The impact of monetary policy shocks on commodity prices

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Abstract

Global monetary conditions have often been cited as a driving factor of commodity prices. In this paper, we investigate the empirical relationship between the US monetary policy and commodity prices by means of a standard VAR system of the US economy, commonly used in analysing the effects of monetary policy shocks.

We find empirical evidence of a significant impact of the US monetary policy on commodity prices. In particular, an expansionary monetary policy shock drives up the broad commodity price index and all of its components. While the effects are significant they do not appear however to be overwhelmingly large, hence one can deduct that US expansionary monetary policy stance alone is not likely to produce a major surge in commodity prices.

1. Introduction

Commodity price developments have been one of the major sources of concern for policymakers during the recent years. After having surged with increasing momentum to unprecedented levels in the course of 2008, prices of commodities fell abruptly in the wake of the financial crisis and the global economic downturn. Since the beginning of 2009, however, commodity prices first stabilised, and then resumed an upward path. As commodity prices in general and the oil price in particular are an important component of Consumer Price Indexes, the evolution of these prices and the driving forces behind them are clearly of interest for the conduct of monetary policy.

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There is a wide strand of literature concerning the impact of commodity prices – oil in particular – on macroeconomic variables. Among the others, Hamilton (1983) argued that almost all post-WWII US recessions have been preceded by oil price shocks; Hamilton (1996) also argues that such a relationship appears to be nonlinear, with oil price increases being much more important than oil price decreases; Kilian and Vigfusson (2009) however find little support for this idea.

On the other hand, Barsky and Kilian (2002, 2004) suggest that oil price increases did not cause the stagflation of the 1970s. Kilian (2008a 2008b, 2009) also challenges the common lore that oil price increases in the 1970s have been caused by supply-side shocks. Using a VAR framework, Bernanke, Gertler and Watson (1997) suggest that oil price shocks induce a monetary policy response which can amplify the recessionary effects of the oil price shock itself; Kilian and Lewis (2009) however report no evidence of systematic Fed reaction to oil shocks after 1987. From a more structural perspective, Kim and Loungani (1992) and Backus and Crucini (2000) examined the issue in a RBC setting. Carlstrom and Fuerst (2006) extended their analysis into a DSGE model with monetary policy, but Nakov and Pescatori (2010) argue, in line with Kilian (2009), that oil prices should be treated endogenously in DSGE models.

Yet, fewer attention has been devoted to the other direction of causality, i.e. the impact of monetary conditions on oil and other commodity prices, Barsky and Kilian (2002, 2004) being a notable exception: in their papers they show that monetary policy stance is a good predictor of commodity prices. Apart from physical demand and supply, in fact, commodity prices can be influenced by many factors, such as the precautionary demand[1], the financialisation of the commodity markets, interest rates or the nominal effective exchange rate of the dollar, just to mention a few (Anzuini *et al.*, 2007). While supply and demand factors can in general explain the bulk of the fluctuations in commodity prices, other forces may at times play a role.

Since the seminal contribution by 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) also suggested that the oil price increases of the 1970s could have been partly caused by monetary conditions. More recently, Gillman and Nakov (2008) have examined the issue in the setting of a DSGE, finding that nominal oil prices moves proportionally to nominal interest rates.

[1] Here we are following Kilian (2009) and Alquist and Kilian (2010) in labelling precautionary demand shocks the increase in current demand driven by the uncertainty about future oil supply shortfalls.

During the price surges of 2008 some commentators indicated that loose monetary policy and persistently low interest rates could have at least in part fuelled the price hike (Hamilton 2010). If this is so, it is relevant at the present juncture to understand whether and to what extent the massive monetary policy easing which is taking place may again sow the seeds for another surge in commodity prices.

Most of the empirical literature devoted to the assessment of the relationship between monetary policy and commodity prices has focused on the US interest rate as an indicator of monetary policy stance (Frankel 2007, Frankel and Rose 2009). 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 the general developments of the economy.

