The Impact of Monetary Policy Shocks on Commodity Prices*

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Global monetary conditions are often cited as a driver of commodity prices. This paper investigates the empirical relationship between U.S. monetary policy and commodity prices by means of a standard VAR system, commonly used in analyzing the effects of monetary policy shocks. The results suggest that expansionary U.S. monetary policy shocks drive up the broad commodity price index and all of its components. While these effects are significant, they do not, however, appear to be overwhelmingly large.

JEL Codes: E31, E40, C32.

1. Introduction

Commodity price developments have been one of the major sources of concern for policymakers in recent years. After surging rapidly to unprecedented levels in the course of 2008, commodity prices fell abruptly in the wake of the financial crisis and global economic downturn. Since the beginning of 2009, however, they first stabilized and then resumed an upward path, characterized by relatively high volatility. As commodity prices in general—and the price of oil in particular—are an important component of a consumer price index (CPI), their evolution and the driving forces behind them are clearly crucial for the conduct of monetary policy (Svensson 2005).

*We gratefully acknowledge useful comments received from the editor and two anonymous referees. We also thank Lutz Kilian, Ron Alquist, and all seminar participants at the Bank of Canada, the Bank of Chile, and the Bank of England. Views expressed in this paper are solely those of the authors and should not be attributed to the Bank of Italy or the BIS. Author e-mails: alessio.anzuini@bancaditalia.it; marco.lombardi@bis.org (corresponding author); patrizio.pagano@bancaditalia.it.

A wide strand of literature has examined the impact of commodity prices—oil in particular—on macroeconomic variables (see, e.g., Kilian 2008 for a survey), but less attention has been devoted to the other direction of causality, i.e., the impact of monetary conditions on oil and other commodity prices. In this paper we focus on the latter relationship to analyze how far an expansionary monetary policy shock can drive up commodity prices and through which channel.

While supply and demand factors can generally explain the bulk of the fluctuations in commodity prices, other forces may at times play a role (Hamilton 2009). Kilian (2009) and Alquist and Kilian (2010) highlight the relevance, in the behavior of oil prices, of precautionary demand shocks, which increase current demand for oil through increased uncertainty about future oil supply shortfalls.[1] Since the seminal contribution of Frankel (1984), monetary conditions and interest rates have attracted attention as possible driving factors of commodity prices. Frankel (1986) extends Dornbusch's theory of exchange rate overshooting to the case of commodities and, using no-arbitrage conditions, derives a theoretical link between oil prices and interest rates. Barsky and Kilian (2002, 2004) show that monetary policy stance is a good predictor of commodity prices. In particular, Barsky and Kilian (2002) also suggest that the oil price increases of the 1970s could have been caused, at least in part, by monetary conditions.[2]

Most of the empirical literature devoted to the assessment of the relationship between monetary policy and commodity prices has focused on the U.S. interest rate as an indicator of monetary policy stance (Frankel 2007; Frankel and Rose 2010). However, interest rates may not fully represent the impact of a monetary policy shock and, more importantly, their movements can reflect the endogenous response of monetary policy to general developments in the economy. For instance, Bernanke, Gertler, and Watson (1997), using a VAR framework, suggest that positive shocks to oil prices induce a monetary policy response which can amplify the contractionary

[1] Anzuini, Pagano, and Pisani (2007) show that such oil shocks contributed significantly to U.S. recessions.

[2] Nakov and Pescatori (2010) argue, in line with Kilian (2009), that oil prices should be treated endogenously in dynamic stochastic general equilibrium models as well. Hence, Gillman and Nakov (2009) find that nominal oil prices react proportionally to nominal interest rate shocks.

effects of the oil price shock itself. Kilian and Lewis (2011), however, report no evidence of a systematic Federal Reserve reaction to oil shocks after 1987.

During the commodity price surge of 2008, some commentators suggested that loose monetary policy and persistently low interest rates could have, at least in part, fueled the price hike (Hamilton 2009). If this is so, then it is important to understand whether and to what extent the massive monetary policy easing now taking place will sow the seeds of another surge in commodity prices. In this paper, we do not work with a plain analysis of co-movement between commodity prices and interest rates; instead we identify a monetary policy shock in a VAR system for the U.S. economy and then assess its impact on commodity prices. This allows us not only to examine the impact of monetary policy net of other interaction channels but also to avoid employing indicators of global monetary conditions that are inherently difficult to measure. More specifically, we use a standard identification scheme for the monetary policy shock (Kim 1999) and then project each of the commodity prices on this shock in order to single out the responses of the different prices to the same monetary policy shock. We find empirical evidence of a significant impact of monetary policy on commodity prices. In particular, a 100-basis-point expansionary monetary policy shock drives up moderately the broad commodity price index and all of its major components, with the increase ranging from 4 to 7 percent at the peak. Although the methodology is very different, our approach is similar in spirit to that of Frankel and Hardouvelis (1985), who investigated the impact of money-supply announcements on commodity prices; the main difference is that we work with an identified monetary policy shock in a VAR system.

We assess the robustness of the results by repeating the exercise using several different identification strategies of the monetary policy shock that are commonly used in the literature. In particular, remaining in a VAR context, we also use a Choleski identification strategy similar to that proposed by Boivin and Giannoni (2006) and the one based on sign restrictions in the spirit of Canova and De Nicolò (2002) and Uhlig (2005). We also analyze the effect on commodity prices of both the monetary policy shocks identified according to Kuttner (2001) and to Romer and Romer (2004). We conclude that, overall, all these strategies lead to similar conclusions.

