.[21] It would have allowed the Malaysian ringgit

20. Neither regime delivers that result. There is a reason for this. In addition to the goal of accommodating terms of trade shocks, there is also the goal of resisting inflation, but to depreciate in the face of an increase in import prices would exacerbate price instability.

21. Earlier research reported simulations of the path of exports over the last three decades if countries had followed the PEP proposal, as compared to hypothetical rigid pegs to a major currency, or as compared to whatever policy the country in fact followed historically: Frankel (2002) focuses primarily on producers of gold, Frankel (2003) on oil exporters, and Frankel and Saiki (2002) on various other agricultural and mineral producers. A typical finding was that developing countries that suffered a deterioration in export markets in the late 1990s, often contributing to a financial crisis, would have adjusted automatically under the PEP regime.

to appreciate automatically in the early 2000s, without the need for the monetary authorities to abandon their nominal anchor, as they did formally in 2005.

How would PEPI be implemented operationally? That is, how would an *index* of export prices be stabilized? As noted, in the simple version of the PEP proposal, there is nothing to prevent a central bank from intervening to fix the price of a single agricultural or mineral product perfectly on a day-to-day basis. Such perfect price fixing is not possible in the case of a broad basket of exports, as called for by PEPI, even if it were desirable. For one thing, such price indexes are not even computed on a daily basis. So it would be, rather, a matter of setting a target zone for the year, with monthly realizations, much as a range for the CPI is declared under the most standard interpretation of inflation targeting.

The declared band could be wide if desired, just as with the targeting of the CPI, money supply, exchange rate, or other nominal variables. Open market operations to keep the export price index inside the band if it threatens to stray outside could be conducted in terms either of foreign exchange or in terms of domestic securities. For some countries, it might help to monitor on a daily or weekly basis the price of a basket of agricultural and mineral commodities that is as highly correlated as possible with the country's overall price index, but whose components are observable on a daily or weekly basis in well-organized markets. The central bank could even announce what the value of the basket index would be one week at a time, by analogy with the Fed funds target in the United States. The weekly targets could be set so as to achieve the medium-term goal of keeping the comprehensive price index inside the preannounced bands, and yet the central bank could hit the weekly targets very closely, if it wanted, for example, by intervening in the foreign exchange market.

A first step for any central bank wishing to dip its toe in these waters would be to compute a monthly index of export prices and publish it. A second step would be to announce that it was "monitoring" the index. The data requirements for computing such an index would not be great. Every country's customs services gathers data on trade volumes and prices; indeed, they tend to do so at earlier stages of development than they gather data on national income or the CPI. For countries that lack fully credible institutions, an added advantage of the PEP proposal is transparency: the components tend to be more readily observable than components of the CPI such as prices of housing or other nontraded services.

A still more moderate, still less exotic-sounding, version of the PEPI proposal would be to target a producer price index (PPI) or the GDP deflator. In practice, it can be difficult to separate production cleanly into the two sectors, nontraded goods and exportables, in which case the two versions of the proposal—targeting an export price index or a producer price index—come down to the same thing. The key point of the PEP proposal is to exclude import prices from the index and to include export prices (as the PPI also does). The problem with CPI targeting is that it does it the other way around.