In this paper, we will not work with a plain analysis of comovements between commodity prices and interest rates, but rather identify a monetary policy shock in a VAR system for the US economy (Kim 1999), 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 which are inherently difficult to measure. Although the methodology is very different, our approach is similar in spirit to that of Frankel and Hardouvelis (1985), which investigated the impact of money supply announcements on commodity prices; the main methodological difference lies in the fact that in our case we work with an identified monetary policy shock in a VAR system.

More specifically, we will use a standard identification scheme for the monetary policy shock and we then project each of the commodity prices on this shock, one at a time, 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, an expansionary monetary policy shock drives up the broad commodity price index and all of its components.

The plan of the paper is the following: first, we describe the theoretical arguments according to which commodity prices should react to monetary policy shocks. Next, we present the data and the econometric framework, which includes the identification scheme, and we provide evidence that monetary policy shocks have an impact on a broad commodity price index; the exercise is also repeated for individual categories of commodities. This impact, however, seems to be rather limited in magnitude, as the variance decomposition suggests. To conclude, we will try to shed some light on the channel through which monetary policy shocks affect commodity prices, investigating whether the positive impact on commodity prices of a monetary policy loosening can be ascribed to incentives to stock accumulation, disincentives to immediate production or to financial flows.

2. Commodity prices and monetary shocks

As anticipated in the introduction, the impact of monetary policy on commodity prices has been studied extensively by Barsky and Kilian (2002, 2004); the most relevant channel through which monetary policy exerts its impact on commodity prices is indeed via (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: i) Low interest rates tend to reduce the opportunity cost of carrying inventories, increasing their demand for commodities; ii) on the supply side, lower rates create an incentive not to extract today exhaustible commodities, as the cost of holding inventories 'in the ground' also decreases; 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 price and, by arbitrage, also on spot prices.

To gauge the quantitative effect of monetary policy shocks on commodity prices, we estimate a VAR for the US, the largest oil-consuming economy in the world.

2.1 Data and model details

Our dataset consists of monthly variables from January 1970 to September 2009.[2] The variables are: the federal funds rate, the money stock (M2), the consumer price index, the industrial production index and a commodity price index (in dollars). 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.[3] We have considered several commodities, one at a time but in what follows, for reasons of space, we report results for four commodity prices: a broad index, two sub-indices (metals and foodstuffs) and crude oil.

We estimate a VAR system with p = 12 lags including the federal fund rate, industrial production, M2, consumer price index and the commodity price index. All variables except the fed fund are in log-level. More precisely, the variables are stored in the vector y_t.

The first line of the VAR system, where the interest rate appears on the left hand side, is a money supply equation modelled as a reaction function of the monetary authority; irrespective of the identification scheme used this interpretation is standard in this literature.

[2] Admittedly, this covers a very long time span during which policy shifts may have happened, as also documented by Barsky and Kilian (2004). For robustness check, we also estimated the model on a restricted, post-Volcker sample starting in January 1980. Results, available upon request, display however no significant differences.

[3] 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 affect contemporaneously all the others.

Here the assumptions are that, due to an informational delay, the current level of prices and industrial production are not available to the monetary authorities.

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.
The structural form is:

$$C(L)y_t = \eta_t$$

where $C(L)$is a polynomial matrix in the lag operator and $VCV(\eta_t) = \Lambda$ is a diagonal matrix with the variances of the structural 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 $VCV(\varepsilon_t) = \Sigma$ and $\eta_t = C_0\varepsilon_t$ therefore $\Sigma = C_0^{-1}\Lambda C_0^{-1'}$. In order to obtain a just identified system we need $\frac{n(n-1)}{2}$ restrictions. Our baseline identification scheme to identify a US monetary policy shocks is the same as Kim (1999):

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

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

Using Akaike information criteria we select 12 lags (using 10 or 14 lags results are unchanged); with monthly data our lags structure capture one year of dynamics and this is enough to eliminate residuals autocorrelation.