The decomposition of the forecast-error variance suggests that monetary policy shocks help predict fluctuations in commodity prices, even though they are not the major source of them. Regarding the commodity price surge between 2003 and 2008, historical decomposition shows that accumulated past monetary policy shocks contributed to the increase in the broad commodity price index and in its main components, but they explain just a small part of the peak in the price of oil and nothing of that in food prices.

Finally, we shed some light on the channels through which monetary policy shocks may affect commodity prices as suggested by Frankel (2007), focusing on the case of oil. In particular, we show that the positive impact on oil prices of a monetary policy loosening can be ascribed to incentives to stock accumulation and to disincentives to immediate production; the link with financial flows is much less evident.

The paper is organized as follows. In section 1 we evaluate the impact of monetary policy shocks on the commodity price index and on its major components, describing first the data and the VAR framework. Next, we present an impulse response analysis. In section 2 we evaluate the extent of the role of monetary policy shocks in explaining commodity price fluctuations. In section 3 we focus on the transmission channels through which monetary policy may directly affect commodity prices. The last section contains some concluding remarks.

2. Monetary Shocks and Commodity Prices

2.1 Data and Model Details

To gauge the quantitative effect of monetary policy shocks on commodity prices, we estimate a VAR for the United States, the largest oil-consuming economy in the world. Our data set consists of monthly variables from January 1970 to December 2008.[3] Admittedly, this covers a very long time span during which policy shifts may have occurred, as documented also by Barsky and Kilian (2004).

[3] We decided to shorten the endpoint of the sample at the end of 2008, as the federal funds rate was then decreased to almost zero and that lower bound might impair the identification scheme.

For a robustness check, we also estimate the model on a restricted, post-Volcker sample starting in January 1980. Results, omitted to save on space, display no significant difference, however. The variables are the federal funds rate, the money stock (M2), the CPI, the industrial production index, and a commodity price index (in dollars).[4] After identifying the monetary policy shock, we add, ordered as last, the commodity price sub-category for which we are interested in recovering the response.[5]

We consider several commodities, one at a time, but to save on space we only report results for four commodity prices: a broad index, two sub-indices (metals and foodstuffs), and crude oil. Commodity prices are included in the reaction function of monetary policy to control for imported inflation. While a generalized increase in commodity prices is likely to generate an increase in domestic inflation and prompt a reaction of the Federal Reserve, a change in the relative price of a commodity is less likely to have a significant domestic inflation effect, prompting a contemporaneous (within a month) reaction of the Federal Reserve. Dropping the price of the sub-components from the analysis would eliminate the possibility of disentangling the asymmetric impact of monetary policy on different commodity prices.

We estimate a VAR system including the federal funds rate, industrial production, M2, CPI, and the commodity price index. All variables except the federal funds rate are in log-level and are stored in the vector y_t.

The structural form is therefore

$$C\left(L\right)y_t = \eta_t,$$

where $C\left(L\right)$ is a polynomial matrix in the lag operator and $Var\left(\eta_t\right) = \Lambda$ is a diagonal matrix with the variances of the structural

[4]The index is the Commodity Research Bureau Spot Price Index. The list of commodities included is available at www.crbtrader.com/crbindex/spot_current.asp. It does not include oil and energy prices.

[5]In practice, we assume that all variables have a contemporaneous effect on the price of the commodity for which we want to recover the response, but this last variable does not contemporaneously affect all the others.

shocks as elements. We estimate (ignoring predetermined variables) the reduced form:

$$y_t = A(L)\, y_{t-1} + \varepsilon_t,$$

where $A(L)$ is a polynomial matrix in the lag operator and $Var(\varepsilon_t) = \Sigma$ and $\eta_t = C_0 \varepsilon_t$ and therefore $\Sigma = C_0^{-1} \Lambda C_0^{-1\prime}$.

In order to obtain a just identified system, we need $\frac{n(n-1)}{2}$ restrictions. Our baseline identification scheme to identify a U.S. monetary policy shock is the same as in Kim (1999):

$$\begin{bmatrix} \eta_t^{ms} \\ \eta_t^{md} \\ \eta_t^{cpi} \\ \eta_t^{ip} \\ \eta_t^{com} \end{bmatrix} = \begin{bmatrix} 1 & g_{12} & 0 & 0 & g_{15} \\ g_{21} & 1 & g_{23} & g_{24} & 0 \\ 0 & 0 & 1 & g_{34} & 0 \\ 0 & 0 & 0 & 1 & 0 \\ g_{51} & g_{52} & g_{53} & g_{54} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_t^{ms} \\ \varepsilon_t^{md} \\ \varepsilon_t^{cpi} \\ \varepsilon_t^{ip} \\ \varepsilon_t^{com} \end{bmatrix},$$

where the η's denote the structural disturbances while the ε's are the residuals in the reduced-form equations, which by construction represent unexpected movements (given the information in the system) of each variable. All restrictions are zero (exclusion) restrictions.

The first line of the VAR system, where the interest rate appears on the left-hand side, is a money-supply equation modeled as a reaction function of the monetary authority; irrespective of the identification scheme used, this interpretation is standard in the literature. Here the assumptions are that the current level of prices and industrial production are not available to the monetary authorities owing to information delays.