Appendix A

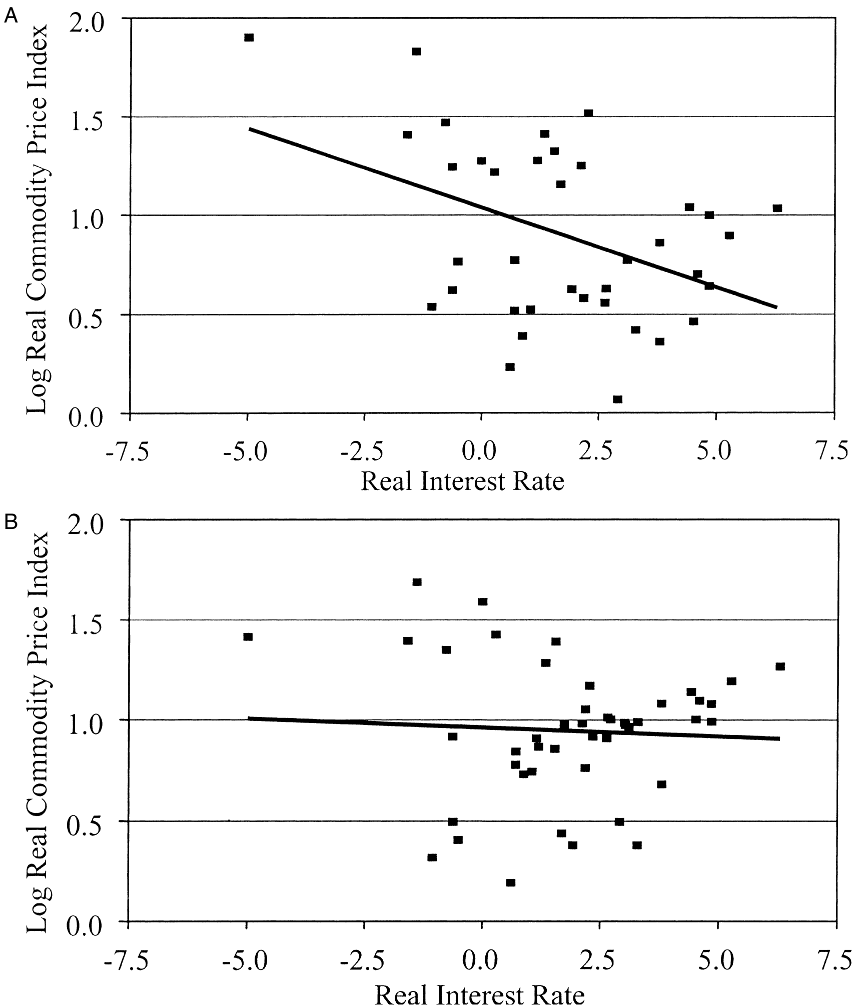

Fig. 7A.1 U.S. real commodity prices and real interest rates: *A*, Goldman Sachs commodity price index versus real interest rate, annual 1969–2005; *B*, Reuters commodity price index versus real interest rate, annual 1959–2005

Source: Global Financial Data.

Table 7A.1 Regression of log real commodity prices on real interest rates, 1950–2005: results by commodity indexes, individual commodities, and fixed effects panel.

	Coefficient	SE
A. 1950–1979 (30 annual observations)		
Reuters (1959–)	–0.080	0.023**
Goldman Sachs (1969–)	–0.078	0.028**
Dow Jones	–0.060	0.015**
Moodys	–0.052	0.013**
CRB	–0.044	0.012**
Commodities		
Sugar	–0.173	0.040**
Gold	–0.117	0.036**
Soy bean oil	–0.093	0.021**
Zinc	–0.090	0.025**
Oil	–0.085	0.032**
Corn	–0.071	0.017**
Cocoa	–0.070	0.037
Silver	–0.068	0.044
Palladium	–0.067	0.023**
Wheat	–0.061	0.024**
Rubber	–0.058	0.041
Fixed effects panel	–0.056	0.006**
Coffee	–0.055	0.028
Oats	–0.053	0.015**
Soy beans	–0.048	0.014**
Tin	–0.048	0.027
Lead	–0.042	0.018**
Cotton	–0.034	0.025
Platinum	–0.030	0.015**
Cattle	–0.026	0.014
Hogs	–0.020	0.024
Nickel	–0.014	0.017
Aluminum	0.000	0.011
Copper	0.029	0.021
B. 1980–2005 (26 annual observations)		
Moodys	0.014	0.018
Goldman Sachs	0.033	0.030
Dow Jones	0.056	0.026**
CRB	0.076	0.026**
Reuters	0.108	0.024**
Commodities		
Nickel	–0.036	0.038
Palladium	0.012	0.051
Lead	0.016	0.029
Cattle	0.020	0.015
Sugar	0.026	0.049
Platinum	0.031	0.029
Oil	0.039	0.044

(*continued*)

Table 7A.1 (continued)

	Coefficient	SE
Zinc	0.044	0.022**
Aluminum	0.049	0.022**
Hogs	0.061	0.030**
Copper	0.068	0.036
Rubber	0.069	0.038
Fixed effects panel	0.072	0.008**
Gold	0.078	0.037**
Soy bean oil	0.079	0.031**
Wheat	0.081	0.034**
Cotton	0.084	0.030**
Corn	0.086	0.034**
Soy beans	0.087	0.032**
Oats	0.090	0.040**
Cocoa	0.120	0.039**
Silver	0.126	0.045**
Tin	0.163	0.045**
Coffee	0.253	0.036**

Source: Global Financial Data.

Notes: Real interest rates in percentages and real commodity prices in log units. Commodities are listed by coefficient in ascending order. SE = standard error.

**Significant at the 5 percent level.

Appendix B

Relationship between Detrended Oil Inventories and Interest Rates

We have used various methods to detrend the inventories series: linear, quadratic and the Hodrick-Prescott (HP) filter. To maximize smoothness, the largest possible smoothness parameter was chosen for the HP filter (1 billion). At this level of smoothness, the HP filter series resembled those generated using the linear or quadratic method.

Graphs show the linear and quadratic detrended series (see figure 7B.1).

Regressions

Six regressions have been estimated to explore this relationship (see table 7B.1).

- In regression 1, there is no detrending.
- In regressions 2 and 3, linear (αt) or quadratic trends ($\alpha t + \beta t^2$) are included as extra regressors.
- Regressions 4 to 6 use a two step procedure, first detrending the inventories series and then estimating the relationship.