After identifying the shock we re-estimate 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:

$$\begin{bmatrix} \eta_t^{Monetary} \\ \eta_t \\ \eta_t \\ \eta_t \\ \eta_t \\ \eta_t \end{bmatrix} \begin{bmatrix} 1 & g_{12} & 0 & 0 & g_{15} & 0 \\ g_{21} & 1 & g_{23} & g_{24} & 0 & 0 \\ 0 & 0 & 1 & g_{34} & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ g_{51} & g_{52} & g_{53} & g_{54} & 1 & 0 \\ g_{61} & g_{62} & g_{63} & g_{64} & g_{65} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_t^{ms} \\ \varepsilon_t^{md} \\ \varepsilon_t^{cpi} \\ \varepsilon_t^{ip} \\ \varepsilon_t^{cp} \\ \varepsilon_t^{single-commodity} \end{bmatrix}$$

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. Kilian and Vega (2009), however, report no evidence of any contemporary and systematic reaction of oil prices to macroeconomic announcements; based on this result, we conduct some robustness analysis testing some over-identifying restrictions, in particular: we estimate a system where $g_{62} = g_{63} = g_{64} = 0$, results are virtually unchanged. We then exclude commodity price from the Fed reaction function (g_{15}=0) again results did not change.[4]

2.2 The impact of a conventional monetary policy shock

As said, the US monetary policy shock is identified in a five variables VAR system. We here focus on the response of the commodity price index, which is the variable ordered as last, to the monetary policy shock, defined as a 100 basis point decrease in the Federal funds rate equation (Figure 1).

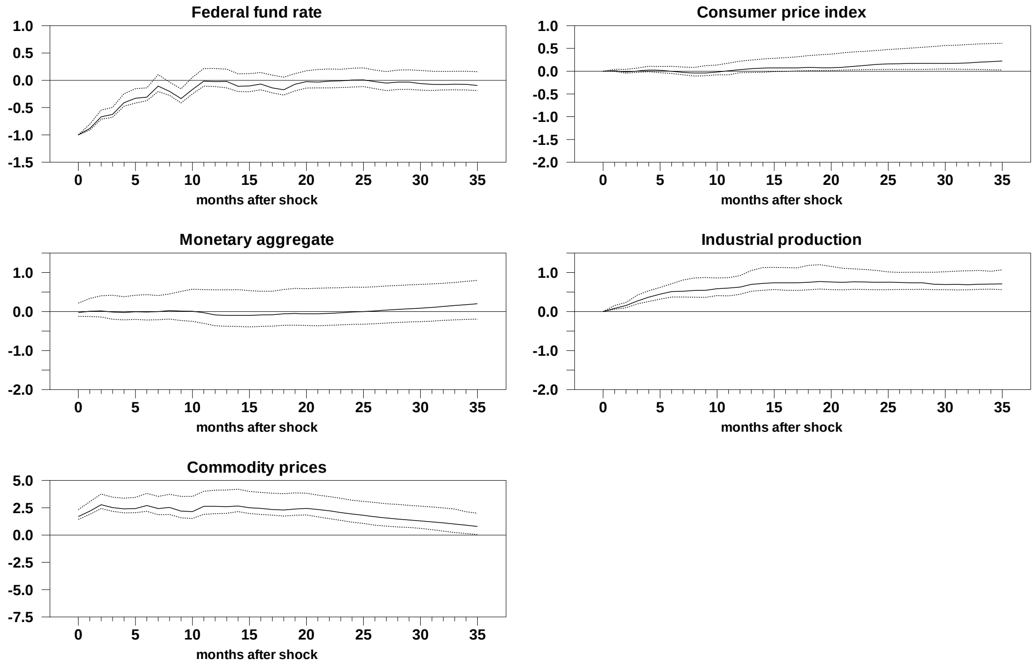
All responses have the expected sign (with the exception of M2 which is not significant) and are significant (with the exception of the CPI, although the sign is correct). Focusing on the response of the commodity price index to the monetary shock, it appears to be significant and persistent, as it takes 36 months for it to converge back to the baseline. The magnitude of the response, however, is somehow limited given that the monetary policy shock leads to an increase of the commodity price index of roughly 2.5%, in the first 24 months after the shock.[5] 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 CPI starts to increase and commodity prices converge back to lower levels. The hump-shaped response of commodity prices testifies an initial overshooting − which dies out after few quarters − with respect to their long run level. This effect is usually ascribed to the higher flexibility of the commodity

[4] Notice that in our identification scheme the Federal Reserve never responds to the development in price of a single commodity. Moreover, it is worth to remembering that in general a non-zero coefficient in the impact matrix means that variables are allowed to respond contemporaneously to shocks, not that they have to.