The second line is a standard money-demand equation. The demand for real money balances depends on real activity and the opportunity cost of holding money—the nominal interest rate. The third and fourth lines encapsulate the hypothesis of price stickiness or adjustment costs: real activity responds to price and financial signals only with a lag. The interest rate, money, and the commodity price index are assumed not to affect real activity contemporaneously. The last equation is an arbitrage equation which describes equilibrium in the commodity market as a kind of financial market equilibrium. All variables are assumed to have contemporaneous effects on the commodity price.

As is common in the oil literature (e.g., Kilian 2009), we select twelve lags: with monthly data our lag structure captures one year of dynamics, which appears to be sufficient to eliminate autocorrelation of residuals.[6]

After identifying the shock, we reestimate the system adding the oil price or the single commodity price for which we want to trace the response, and the scheme becomes the following:

$$\begin{bmatrix} \eta_t^{ms} \\ \eta_t^{md} \\ \eta_t^{cpi} \\ \eta_t^{ip} \\ \eta_t^{com} \\ \eta_t^{oil} \end{bmatrix} = \begin{bmatrix} 1 & g_{12} & 0 & 0 & g_{15} & 0 \\ g_{21} & 1 & g_{23} & g_{24} & 0 & 0 \\ 0 & 0 & 1 & g_{34} & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ g_{51} & g_{52} & g_{53} & g_{54} & 1 & 0 \\ g_{61} & g_{62} & g_{63} & g_{64} & g_{65} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_t^{ms} \\ \varepsilon_t^{md} \\ \varepsilon_t^{cpi} \\ \varepsilon_t^{ip} \\ \varepsilon_t^{com} \\ \varepsilon_t^{oil} \end{bmatrix}.$$

In ordering the new price as last, we allow for a contemporaneous effect of all other variables on this price while assuming that any shock to the last variable will affect all other variables with a one-month delay.[7] Kilian and Vega (2011), however, report no evidence of any contemporary and systematic reaction of oil prices to macroeconomic announcements. Based on this result, we conduct some robustness analyses, testing some over-identifying restrictions; in particular, we estimate a system where $g_{62} = g_{63} = g_{64} = 0$ and results are virtually unchanged. We then exclude commodity price from the Federal Reserve reaction function ($g_{15} = 0$), and again results do not change.[8]

2.2 The Impact of a Conventional Monetary Policy Shock

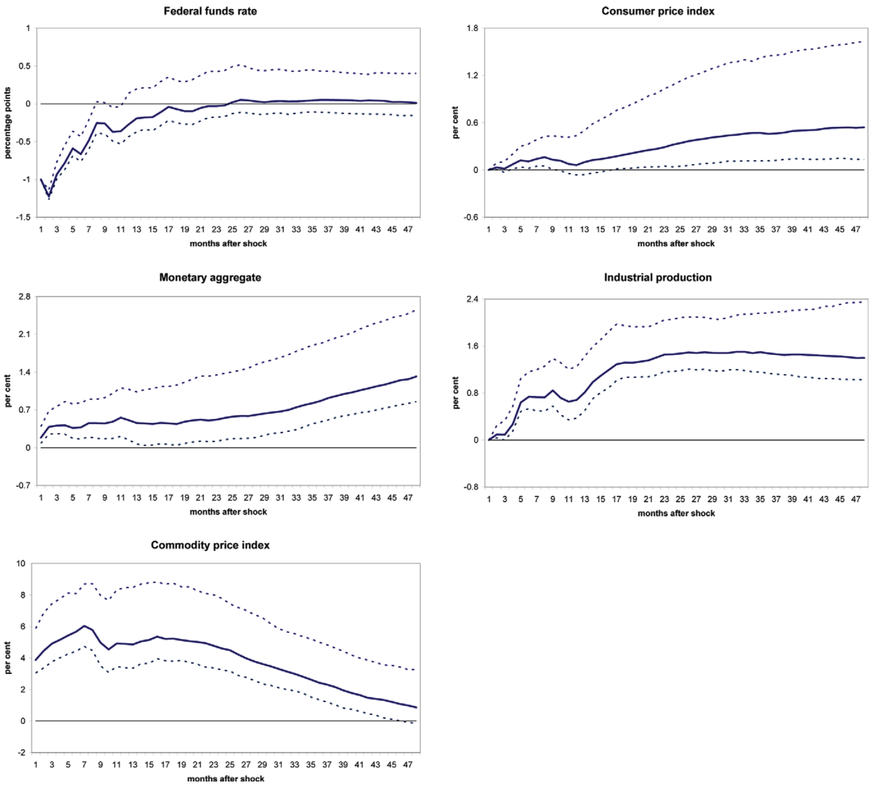
As explained, the U.S. monetary policy shock is identified in a five-variable VAR system. Here we focus on the response of the commodity price index, which is the variable ordered as last, to the

[6]However, we checked that results remained unchanged using from ten up to fourteen lags.

[7]Pagano and Pisani (2009) document that taking into account business-cycle indicators may help in forecasting oil prices.

[8]Note that in our identification scheme the Federal Reserve never responds to the price development of a single commodity. Moreover, it is worth remembering that, in general, a non-zero coefficient in the impact matrix means that variables may respond contemporaneously to shocks, not that they necessarily do so.

Figure 1. Impulse Response Functions to a 100-Basis-Point Monetary Policy Easing



Note: The x-axis reports the months after the shock. Dashed lines are 68 percent confidence bands.

monetary policy shock, defined as a 100-basis-point reduction in the federal funds rate equation (figure 1).