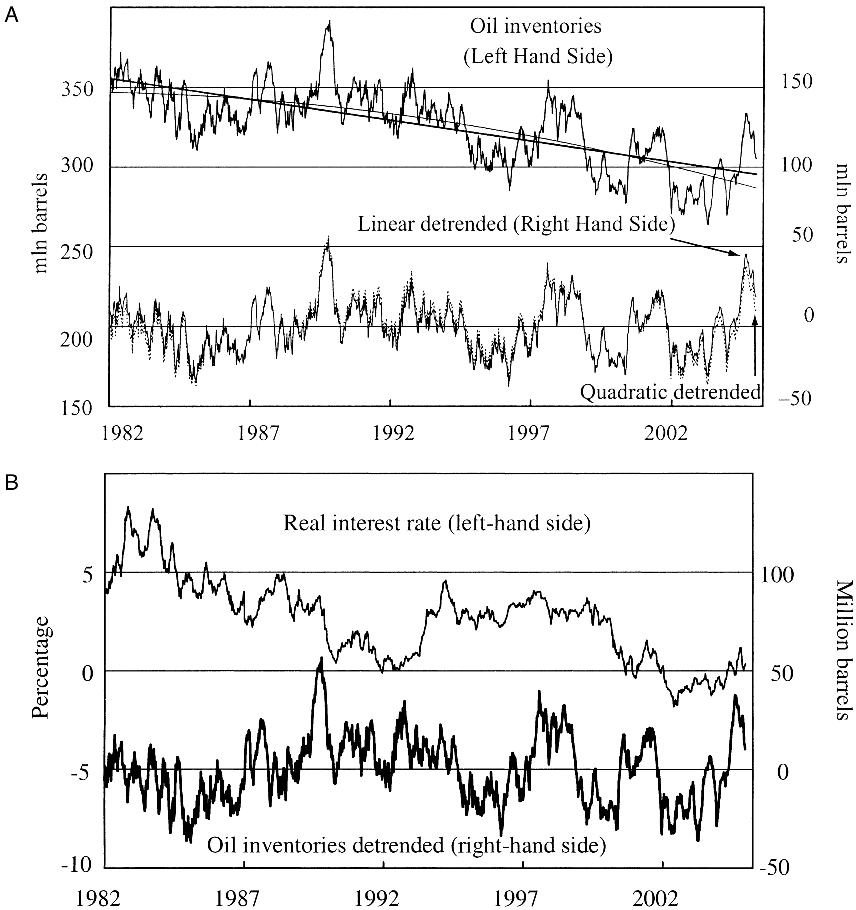

Fig. 7B.1 October 1982 to September 2005, weekly: *A*, oil inventories detrended; *B*, real interest rates and oil inventories

Table 7B.1 Relationship between oil inventories and interest rates

Regressand	Regressors	Real rate coefficient	Standard error
1. Inventories	Real rate	5.96	0.29*
2. Inventories	Real rate and linear trend	–0.69	0.35*
3. Inventories	Real rate and quadratic trend	–0.36	0.35
4. Linear detrended inventories	Real rate	–0.31	0.23
5. Quadratic detrended inventories	Real rate	–0.17	0.23
6. Hodrick-Prescott detrended inventories	Real rate	0.04	0.22

*Significant at the 10 percent level.

When the linear detrending method is used, there is a significant negative relationship between the real rate and inventories. However, this result is not robust to the use of alternative detrending methods if one fails to control for other important influences on inventory demand.

Appendix C

Relationship between Detrended Oil Inventories and Real Interest Rates Controlling for Additional Regressors

This appendix estimates an inventory equation controlling for three regressors, beyond the interest rate: risk in oil exporters, industrial activity in importing countries, and the spot-futures spread.

1: Risk in Oil Exporting Countries (Used As a Measure of Risk of Supply Disruptions)

We obtained monthly data from the Political Risk Services (PRS) Group on the "composite risk" for each of the top twelve oil exporting countries. The composite risk ratings cover political risk, economic risk, and financial risk. We have constructed a single measure for the top twelve oil exporters by arithmetically weighting the composite risk rating for each country by the country's share of world oil exports in 2003 and 2004. The countries included are (in descending order of importance): Saudi Arabia, Russia/USSR, Norway, Iran, Venezuela, United Arab Emirates (UAE), Kuwait, Nigeria, Mexico, Algeria, Libya and Iraq. A fall in the index represents an increase in risk. Since the series trends up over time, we have made the series stationary by detrending or differencing. When differencing, we use a relatively tight twelve-week change so there is not a large phase shift (see figure 7C.1).

2: Industrial Countries' Industrial Production (a Measure of Changes in Demand)

A monthly series of Industrial Production in Industrial Countries has been obtained from the International Monetary Fund (IMF), International Financial Statistics (IFS) database. Because the data were not seasonally adjusted and displayed a strong seasonal pattern, we seasonally adjusted the data using the X-12-ARIMA algorithm provided in the software Demetra. The series trended up, so detrending or differencing have been used to make the series stationary:

3: Spot—Futures Price Spread

The spot-futures price spread has been calculated by taking the percentage difference between the first futures contract (which is close to the