[5] Notice that our monetary policy shock has been normalised to a 100 bp points which is quite larger than the usual one standard deviation shock used in literature.

prices with respect to the price 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 expectation following a monetary expansion.

Figure 1. Impulse response functions to a 100 basis points monetary policy easing. The x-axes reports the months after the shock. Dashed lines are 68% confidence bands.



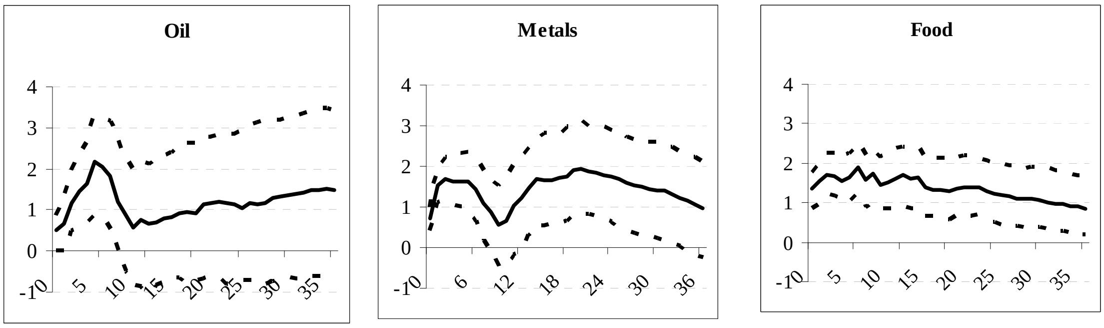
2.3 The impact on individual commodity prices

After having identified the monetary policy shock, we add to the system the commodity price for which we want to trace the response.[6] For all the commodities considered a monetary expansion generates an increase in price, yet the size and the time path of such increase vary considerably (Figure 2).

The impact on oil is rather quick, peaking six months after the shock, and the response of metal commodities is rather similar, although it has a second (significant) peak 18 months after the shock. Food commodities instead respond in a rather smooth fashion, and effects remain significant up to 3 years after the shock has occurred.

Figure 2. Response of individual commodities to a 100 basis points monetary policy easing. Dashed lines are 68% confidence bands.