All responses have the expected sign. Focusing on the response of the commodity price index to the monetary shock, this peaks rather quickly at 6 percent after just seven months, and then the effect slowly diminishes.[9] The response appears to be significant and

[9]In the VAR literature addressing the effects of monetary policy shocks, following the suggestion of Sims (1992), the commodity price index is commonly included in the analysis in order to solve the so-called price puzzle: the negative

persistent, as it takes three years to converge back to the baseline. The magnitude of the effect, however, is not very large given that the monetary policy shock leads to an increase in the commodity price index of roughly 4.5 percent in the first two years after the shock.[10] As the effect on commodity prices is positive and significant on impact and the CPI responds only sluggishly, there is a significant effect of monetary policy on relative prices. This effect is, however, reabsorbed in the medium run, when the CPI starts to increase and commodity prices converge back to lower levels. The hump-shaped response of commodity prices testifies to an initial overshooting—which disappears after a few quarters—with respect to their long-run level. This effect is usually (see, e.g., Furlong and Ingenito 1996) ascribed to the greater flexibility of commodity prices with respect to the prices of other items. This interpretation may suggest that part of the increase in commodity prices is due to the increase in the short-term inflation expectations following a monetary expansion.

2.3 The Impact on Individual Commodity Prices

After identifying the monetary policy shock, we add to the system the commodity price for which we want to trace the response.[11] For all the commodities considered, a monetary expansion generates an increase in price, yet its size and time path vary considerably (figure 2).

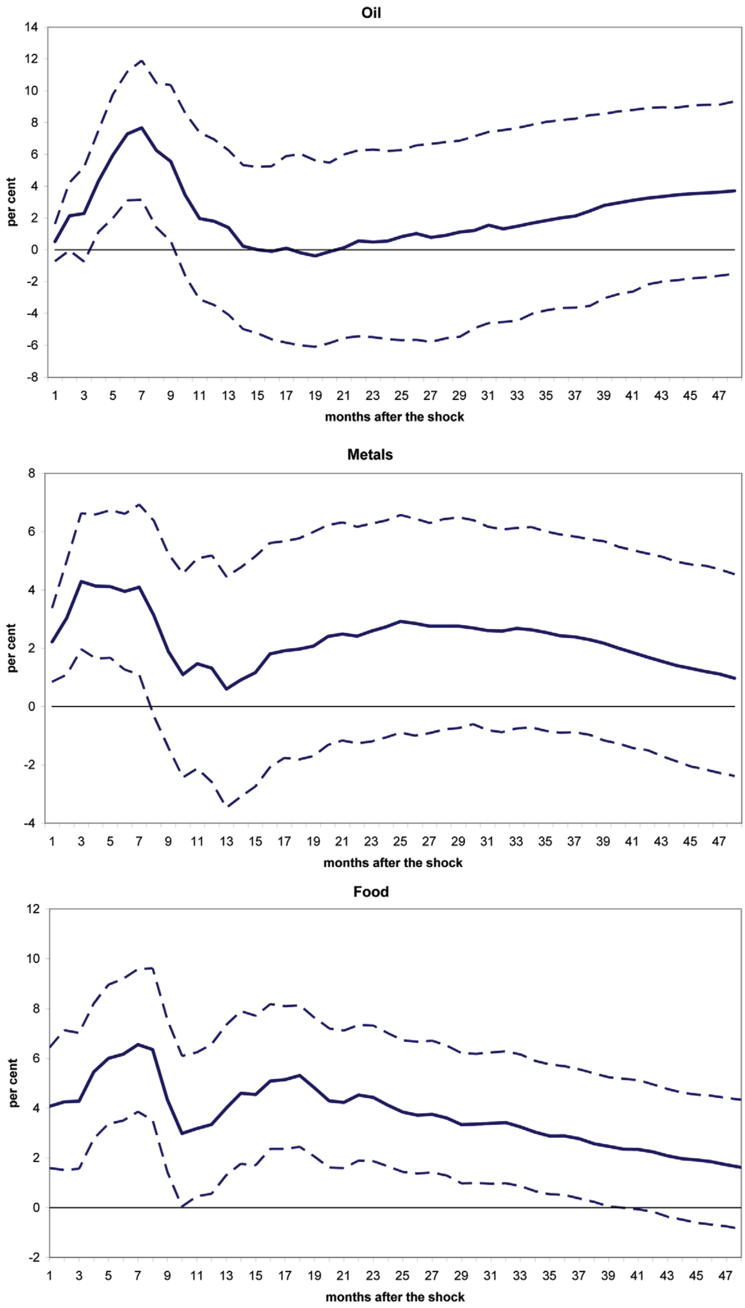
The impact on oil is rather sharp, peaking six months after the shock, but it then vanishes after ten months. The response of metals is rather similar, although it has a second (albeit not significant) peak two years after the shock. Food commodities instead respond

(positive) response of the CPI, on impact, to expansionary (contractionary) monetary policy shocks. When the commodity price index is included in the system, the response of the CPI to a monetary policy shock turns out to be in line with predictions from economic theory. The increase in commodity prices that we show is consistent with many previous studies employing VAR methodology, such as Sims (1992), Christiano, Eichenbaum, and Evans (1999), and Kim (1999).

[10] Note that our monetary policy shock has been normalized to 100 basis points, which is quite larger than the usual one-standard-deviation shock used in the literature.

[11] This procedure is often referred to as the "marginal method" and has been proposed by Kim (2001).

Figure 2. Response of Individual Commodities to a 100-Basis-Point Monetary Policy Easing



Note: Dashed lines are 68 percent confidence bands.

in a more persistent fashion, as the effects remain significant up to three years after the shock has occurred. In all cases the size of the response is quite moderate, ranging between 4 and 7 percent at the peak.