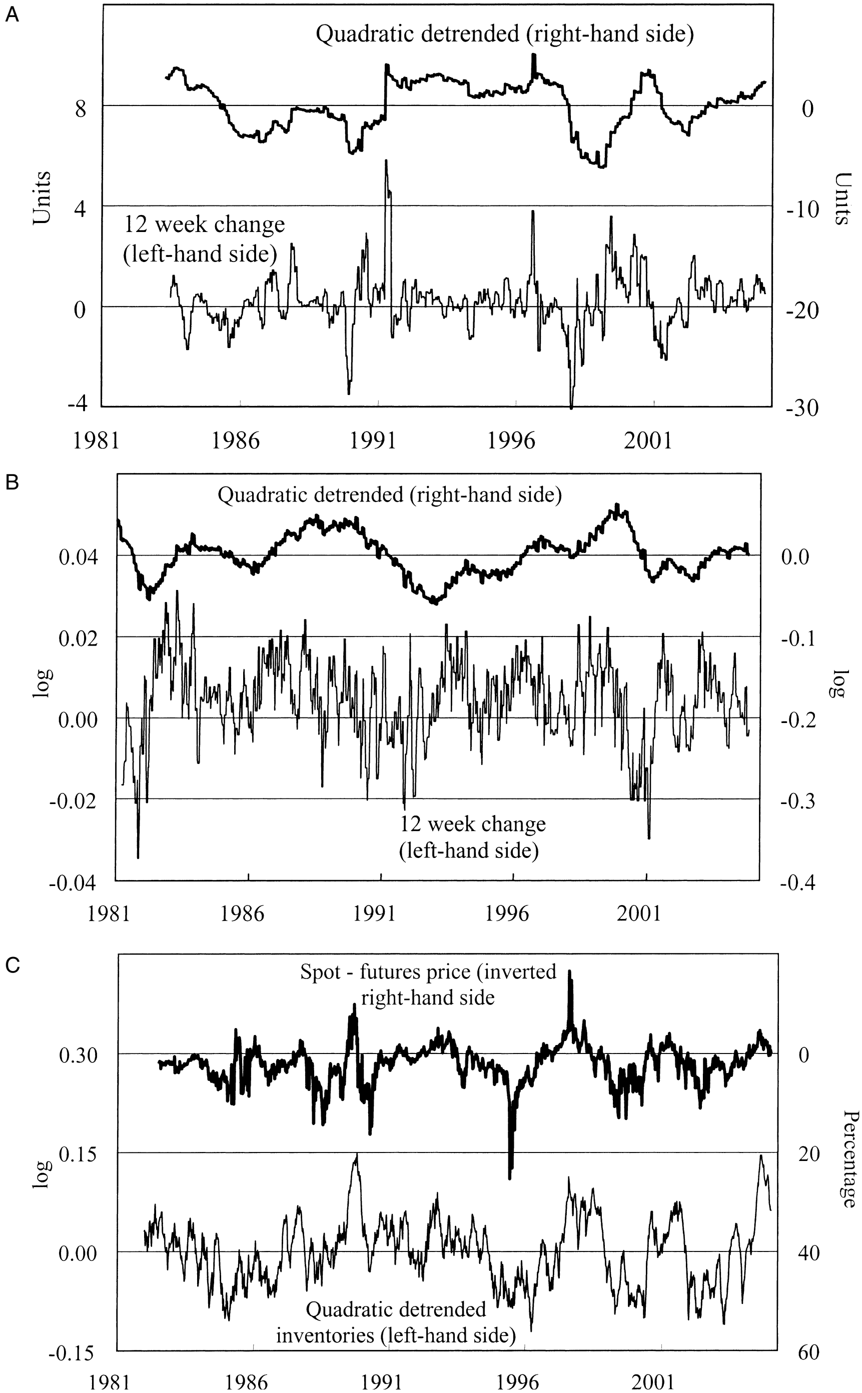

Fig. 7C.1 ***A*, Risk in top twelve oil exporters, monthly, weighted by 2003–2004 oil exports; *B*, log industrial countries IP, monthly; *C*, inventories and futures prices, weekly**

spot rate) and the third futures contract ($s + i - f$), adjusting for the three-month Treasury rate over the two-month period between the contracts (the maturity is not matched perfectly). There is quite a high correlation between this spread and movements in U.S. oil inventories:

Regression results

The relationship between weekly oil inventories and real interest rates is estimated controlling for the three regressors described in the preceding. When included individually, the **spot-futures price spread** is significant with the expected sign (when the spot price rises relative to the futures price, oil inventories fall). The twelve-week change in **oil exporter risk** is also significant with the expected sign (a negative change in the risk rating leads to an increase in oil inventories). However, **industrial production** is not significant. The real interest rate coefficient is negative in all these regressions but is not significant.

When all the regressors are included simultaneously (either in levels *or* in changes), the spot-futures spread and risk are both significant with the expected sign. The real rate coefficient is negative and significant. When **lagged inventories** are added, the real rate coefficient is no longer significant. When the spot-futures spread is assumed to be endogenous and industrial production (IP) and risk are used as instruments, the real rate coefficient is not significant (see table 7C.1).

The results are reasonably similar when the data are detrended by including quadratic terms in each regression or through a first-stage regression of each non-stationary regressor on a quadratic trend, with the residuals used in the second-stage regression where inventories is the regressand.