6 This procedure is often referred to as “marginal method” and has been proposed by Kim (2001).



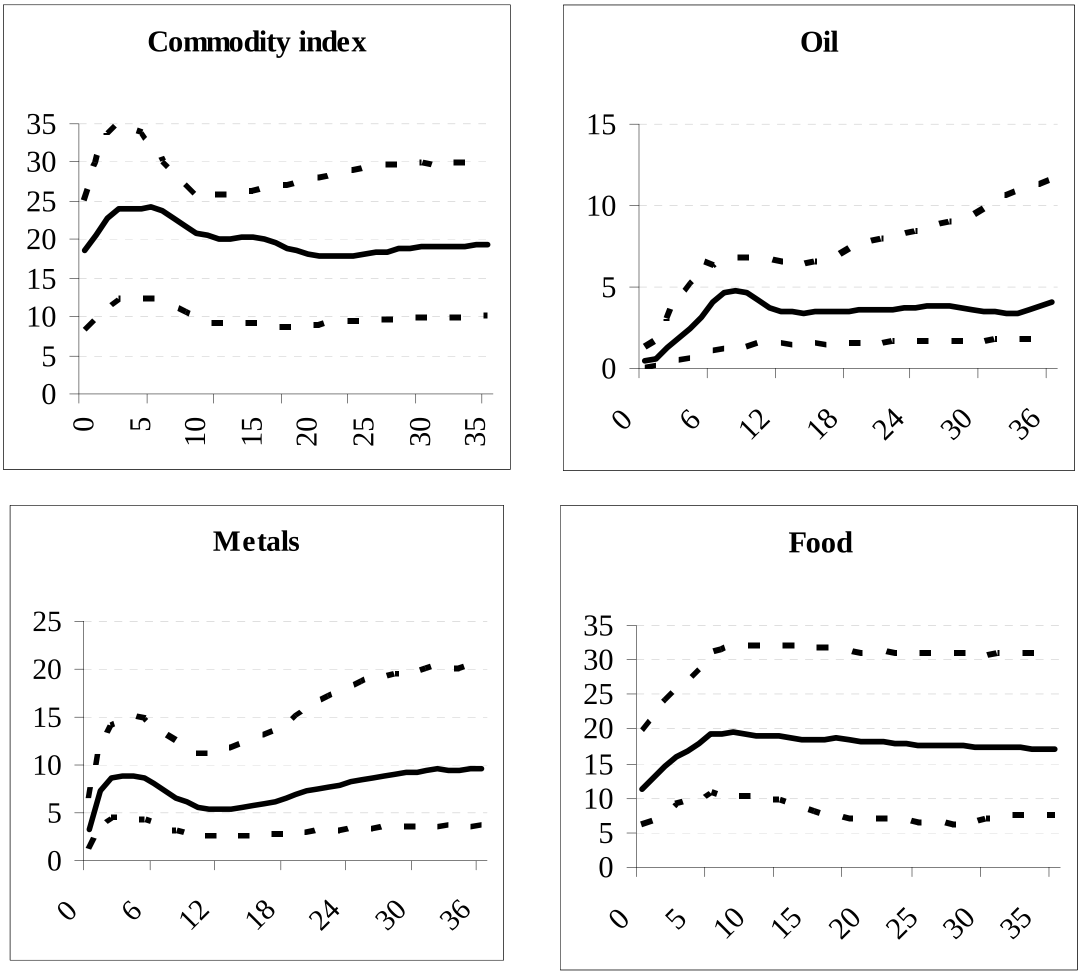
2.4 Monetary policy and commodity prices fluctuations

Given the significant effect of monetary shocks, one may wonder whether their relative contribution to overall commodity price fluctuations is large. This question may 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.

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 5 and 10 percent. Food commodities seem to have responded more to monetary policy shocks, which post a variance contribution of around 20 percent.

Overall, we may conclude that monetary policy shocks help predicting commodity price movements but these shocks are not the main sources of fluctuations in prices, which is in line with the results of Barsky and Kilian (2002). Our findings are also in line with that of Frankel (2007) and Frankel and Rose (2009), who also finds mixed evidence on the impact of interest rates on commodity prices.

Figure 3. Forecast error variance decomposition. Dashed lines are 68% confidence bands.



3. The transmission channel

Having found a significant impact of the monetary policy shocks on commodity prices, however, does not tell us anything about the channel through which the effect is taking place. As anticipated, besides the indirect impact through expectations of inflation and growth, there are other direct channels through which monetary policy can exert its impact on commodity prices. More specifically, we have mentioned an ‘inventory channel’, a ‘supply channel’ and a ‘financial channel’ (Frankel 2007).

We will here try to assess the relevance of such alternative channels for the case of oil. The reason of the choice is twofold: on one hand, oil is by far the most relevant 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 be the case for other commodities.

To make such assessment, we will first check whether the monetary policy shock, identified as above, is able to explain fluctuations in oil inventories and oil supply, and speculative activity in futures markets. The data on we will use on oil inventories refers to US industry stocks of crude oil, collected by the US Energy Information Administration, and covers the time span from January 1970 until September 2009. 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 September 2009. Measuring speculative activity in crude oil futures market is a more daunting task. The US 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 positions, i.e. the difference between the number of long and short positions held by agents not related to physical oil.[7] The rationale is that a positive net positioning should suggest that non-commercial agents, i.e. speculators, are mostly bullish about oil price prospects.