While the increase in the prices of oil and of other commodities involved in the industrial process is intuitive, explaining the increase in food price is trickier. One explanation, put forward in Timilsina, Mevel, and Shrestha (2011), is that an increase in oil prices would reduce the global food supply through direct impacts as well as through the diversion of food commodities and cropland towards the production of biofuels.

2.4 Robustness

Results presented above rest on the identifying assumptions of the monetary policy shock. Admittedly, the scheme we have employed (Kim 1999) is not the only one possible, and we chose it on the grounds of its close connection with our setup, as well as for its simplicity and widespread use in the literature. In this section we examine to what extent our results remain valid when using different identification schemes for the monetary policy shock. The literature on monetary policy shocks is vast and we do not aim to be exhaustive. Rather, we concentrate on four schemes that somehow stem from different approaches to the issue and which are very popular in the applied literature.

The first alternative shock we consider follows an approach similar to that of Christiano, Eichenbaum, and Evans (1996, 1999) and is based on a simple VAR with Choleski identification featuring (in order) output, CPI, commodity prices, and the federal funds rate.[12] This approach has become very popular in the recent years, due to its simplicity.

The second alternative identification scheme is based on sign restrictions. Following Faust (1998), Canova and De Nicolò (2002),

[12]Christiano, Eichenbaum, and Evans (1996) work with quarterly variables and use GDP as a measure of output and the GDP deflator as a measure of inflation. Given our monthly setup, we had to replace this with, respectively, industrial production and CPI. However, this does not seem to affect the validity of the identification scheme. Correspondingly, as they employ four lags, we select twelve. Note also that this scheme has more recently been used by Boivin and Giannoni (2006).

and Uhlig (2005), we impose sign restrictions directly on impulse responses; i.e., after an expansionary monetary policy shock, the interest rate falls while money, output, and prices rise.[13] As we focus on the response of commodity prices, no restriction is imposed on this variable. The response of the single sub-component of the commodity price index is then obtained (as before) by simply adding the new variable to the old system without any further restriction. The actual implementation of this scheme is obtained through a QR decomposition following Rubio-Ramírez, Waggoner, and Zha (2010). We will use this identification strategy only to assess the robustness of the response of commodity prices (and sub-components) to a monetary policy shock. While in our view sign restrictions are a useful tool in SVAR analysis, we acknowledge that they have been the subject of some criticism, given that all percentiles of the distribution in this case are computed across different rotations, which correspond to different models (Fry and Pagan 2007). To circumvent this critique, we could extract a monetary policy shock by selecting an arbitrary rotation or averaging across shocks generated by different rotations; however, as a certain degree of arbitrariness would be involved in this process, we decided not to use the shock series implied by this identification procedure in the robustness analysis of the transmission channel of the next section.

We then move to other identification schemes not based on a VAR: our third alternative relies instead on financial market information. Kuttner (2001) proposes gauging a monetary policy shock by subtracting from the actual change in the federal funds rate its expectation, i.e., computing the difference between federal funds futures immediately before and after the decision of the Federal Open Market Committee (FOMC). The idea is that many of the monetary policy decisions (and often the size of the change) are expected and therefore cannot be labeled "shocks." The remaining monetary policy "surprises" that agents face should therefore produce stronger effects. This series of monetary policy shocks is available since 1989, when the futures market for the federal funds rate was established at the Chicago Board of Trade. To determine how

[13]Such responses are constrained for three periods. The lags included in the VAR are twelve.

commodity prices respond to monetary shocks, we simply regress the log change in the commodity price index on a constant, its own lagged values, and lagged values of the policy measure. The lagged values of the shock series are included to capture the direct impact of shocks on commodity price changes, and the lagged values of commodity price changes are included to control for the normal dynamics of the commodity price index.[14]

The last alternative monetary policy shock series we consider is that derived by Romer and Romer (2004). This scheme combines narrative accounts of each FOMC meeting included in the minutes with the Federal Reserve's internal forecasts of inflation and real activity (the "Greenbook" forecasts) to purge the intended funds rate of monetary policy actions taken in response to information about future economic developments. The resulting series of monetary shocks should show changes in the funds rate not made in response to information about future economic developments. Unfortunately, the series is not very up-to-date, as it is available only from January 1969 to December 1996.[15]

The different methodologies generally display an increase in commodity prices in the first few months after the shock has occurred: for instance, in table 1 we report the peak values of the impulse response functions obtained under each identification scheme considered and the month when such peak occurs.[16] On impact, the

[14]We included eighteen lags of (log) commodity price changes and four lags of the monetary policy measure, plus a complete set of monthly dummies.

[15]In the regression with such shock, we include eighteen lags of log commodity price changes and six lags of the monetary policy measure, plus a complete set of monthly dummies.

[16]It is worth noting that this result also appears in other VAR studies on the effects of monetary policy shocks. For instance, Christiano, Eichenbaum, and Evans (1996), in a recursive VAR featuring (in order) real GDP, GDP deflator, an index of commodity prices, the federal funds rate, non-borrowed reserves, total reserves, and an indicator of aggregate production activity (such as employment), find that a standard deviation increase in the federal funds rate delivers a significant and persistent fall in the commodity price index. An analogous conclusion is reached by the same authors (Christiano, Eichenbaum, and Evans 1999) in a VAR featuring, in order, industrial production, CPI, an index of commodity prices, the federal funds rate, non-borrowed reserves, and total reserves. Faust, Swanson, and Wright (2004) find a similar result in a VAR featuring the same variables, but having identified the monetary shock with high-frequency financial market data.