Table 7C.1 Relationship between inventories and interest rates (weekly data; 1,114–1,190 observations depending on data availability)

	Real rate	Spot-futures	IP	ΔIP	Risk	Δrisk	Inventories ($t-1$)
A. Nonstationary variables detrended by including quadratic terms in each regression							
Real rate only	–0.064						
	0.097						
Spot-futures spread	–0.093	–0.760**					
	0.077	0.039					
IP	–0.057		0.008				
	0.101		0.059				
12 week ΔIP	–0.014			–0.178			
	0.103			0.136			
Oil exporter risk	–0.095				0.000		
	0.103				0.001		
12 week Δoil exporter risk	–0.192					–0.009**	
	0.100					0.001	
Spot-futures, IP, risk	–0.394**	–0.821**	0.397**		–0.002**		
	0.089	0.041	0.062		0.001		
Spot-futures, IP, risk and	–0.056	–0.079**	0.052**		0.000		0.931**
lagged inventories	0.032	0.013	0.020		0.000		0.009
Spot-futures, ΔIP, Δrisk	–0.211**	–0.727**		0.131		–0.005**	
	0.085	0.040		0.126		0.001	
Spot-futures, ΔIP, Δrisk and	–0.017	–0.071**		0.009		0.000	0.937**
lagged inventories	0.032	0.012		0.045		0.000	0.009
Instrumental variables							
Spot-futures; instruments:	–0.068	0.343					
IP and risk	0.124	0.178					
Spot-futures; instruments:	–0.159	–1.313**					
ΔIP and Δrisk	0.102	0.212					
B. Inventories, IP, and oil exporter risk detrended using first stage regressions with quadratic trends							
Real rate only	–0.031						
	0.065						
Spot-futures spread	0.021	–0.754**					
	0.053	0.039					
IP	0.011		–0.003				
	0.065		0.058				
12 week ΔIP	0.043			–0.200			
	0.070			0.133			
Oil exporter risk	–0.154**				0.000		
	0.076				0.001		
12 week Δoil exporter risk	–0.226**					–0.009**	
	0.077					0.001	
Spot-futures, IP, risk	–0.131**	–0.806*	0.304**		–0.002**		
	0.067	0.042	0.062		0.001		
Spot-futures, IP, risk and	–0.027	–0.076**	0.044**		0.000		0.933**
lagged inventories	0.023	0.013	0.019		0.000		0.009
Spot-futures, ΔIP, Δrisk	–0.066	–0.723**		0.089		–0.005**	

(*continued*)

Table 7C.1 (continued)

	Real rate	Spot-futures	IP	ΔIP	Risk	Δrisk	Inventories $(t-1)$
	0.065	0.041		0.127		0.001	
Spot-futures, ΔIP, Δrisk and	–0.003	–0.070**		0.006		0.000	0.937**
lagged inventories	0.024	0.012		0.044		0.000	0.009
Instrumental variables							
Spot-futures; instruments:	–0.145	0.282					
IP and risk	0.086	0.179					
Spot-futures; instruments:	0.076	–1.368**					
ΔIP and Δrisk	0.072	0.231					

**Significant at the 5 percent level.

Appendix D

Relationship between Agricultural Inventories and Real Interest Rates, using Detrended Inventories

Annual inventories data were obtained from the U.S. Department of Agriculture for twelve agricultural commodities. For comparative purposes, we also include results using a series for petroleum inventories from the Energy Department. To make the results easier to compare across commodities, we logged the inventories series, so the coefficients are semielasticities. Quarterly inventories data are available for some commodities, but the seasonal patterns are extremely strong, so we converted all the commodities to a common annual frequency.

We estimated five regressions to explore this relationship for each commodity:

- In regression 1, there is no detrending.
- In regressions 2 and 3, linear (αt) or quadratic trends ($\alpha t + \beta t^2$) are included as extra regressors.
- Regressions 4 and 5 use a two-step procedure, first detrending the inventories series and then estimating the relationship.

The data suggest no systematic negative relationship between real interest rates and agricultural inventories. The different specifications do not appear to have a significant effect on the results. The relationship has also been estimated for the fixed effects panel of the nine commodities with data available from 1950 to 2004. This sample is broken in 1982 to test for any effect from the change in monetary policy regime. The results suggest there is a spurious positive relationship between interest rates and inventories. The results for agricultural inventories are not to be taken too seriously as we were unable to control for risk or other important variables.

