Preliminary

Large Scale Asset Purchases: Impact on Commodity Prices
and International Spillover Effects

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Abstract

Prices of commodities, including metals, energy, and agricultural prices, have been rising over the past two years. Critics of the Fed argue that its large scale assets purchase (LSAP) programs have led to an excessively expansionary monetary policy stance, which, in turn, contributed to the rise in commodity prices. Using event study methodologies, this paper investigates whether the announcement and subsequent implementation of the three rounds of the Fed's LSAPs affected commodity prices. Results do not suggest that LSAP announcements increased commodity prices. However, there is some evidence that suggests that the currencies of commodity exporters appreciated, and that their stock markets posted gains. These findings suggest that while other factors, such as supply constraints and robust EME demand were the likely drivers behind the increase in commodity prices, LSAPs did have spill-over effects into currencies and stock prices. Last, the paper finds that commodity prices have become more sensitive to macroeconomic news when monetary policy is at the effective lower bound.

JEL classification codes: E58 G14, Q00

1. Introduction

In response to the recent financial and economic crisis, the Federal Reserve Bank of the United States (Fed) has responded aggressively, lowering its policy rate to near zero and engaging in a wide array of "unconventional" monetary policies. While the initial interventions sought to address failures in specific markets, they eventually turned to large scale asset purchases (LSAPs) in order to lower long-term interest rates and stimulate economic activity. These purchases included longer-term Treasury securities, as well as mortgage-backed securities and agency debt. As the recovery showed renewed weakness in 2010, in a speech at Jackson Hole, Bernanke suggested that further stimulus was necessary. Subsequently, a second round of LSAPs (QE2) was officially announced in November. With sovereign debt concerns in Europe and ongoing weakness in the US labor and housing markets weighing on the outlook, the Fed announced further LSAPs in September 2011 (this time sterilized by sales of its short term debt holdings).

The initial assessments of the effectiveness of these policies have been largely positive, as the LSAPs helped the Fed to achieve its monetary policy objectives.[1] However, some observers have argued that exceptionally accommodative monetary policy also has significant spillovers, including contributing to an increase in capital flows to emerging market economies, a depreciation of the U.S. dollar, and rising commodity prices.[2] Indeed, commodity prices (as measured by the Thomson Reuters/Jefferies CRB Index) rose 42 per cent throughout 2009 following the implementation of the first round of LSAPs, and surged another 37 per cent between the Jackson Hole speech and the end of March (Chart 1). The increase in commodity prices appeared to be broad based, with oil and metals prices increasing from early 2009 onwards, and agricultural prices gaining momentum from late 2010 (Chart 2).

While the recent widespread run-up in the prices of crude oil and other commodities can largely be explained by fundamentals (Murray 2011), it is nevertheless important that central banks understand to what extent unconventional monetary policy itself may have contributed to higher commodity prices. In particular, rising energy and food prices can feed both directly and indirectly into higher inflation. Moreover, for energy importers, the rise in oil prices restrains spending, weakens confidence, and is thus a potential drag on the recovery.

Despite the often elevated rhetoric with respect to the spillovers of QE2 on commodity prices, there is surprisingly little empirical evidence to support (or deny) these claims. Glick and Leduc (2011) study the response of commodity prices on announcement dates; they find that commodity prices actually fell, on average, around LSAP announcement dates.

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[1] For a review of the literature, see Kozicki, Santor and Suchanek (2011)
[2] For instance, see Reinhart (2011).

In our paper, we use two different event study methodologies to empirically investigate whether the announcement and subsequent implementation of LSAPs affected commodity prices. This approach is based on the underlying assertion that the impact of LSAPs on commodity prices should occur within a short period of time following their announcement, as forward-looking financial markets quickly incorporate the new information.