In practical terms, we will regress net long positions in futures and changes in oil supply and oil stocks[8] on their lags and on the monetary policy shock. Results, reported in Table 1, highlight that all variables are somehow sensible to the monetary policy shock. Furthermore, the signs of the coefficients are in accordance with the theory: a positive shock (i.e. a tightening of the monetary policy stance) produces an increase in oil production (as producers find 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 becomes higher), and a decrease in speculative positions (as investors face a higher opportunity cost). It is also interesting to point that lagged values of the monetary policy shock appear to be non-significant.[9] At any rate, we remark that coefficients are small, and the R^2 of the regression is also extremely tiny.[10] Hence, the tentative conclusion could be that direct transmission channels are significant, but the bulk of the impact of monetary policy on commodity prices transits through the indirect channel of expected growth and inflation, as also reported by Barsky and Kilian (2004).

Table 1. Regression results of oil supply, oil stocks on the monetary policy shock

[7] There are a number of caveats related to measuring speculative activity with such an indicator. First of all, the distinction between commercial and non-commercial agents is somehow 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 labelled as speculator? And why should a pension fund taking a long position in energy futures to diversify its portfolio and hedge against inflation be labelled as speculator? Second, index funds, i.e. financial instruments that replicate oil price developments, are managed by swap dealers and are hence fall in the commercial category. Finally, data is incomplete as it covers only regulated markets.

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

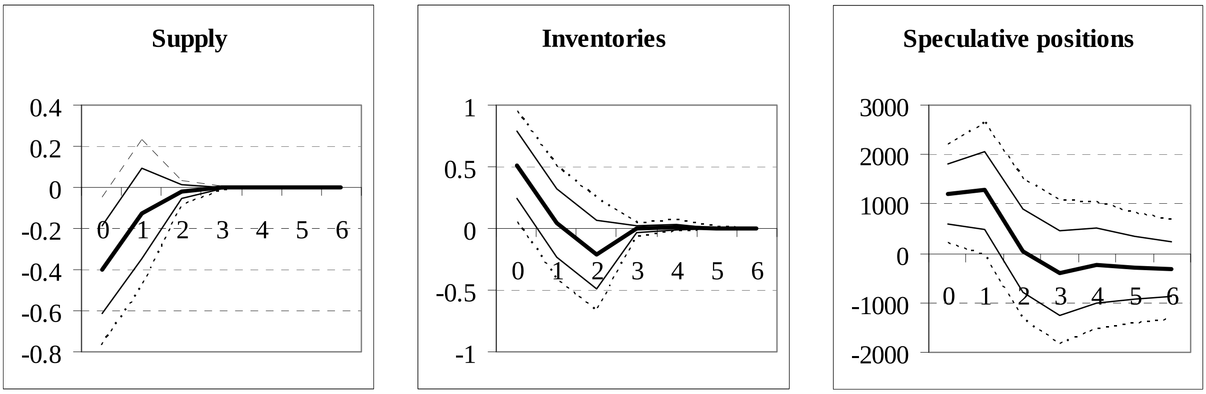
[9] We also tried different specifications including more lags of the dependent variable and/or the monetary policy shock, but we failed to identify any relevant pattern of significance. Therefore, to keep the model to a reasonable size, we decided to stick to a very parsimonious formulation, which is also preferred by any information criterion.

[10] The net speculative positions represent an exception with this respect, but we remark that most of the explanatory power of the regression come from the serial dependence of speculative positions on their past.