Table 7D.1 Relationship between agricultural inventories and interest rates (annual data)

	Log inventories (1)	Log inventories with linear trend (2)	Log inventories with quadratic trend (3)	Linear Detrended Log inventories (4)	Quadratic detrended log inventories (5)
Hay (1950–2004)	0.023**	0.008	0.005	0.007	0.004
	(0.008)	(0.005)	0.005	0.004	0.004
Rice (1956–2004)	0.050	0.029**	0.019**	0.029**	0.018**
	(0.027)	0.013	0.010	0.013	0.009
Barley (1950–2005)	0.050**	0.048**	0.026	0.045**	0.023
	(0.019)	0.020	0.020	0.019	0.018
Sheep (1950–2005)	–0.045	0.016**	0.016**	0.015**	0.014**
	(0.026)	0.007	0.007	0.006	0.006
Hogs (1950–2004)	–0.006	–0.009	–0.010	–0.008	–0.008
	(0.004)	0.005	0.006	0.004	0.004
Cattle (1950–2005)	0.007	0.006	–0.008	0.006	–0.007
	(0.010)	0.010	0.004	0.010	0.004
Wheat (1950–2004)	0.074**	0.069**	0.063**	0.065**	0.053**
	(0.010)	0.010	0.010	0.009	0.009
Soybeans (1950–2004)	0.100**	0.023	–0.011	0.021	–0.010
	(0.041)	0.016	0.009	0.015	0.008
Oats (1950–2005)	–0.031	0.014	–0.013	0.013	–0.011
	(0.020)	0.015	0.011	0.014	0.009
Corn (1950–2004)	0.070**	0.033**	0.027**	0.031**	0.023
	(0.021)	0.011	0.013	0.011	0.012
Wool (1976–2003)	0.020	0.018	–0.013	0.018	–0.008
	(0.014)	0.016	0.028	0.015	0.016
Cotton (1965–2004)	0.004	0.010	0.045	0.010	0.039
	(0.029)	0.032	0.032	0.030	0.030
Petroleum (1973–2004)	0.029**	0.024**	0.001	0.024**	0.000
	(0.010)	0.004	0.003	0.004	0.003
(1950–2004)	0.029**			0.025**	0.010**
	0.009			0.004	0.003
(1950–1981)	0.028**			0.027**	0.016**
	0.010			0.007	0.005
(1982–2004)	0.038**			0.041**	0.004
	0.008			0.007	0.006

Note: Standard errors in parentheses.
**Significant at the 5 percent level.

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Comment Lars E.O. Svensson

This chapter makes two main points. The first point is empirical: commodity prices are decreasing in the real interest rate. The second point is a recommendation about monetary policy: central banks should stabilize the domestic price of exports, and such a policy is better than Consumer Price Index (CPI) inflation targeting.

I have no problems with the first point. Frankel provides considerable empirical evidence to support his conclusion. It also makes theoretical sense that commodity prices may be negatively correlated with real interest rates. Commodity prices can, to a large extent, be seen as asset prices. Asset prices are discounted present values of expected future returns. A rise in the real interest rate reduces the discount factors and thereby the present value of any given expected future returns. Hence, unless increases in real interest rates are systematically correlated with increases in expected returns or reductions in risk premiums, the negative effect of the real interest rate on the present value should dominate.

I have serious problems with the second point. Counter to what Frankel argues, stabilizing the price of exports seems to me to be much inferior to inflation targeting. For an oil exporter such as Norway facing the recent doubling in the international oil price, the policy would imply a drastic deflation of the CPI by approximately 50 percent. Such a policy would be truly disastrous.

Regarding the first point, should we expect commodity prices to be decreasing in the real interest rate or not? Let us consider a storable com-

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modity in period t that will be used up in period $t + 1$. Consider its pricing in period t under the simplest possible circumstances and risk neutrality. Then the price in period t, p_t, would be given by

$$p_t = \frac{-c_{t+1|t} + p_{t+1|t}}{1 + r_t},$$

where $p_{t+1|t}$ is the price expected in period t that the commodity can be sold for in period $t + 1$, $c_{t+1|t}$ is the expected storage cost between period t and period $t + 1$ to be paid in period $t + 1$, and r_t is the real interest rate between period t and period $t + 1$. If $p_{t+1|t}$ and $c_{t+1|t}$ are given, we see that p_t is decreasing in r_t. We can make this case more realistic and complex by introducing production of the commodity in each period at increasing marginal cost and use of the commodity in each period at decreasing marginal benefit. As long as marginal cost and marginal benefit are relatively independent of the real interest rate, we would still expect commodity prices to be negatively correlated with the real interest rate.

Of course, in a more realistic and complex model, commodity prices and real interest rates are endogenous variables that are simultaneously determined by the structure of the economy, the economic policies conducted, and the nature of the exogenous shocks in the economy. In particular, the correlation between commodity prices depends on the nature of the shocks that hit the economy and how these affect the variables on the right side of the preceding asset-price equation. Consider the relation between commodity prices and shocks to expected potential growth. From a simple Euler condition for optimal consumption choice, we get the following relation between the neutral (Wicksellian real) interest rate, r_t^*, the rate of time preference, ρ, and expected potential output growth, $g_{t+1|t}$:

$$r_t^* = \rho + \frac{1}{\sigma} g_{t+1|t},$$

where σ is the intertemporal elasticity of substitution. Here, potential output is the hypothetical flexprice level of output in an economy with sticky prices, and the neutral interest rate is the corresponding hypothetical flexprice real interest rate. Furthermore, monetary policy can be seen as determining the real interest rate gap, the gap between the real interest rate and the neutral interest rate, $r_t - r_t^*$. In this setting, treat potential output growth as an exogenous stochastic process, and suppose that expected potential output growth $g_{t+1|t}$ increases. Suppose that monetary policy maintains a relatively stable real interest-rate gap. Then, both r_t^* and r_t increase. Furthermore, the increase in potential output growth might increase $p_{t+1|t}$, due to increasing demand for commodity use. In this case, both the numerator and denominator in the preceding expression for the current commodity price increase, so it is no longer obvious that, for this kind of shock, commodity prices and the real interest rate are negatively correlated.