Table 1. Peak Responses of Various Commodity Prices after a Differently Identified Monetary Policy Shock

	Kim	Choleski	Sign Restrictions	Romer & Romer	Kuttner
Commodity Index	6.0 [6]	0.7 [6]	3.4 [6]	2.7 [15]	4.0 [3]
Oil	7.7 [6]	2.1 [5]	14.4 [5]	3.0 [4]	7.1 [5]
Metals	4.3 [2]	0.2 [2]	5.0 [6]	2.0 [13]	8.6 [3]
Food	6.6 [6]	2.4 [5]	5.7 [3]	8.0 [4]	6.2 [3]

Notes: Maximum percentage changes of commodity prices after a –100-basis-points monetary policy shock identified with different methodologies. For Kim, Choleski, and sign restrictions: median responses. In square brackets: month of the maximum response.

responses obtained with the monetary shock à la Kuttner (2001) are the most similar to those with Kim's identification, but they are also rather short-lived; the other responses are less pronounced but considerably more persistent.[17] Overall, the robustness exercise supports the above conclusion that commodity prices increase after an expansionary monetary policy shock but that the size of the effect is generally moderate.

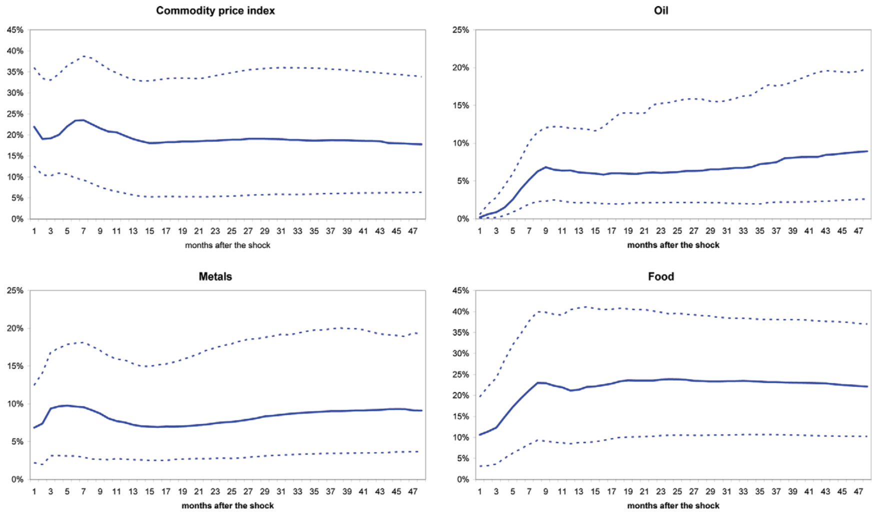
3. Monetary Policy and Commodity Prices Fluctuations

3.1 Forecast-Error-Variance Decomposition

Given the significant effect of monetary shocks, one may wonder how large is their relative contribution to overall commodity price fluctuations. This question can be tackled by means of a forecast-error-variance decomposition, which measures the percentage share of the forecast-error variance due to a specific shock at a specific time horizon.

[17] Scrimgeour (2010) estimates the effect of a monetary policy surprise on commodity prices with an instrumental-variables method, finding a very similar result: a 100-basis-point surprise increase in interest rates leads to an immediate 5 percent decline in commodity prices.

Figure 3. Forecast-Error-Variance Decomposition



Note: Dashed lines are 68 percent confidence bands.

In figure 3 we report the forecast-error-variance decomposition of the commodity price index and individual commodities with respect to the monetary shocks. The horizons at which forecast errors are calculated are indicated on the x-axis. The median percentage of the variance of the commodity index hovers around 20 percent, whereas contributions to oil and metals prices are, respectively, around 6 and 8 percent. Food commodities appear to have responded more strongly to monetary policy shocks, posting a variance contribution of around 20 percent.

Overall, we may conclude that monetary policy shocks help predict commodity price movements but are not the main source of fluctuations in prices. This result is in line with that of Barsky and Kilian (2002), Frankel (2007), and Frankel and Rose (2010), who find, at best, mixed evidence on the impact of interest rates on commodity prices.

3.2 Historical Decomposition

In this section we address the following question: to what extent have monetary policy shocks contributed to the recent movements

Figure 4. Historical Decomposition

in commodity prices? Similarly to Kilian (2009), we calculate the cumulative contribution of the monetary shock to the price of the different commodities based on a historical decomposition of the data. These estimates are, naturally, subject to considerable sampling uncertainty, so they should be considered to be only suggestions.

The exhibits presented in figure 4 focus on the period between January 2003 and July 2008, when all the commodities under examination recorded a run-up. The role of accumulated past monetary policy shocks (the dashed line) appears generally limited, although differentiated across commodities. In particular, the non-systematic component of monetary policy appears to have contributed to the increase in commodity prices above the baseline since early 2006, but it has not contributed to their peak at mid-2008.

Focusing on the case of oil, the contribution of monetary policy shocks to the increase in oil prices in 2006 and 2007 is non-trivial, but it fades after early 2008 and is quite limited when oil prices peak. Viewing this result through the lens of the direct transmission channels—which will be analyzed in the next section—it is striking that in 2007–08, despite the reduction in interest rates, in the United

States oil inventories were actually depleted.[18] Since OPEC, crude oil production did not increase much and, in particular, did not keep pace with oil demand: in mid-2008, when oil prices reached record highs, OPEC excess capacity was down to 1 million barrels a day. Whether the sensitivity of these channels to monetary policy shocks has changed over time is beyond the scope of this work, but it may prove an interesting route for future investigation.