Dep. Variable:	**Supply**			R^2=0.0129
Variable	Coefficient	Std. error	t-stat	P-value
MP Shock	0.4021	0.2128	1.8897	0.0597
Supply (-1)	0.0432	0.0570	0.7588	0.4485
Dep. Variable:	**Stocks**			R^2=0.0081
Variable	Coefficient	Std. error	t-stat	P-value
MP Shock	-0.5252	0.2755	-1.9063	0.0572
Stocks (-1)	0.0313	0.0460	0.6812	0.4961
Dep. Variable:	**Net long**			R^2=0.5701
Variable	Coefficient	Std. error	t-stat	P-value
MP Shock	-1049589	572459.9	-1.8335	0.068769
Net long (-1)	0.888	0.081	10.9428	0
Net long (-2)	-0.247	0.107	-2.3145	0.022034
Net long (-3)	0.188	0.081	2.3193	0.021767

This being established, the next reasonable step is to assess the dynamic response of the variables to the monetary policy shock. We accomplish this in a VAR system, featuring the monetary policy shock and, in turn, oil supply, oil stocks and non-commercial net long positions. The preferred specification, according to the Akaike information criterion, is a VAR(1) for the case of production, a VAR(2) in the case of stocks and a VAR(3) for speculative positions.

Figure 4. Impulse response functions to a 100 basis points monetary policy easing. The x-axes reports the months after the shock. Solid and dashed lines are, respectively, 68% and 90% confidence bands.



The identification scheme adopted in these simple bivariate VARs is Choelski, with the monetary policy shock order first.[11] Given the lack of significance of the lags of the monetary policy shock, as outlined above, impulse responses to a monetary policy shock (Figure 4) are not hump-shaped, but rather smoothly-decreasing.

[11] This choice is motivated by the fact that in the regressions performed above we found a contemporaneous impact of the monetary policy shock on oil supply and inventories but not vice-versa.

Having assessed that monetary policy plays a role in explaining – at least partly – oil price developments, and that the 'financial channel' appears to have some significance, an interesting question is whether the recent oil price surge and collapse can be ascribed to financial speculation. The issue, however, is very difficult to be examined for several reasons. First of all, the word 'speculation' has itself a plethora of nuances and a practical definition has to be agreed upon to make formal assessment. Furthermore, data limitations further hamper a thorough assessment.

Using the net long positioning of non-commercial agents on the NYMEX disseminated by the CFTC, as a proxy for speculative activity we test weather positions have some ability in predicting oil prices. Our results are based on a VAR system[12] at weekly frequency from January 2nd, 1996 to November 2nd 2009 (716 observations)[13] featuring returns on WTI crude oil prices and non-commercial net long positions on WTI futures contracts. A Granger causality test (Table 2) highlights that the null hypothesis of absence of causality can be reject only for what concerns the direction from prices to speculative positions.[14] So, if any causality exists, it goes into the opposite direction: speculative positions do not cause price increases, but rather price increases can suggest speculators to enter the market and hence cause an increase in speculative positions.

Table 2. Granger causality test for speculative positions and returns on WTI oil prices.

H_0	F-stat	P-value
NETLONG does not Granger Cause R_WTI	0.68790	0.5030
R_WTI does not Granger Cause NETLONG	4.87384	0.0079

Our results are in line with those already present in the literature, Gorton *et al.* (2008). Nevertheless, we also stress that this is the mostly wide indicator used in the literature (Haigh *et al.* 2005, IMF 2006). Using non-public CFTC data, Büyükşahin *et al.* (2008) conducted a wider set of test and found that the activity of non-commercial agents helped linking futures and spot prices; Haigh *et al.* (2007) fail to identify an impact of hedge funds on oil price volatility.

[12] Lag length was chosen according to minimization of the Akaike Informaion Criterion.

[13] The CFTC only discloses data on speculative positions at weekly frequency.

[14] For the sake of robustness, we also repeated the test by including in the VAR crude oil stocks, and in that no causality relationship was found.

4. 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 supportive of this theoretical argument and in line with the results of Barsky and Kilian (2002) but we also found that the effect of an expansionary monetary policy in the US does not appear to be overwhelmingly large.

Our findings also suggest that the extraordinarily monetary policy easing deployed to contrast the real effects of the financial crisis is likely to have an impact on commodity prices. However we acknowledge that our identification scheme is not designed to account for unconventional monetary policy measures. While this is of course an interesting research avenue, 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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