Thus, Frankel's empirical results can be interpreted as stating that the direct negative effect of the real interest rate on commodity prices dominates in most cases. This is not an obvious result, but it is arguably also not that surprising.

The second main point is the shocking suggestion (to me, at least) that pegging the export price index (PEPI) would be a better monetary policy than the (core or headline) CPI inflation targeting currently pursued in many countries. The reasons for this suggestion are not very well developed. Frankel states that PEPI has the property that an adverse terms-of-trade movement would be associated with a currency depreciation. He seems to take for granted that such a property is desirable. Frankel also states that current CPI inflation targeting has the property that an adverse terms-of-trade movement is associated with a currency *appreciation*, which consequently is considered undesirable. It would have been good to have a simple model where these properties of PEPI and CPI inflation targeting and their desirability could be demonstrated.

Is it true that PEPI has the property that an adverse terms-of-trade effect is associated with a currency depreciation? First, consider a terms-of-trade deterioration for a small open economy caused by a fall in the world price (the foreign-currency price) of exports. At an unchanged exchange rate, the domestic-currency price of exports would fall. Keeping the domestic-currency price of exports stable, as PEPI implies, would, hence, indeed require a currency depreciation. Second, consider a terms-of-trade deterioration caused by a rise in the world price of imports at an unchanged world price of exports. At an unchanged exchange rate, the domestic-currency price of exports would remain the same. Hence, in this case, PEPI requires a constant exchange rate and no currency depreciation. Third, consider a terms-of-trade deterioration associated with a rise in the world prices of both exports and imports (that is, with a larger rise in the price of imports than in the price of exports). At an unchanged exchange rate, the domestic price of exports would rise. Hence, in this case, PEPI requires an appreciation of the home currency. Thus, it is not always the case that PEPI implies that an adverse terms-of-trade effect is associated with a currency depreciation.

The optimal policy for the exchange rate in the face of a terms-of-trade deterioration is not obvious and requires a more elaborate model and analysis than there is room for here. Because that step is crucial for Frankel's argument, there should arguably be room for such a model and analysis in his chapter.

Frankel does not provide any convincing argument that inflation targeting is problematic. To be more specific, consider flexible (core) CPI inflation targeting, which is practiced in many countries. This involves stabilizing both the inflation gap between inflation and an inflation target and the output gap between output and potential output. It seems to work fine in both advanced and emerging-market countries. That it works fine in advanced countries is well known. What is somewhat new is that it seems to work so well in many emerging-market countries. The International Monetary Fund (IMF) *World Economic Outlook* of September 2005 notes that inflation targeting has worked fine in a number of emerging-market countries. No country that has adopted inflation targeting has abandoned it, and no country has even expressed any regrets. In particular, inflation targeting seems to work fine even without a number of so-called preconditions, such as good institutions, well-developed financial markets, responsible fiscal policies, and so forth.

Frankel's PEPI may be interpreted as inflation targeting with the CPI price index being replaced by the export price index. But what price index should inflation targeting ideally refer to? Theoretical work by Kosuke Aoki, Pierpaolo Benigno, and others has emphasized that, from a welfare point of view, monetary policy should stabilize sticky prices rather than flexible prices. This minimizes the distortion caused by the existence of sticky prices and brings the economy closer to a flexprice equilibrium. These results can be interpreted as favoring a core CPI or domestic inflation targeting. In particular, these results suggest that central banks should not try to stabilize flexible commodity prices, in direct contradiction to PEPI. Other often-mentioned reasons for choosing a CPI-related index is that the CPI is the index best known by the general public, that stabilizing it would simplify decisions for the average consumer, that it is frequently published, and that it is usually not revised. Indeed, all inflation targeting central banks have chosen the CPI or a core CPI.

The PEPI would imply riding a tiger. Consider Norway, a major oil exporter. The oil price has approximately doubled in a few years. This is a huge terms-of-trade improvement for Norway. Frankel would prefer that Norges Bank, the central bank of Norway, stabilizes the domestic price of oil. In order to keep the domestic-currency price of oil from rising, Norges Bank would have had to double the value of the Norwegian krone during this time, that is, to have had to induce a 100 percent appreciation of the krone. This would be an extremely contractionary policy. Put differently, under the simplified assumption that the relative price of oil to consumer goods has doubled, achieving this new relative price in Norway at an unchanged domestic-currency price of oil requires that other consumer prices are reduced by 50 percent. Thus, Frankel is suggesting that it would have been better for Norway and the Norwegians if Norges Bank had induced such a huge deflation.