4. Transmission Channels

Having found a significant impact of monetary policy shocks on commodity prices, we still do not know through which channel the effect takes place. Barsky and Kilian (2002, 2004) argue that the channels through which monetary policy exerts its impact on commodity prices are (expectations of) stronger inflation and economic growth. There are, however, a number of other channels, related to the opportunity cost of investing in real assets, according to which an expansionary monetary policy can cause an increase in commodity prices. Frankel (2007) summarizes them as follows: (i) low interest rates tend to reduce the opportunity cost of carrying inventories, increasing the demand for commodities (inventory channel); (ii) on the supply side, lower rates create an incentive not to extract exhaustible commodities today, as the cost of holding inventories "in the ground" also decreases (supply channel); and (iii) for a given expected price path, a decrease in interest rates reduces the carrying cost of speculative positions, making it easier to bet on assets such as commodities; under certain conditions, this will put upward pressure on futures prices and, by arbitrage, also on spot prices (financial channel).

In what follows we investigate the relevance of these alternative channels in the case of oil. The reasons for this choice are twofold: on the one hand, oil is by far the most important commodity for the global economy, and its macroeconomic impacts have been studied extensively; on the other hand, comprehensive data is available on inventories and production, which is not the case for other commodities. In particular, we check whether the monetary policy shock à la

[18] Plante and Yücel (2011) show that floating storage in oil tankers also declined throughout the summer of 2008.

Kim (1999) derived in section 1 helps to explain the fluctuations in oil inventories, oil supply, and speculative activity in futures markets.

4.1 Monetary Policy Shock and Transmission Channels

Let us start by looking at the inventory channel. Holding oil inventories has a cost not only in terms of the fee due to the owner of the storage facilities but also because of the opportunity cost of using money to buy oil which goes into storage and is not immediately burnt instead of investing the amount needed at the risk-free rate. Of course, that cost will be lower in an environment of low interest rates. Hence, loose monetary policy may generate incentives to accumulate inventories, thereby raising the demand for oil as well as its price. To check whether this channel appears to be at work, we regress a measure of crude oil inventories on the monetary policy shock, as well as the respective lags. The data on oil inventories refers to U.S. industry stocks of crude oil, collected by the U.S. Energy Information Administration, and covers the period from January 1970 to December 2008; data is expressed in month-on-month growth rates.[19] This is admittedly only a partial representation of the status of global oil inventories, which also comprise stocks held in other countries as well as floating storage. Yet no reliable data is available for non-OECD inventories and floating storage, and data for inventories held in OECD countries is available only at quarterly frequency and for a shorter time span.

An environment of loose monetary policy will not only have impact on the fundamentals of the oil market via the incentives to accumulate inventories. Oil producers will also have fewer incentives to pump enough oil to satisfy growing demand. The reason is that the opportunity cost of leaving oil in the ground with the expectation of selling it later for a higher price will be lower. Therefore, producers facing the decision whether to extract oil immediately and invest the revenues at the current (low) interest rate or, rather, to leave oil in the ground may indeed prefer to postpone extraction. To check whether this is indeed the case, we regress a measure of world oil supply on the monetary policy shock, as well as the respective

[19]We deliberately exclude government stocks since in their case accumulation depends on considerations other than interest rates.

lags. The data on oil supply refers to world production of crude oil as measured by the International Energy Agency and is from February 1984 to December 2008; data is expressed in month-on-month growth rates.

Finally, loose monetary policy could also affect physical oil prices via the futures market channel. Low interest rates imply that investors will have stronger incentives to chase risky assets (such as commodities) in search of higher returns. In addition, the opportunity cost of carrying speculative positions in the oil futures market is reduced. This may encourage speculators to take long positions in the futures market, thereby exerting upward pressure on the futures curve. In the case of frictions to arbitrage opportunities, this pressure could eventually transmit to physical spot prices.[20] To assess the importance of this channel, we regress a measure of speculative activity in oil futures markets on the monetary policy shock, as well as the respective lags. Unfortunately, measuring speculative activity in the crude oil futures market is a daunting task. The U.S. Commission for Futures Trading in Commodities (CFTC) collects and disseminates weekly data on the positions held by non-commercial agents in WTI crude oil futures contracts traded on the NYMEX; data is available since January 1996. A measure of speculative activity widely employed in the literature is the so-called non-commercial net long position, i.e., the difference between the number of long and short positions held by agents not related to physical oil.[21] The rationale is that a positive net positioning suggests that non-commercial agents, i.e., speculators, are mostly bullish about oil price prospects. In practical terms, we regress the month-on-month percentage changes in

[20]For a detailed overview of how the linkage between futures and spot prices works and how frictions may hamper it, including some empirical results, see Lombardi and Van Robays (2011).