How should the central bank respond to oil-price changes (or any terms-of-trade changes)? This follows from the principles of Good Monetary Policy (Svensson 2002). Indeed, for monetary policy, oil-price changes are not very special: they are just another shock (although potentially large and persistent). Good Monetary Policy is flexible inflation targeting, which can more narrowly be specified as aiming at both stabilizing inflation around an inflation target and stabilizing the output gap around zero. Furthermore, the lags between monetary policy actions on one hand and the effects on inflation and output on the other hand imply that central banks should do "forecast targeting." That is, they should look at forecasts of inflation and set the interest-rate path (or plan) such that forecasts of inflation and the output gap "look good." Here, look good means that the inflation forecast (path) approaches the inflation target and the output gap forecast (path) approaches zero. In other words, look good means a reasonable compromise between stabilizing inflation and stabilizing the output gap. These principles for Good Monetary Policy are very simple to state. The practice of achieving them can be quite difficult, though.

Implementing inflation targeting requires interpreting and understanding the nature of the disturbances hitting the economy. Terms-of-trade movements are movements in the *relative* price between exports and imports. Relative-price movements have both income and substitution effects on aggregate demand that need to be sorted out. Terms-of-trade movements can also be accompanied by movements in world inflation or the world price level. Such movements are movements in *absolute* prices, the effects of which also need to be sorted out. A standard problem for inflation targeting central banks is to assess whether incoming shocks are temporary or persistent, for instance, whether a particular shock corresponds to a one-time price-level shift or a persistent inflation-level shift. Making such assessments is a standard part of the analysis by inflation targeting central banks.

These principles and analysis are routinely applied by central banks to oil-price changes (Svensson 2005). Oil-price changes shift inflation and output-gap forecasts at a given interest rate path (they have both income and substitution effects and lead to shifts in the forecasted inflation, output, and potential-output paths). After such shifts, these forecasts may no longer look good. Then central banks adjust the interest-rate path, so the inflation and output-gap forecasts look good again.

What happens to the exchange rate during these shifts? That depends, since the impact of oil-price changes is quite complex. A short answer is whatever is consistent with the optimal inflation, output-gap, and interest-rate forecasts. In some cases, a depreciation is called for, in other cases, an appreciation. Importantly, under inflation targeting, the exchange rate is not a target variable, and there is no target exchange rate level.

In each *Monetary Policy Report* (available at http://www.norges-bank.no), Norges Bank routinely analyzes these issues and presents its conclusion and decision in the form of informative graphs of an optimal instrument rate, inflation, output-gap, and exchange rate forecast, with fan charts emphasizing the unavoidable uncertainty of the forecasts. This inflation and output-gap forecast represents the bank's best compromise between stabilizing the inflation gap and the output gap. The bank presents a baseline scenario but also alternative scenarios with alternative assumptions about exogenous disturbances and the transmission mechanism. This is an excellent example of current best-practice inflation targeting.

My point with this reference to routine elements of the *Monetary Policy Report* of Norges Bank is that there is absolutely no reason to abandon flexible inflation targeting for PEPI. Flexible inflation targeting is superior in handling all kinds of disturbances. The PEPI would be a disaster.

References

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Discussion Summary

Jeffrey A. Frankel responded to Lars E.O. Svensson that there is limited popular understanding of the core Consumer Price Index (CPI) which makes this a less suitable price index for inflation targeting than Svensson suggested. Frankel also argued that even those who are unwilling to peg an export price index should place some extra weight on export prices in defining the price index that is to be targeted.

William C. Dudley asked why a commodity price change should demand a monetary policy response if it was merely a relative price change. Frankel responded that he thought of commodity price changes as informative about the natural rate of interest, just as previous discussion had suggested that other asset prices were a useful input in estimating the natural rate.

Donald L. Kohn said that a jump in commodity prices would tell policymakers that the natural interest rate had declined, but that commodity prices would then tend to drift down. It was hard to know how central banks could distinguish initial jumps from subsequent movement.

Martin Schneider pointed out that the effects of interest rates seemed strongest on perishable goods. Frankel agreed that this was surprising.

Andrew Levin said that, judging from the graphs, the results from fifty years of data were being driven by three outlier years. On the topic of interest rates driving commodity prices, he was skeptical in the case of a commodity such as hogs: he wondered whether the relationship was being driven not by intertemporal optimization, but rather by some kind of aggregate demand shift. Frankel argued that farmers should satisfy an intertemporal optimization condition. Simon Gilchrist observed that commodities such as soybeans require large amounts of land; he suggested that this might explain why interest rates were important. Regarding pegging export prices, Levin said that the optimal policy regime should vary from country to country. In the case of Ghana, for example, with a centralized market for cocoa, it was most important to ensure that the currency is stable against the U.S. dollar.

Tommaso Monacelli said that for terms of trade to enter the loss function, all that was required was to have a non-Cobb-Douglas utility function.

Lars E.O. Svensson said that a country with volatile terms of trade may wish to consider other strategies for insuring against the welfare effects of changes in the terms of trade. Norway, for example, saves part of its windfall gain from rising oil prices in a national fund invested in global assets. Other countries should consider emulating this approach.