[21]There are a number of caveats relating to the measurement of speculative activity with such an indicator. First of all, the distinction between commercial and non-commercial agents is somewhat arbitrary and does not imply that only non-commercials can act as speculators: for example, shouldn't an airline betting on oil price increases also be labeled a speculator? And why should a pension fund taking a long position in energy futures to diversify its portfolio and hedge against inflation be labeled a speculator? Second, index funds, i.e., financial instruments that replicate oil price developments, are managed by swap dealers and hence fall in the commercial category. Finally, data is incomplete, as it covers only regulated markets.

oil supply and oil stocks and the ratio of net long positions in futures to open interest on their lags and on the monetary policy shock.[22] In table 2 we report the coefficient of the monetary shock as well as the lagged coefficient of the dependent variable selected using the Schwarz information criterion. As we used a generated regressor (the monetary shock), we report Newey-West (HAC) standard errors. Results highlight that all variables are somewhat sensitive to the monetary policy shock. The signs of all coefficients are in line with the theory: a tightening of the monetary policy stance (i.e., a positive shock) produces an increase in oil production (as producers find it more convenient to extract oil today and invest their revenues at higher rates), a decrease in oil inventories (as the opportunity cost of holding inventories rises), and a decrease in speculative positions (as investors face a higher opportunity cost). However, the effect of the monetary shock on speculative positions is statistically not significant. It is also interesting to note that lagged values of the monetary policy shock always appear to be non-significant and were discarded in the model-selection process.

4.2 Robustness

To check the robustness of our results on the transmission channel, we repeat the regression of table 2 employing different identification schemes for the monetary policy shock as explanatory variables. As in section 2.4, we use a very simple Choleski scheme (Boivin and Giannoni 2006), a financial-markets-based measure (Kuttner 2001), and a more narrative approach (Romer and Romer 2004).

The results of the regressions are reported in table 3. The shock à la Boivin and Giannoni (2006), being the one most closely related in its construction to that of Kim (1999), gives results that are very similar to those of table 2 and thus confirms our analysis. For the other two shocks, the picture is a bit more blurred. Kuttner (2001) does give favorable results for the impact of the monetary policy shock on stocks, while the effect on supply is significant only with a lag. The shock extracted using the Romer and Romer (2004) approach

[22] The series of oil stocks and, to a lesser extent, oil production present a marked pattern of seasonality, which was removed by simply regressing each series on seasonal dummies.

Table 2. Regression Results of Oil Supply, Oil Stocks, and Net Long Positions on the Monetary Policy Shock

Dependent Variable: Supply		$N = 296$	$DW = 2.00$	adj-$R^2 = 0.035$
	Coefficient	*Std. Error*	*t-stat*	*P-value*
MP Shock	0.369	0.195	1.89	0.059
Supply (−1)	0.026	0.063	0.413	0.679
Supply (−2)	−0.130	0.057	−2.28	0.023
Supply (−3)	−0.125	0.060	−2.09	0.038
Dependent Variable: Stocks		$N = 468$	$DW = 1.96$	adj-$R^2 = 0.006$
	Coefficient	*Std. Error*	*t-stat*	*P-value*
MP Shock	−0.496	0.195	−2.54	0.011
Dependent Variable: Net Long		$N = 153$	$DW = 2.02$	adj-$R^2 = 0.52$
	Coefficient	*Std. Error*	*t-stat*	*P-value*
MP Shock	−0.006	0.713	−0.009	0.993
Net Long (−1)	0.845	0.099	8.508	0.000
Net Long (−2)	−0.244	0.105	−2.315	0.021
Net Long (−2)	0.116	0.082	1.418	0.158

Notes: Supply and Stocks are in delta logs; Net Long is the ratio of net long positions of non-commercial traders to open interest. All regressions include a constant. HAC standard errors.

Table 3. Regression Results of Oil Supply, Oil Stocks, and Net Long Positions on Alternative Monetary Policy Shocks

	Choleski	Kuttner	Romer & Romer
Dependent Variable: Supply			
MP Shock	0.577*	−0.003	−0.957**
MP Shock (−1)	—	0.010*	0.998**
Supply (−1)	0.026	0.118*	0.030
Supply (−2)	−0.134**	−0.113*	−0.143*
Supply (−3)	−0.127**	−0.079	−0.144*
Dependent Variable: Stocks			
MP Shock	−0.450**	−0.026*	−0.115
Dependent Variable: Net Long			
MP Shock	1.538	0.019	—
Net Long (−1)	0.845***	0.720***	—
Net Long (−2)	−0.170*	—	—

Notes: Supply and Stocks are in delta logs; Net Long is the ratio of net long positions of non-commercial traders to open interest. *, **, and *** indicate, respectively, significance of the coefficient at the 10 percent, 5 percent, and 1 percent level. All regressions include a constant. HAC standard errors.

instead has non-significant impact for stocks, although the sign is correct, while it is significant for supply. None of the alternatives considered provide a significant effect of monetary shocks on speculative positions.[23]

5. Concluding Remarks

This paper constitutes a formal econometric assessment of the theoretical result, first presented by Frankel (1984), that monetary policy has an impact on commodity prices. Our main finding is that monetary policy shocks do affect commodity prices, but the direct effect is

[23]Due to limited data availability, we could not check the impact of the Romer and Romer (2004) shock on net long positions in futures markets.

not overwhelmingly large. With regard to oil, this conclusion is corroborated by the analysis of the impact of supply, inventories, and financial activity in futures. Notice, however, that a stronger effect of monetary policy on commodity prices may pass through the indirect channels of expected economic growth and inflation (Barsky and Kilian 2004).

Our findings also suggest that the extraordinary monetary policy easing deployed to contrast the real effects of the financial crisis is likely to push commodity prices up, albeit not to a great extent. However, we acknowledge that our identification scheme is not designed to account for unconventional monetary policy measures, so that larger effects cannot be ruled out. While this is, of course, an interesting avenue of research, it would require a brand-new identification strategy for the monetary policy shock, which is beyond the scope of this paper.

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