Detecting the effects of LSAPs on commodity prices, however, may be complicated by a) specific supply and demand factors, or b) the fact that they are not easily accessible to a broad class of investors. Consequently, some investors may instead seek exposure to commodity prices through a broader set of assets. To this end, we also explore the effect of LSAPs on equity markets and exchange rates in commodity producing countries. Last, we study whether the sensitivity of commodity prices to macroeconomic news has changed during periods where monetary policy is at the effective lower bound.

We come to three main conclusions:

1. LSAPs do not appear to have had a measurable abnormal effect on overall commodity price movements. In fact, no consistent pattern emerges when looking at metal, energy, and agricultural products. The results appear to be robust to the specification of the model, including the length of the event window and the regression method applied to calculate normal returns.
2. LSAPs appear to have had positive spill-over effects into commodity exporter currencies and stock markets, including Australia, Brazil, Canada, Mexico, New Zealand, Norway and South Africa.
3. Commodity prices appear to have become more responsive to macroeconomic shocks during the periods covered by LSAPs, when compared to pre-LSAP periods. Positive macroeconomic surprises tend to be associated with higher oil prices during periods where monetary policy is at the effective lower bound.

Overall our results suggest that while other factors, such as supply constraints and ongoing demand growth from EMEs were the primary drivers behind the increase in commodity prices since 2009, LSAPs did had spillover effects on commodity exporting countries.

The paper is structured as follows: section two examines the channels through which monetary policy may affect commodity prices. Section three introduces the event study methodology and the data. Section four presents results from the regressions. Section five estimates the impact of LSAP related announcements on commodity exporter currencies, as well as on their broad and energy-specific stock market indices. Section six examines the impact of surprises in macroeconomic announcements on oil prices and section seven concludes.

2. Monetary policy and commodity prices

There are five main transmission channels from monetary policy to commodity prices.

1. **Portfolio re-allocation:** The primary objective of LSAPs is to reduce long-term Treasury yields. A fall in yields would lead to a reallocation of investors' portfolios, under the hypothesis that different assets are imperfect substitutes (portfolio balance channel). In particular, investors would sell Treasuries and purchase other, riskier assets, including commodities, resulting in higher prices for these assets (Glick and Leduc 2011).

2. **Inventory demand:** Lower interest rates would, ceteris paribus, increase inventory demand for commodities because the cost of carrying inventories decreases. This in turn would lead to a rise in the price of storable commodities.

3. **Exchange rate depreciation:** Commodity prices may be affected indirectly via exchange rates. As an easing of U.S. monetary policy is generally associated with a weakening USD. Commodities, most of which are priced in U.S. dollars, would become more affordable for holders of other currencies, increasing demand and therefore prices.

4. **Supply restrictions:** Low interest rates may lead oil-producing countries to keep crude under the ground if the returns from pumping oil and investing the proceeds at low interest rates are lower than the return to leaving it in the ground. This decrease in supply, together with higher demand, would contribute to a rise in oil prices (Frankel and Rose 2010).[3]

5. **Economic growth:** More stimulative monetary conditions should improve economic growth, and thus the demand for commodities.

While these transmission channels would suggest that lower interest rates are associated with a rise in commodity prices, LSAPs may cause commodity prices to fall through other channels. For instance, LSAP announcements may signal that policy makers perceive the outlook to have become weaker. In this case, market worries about the outlook may lead investors to increase their demand for safe Treasuries, lowering their yields. If investors simultaneously reduce their demand for risky assets, such as commodities, prices would fall (Glick and Leduc 2011). Thus, how LSAP announcements affect commodity prices depends crucially on underlying financial and economic conditions at the time of the announcement. For example, Kozicki, Santor, and Suchanek (2011) argue that the magnitude of the effects of the Federal Reserve's second round of LSAPs on financial markets seems to have been more modest than the first round of purchases, which was implemented at a time of considerable strain in financial markets, severely weakened macroeconomic conditions, and low confidence. Consequently, the reaction

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[3] However, anecdotal evidence does not suggest that firms behave in a manner consistent with this hypothesis.

of commodity prices has likely been different during the pre- and post-LSAP periods - a question which we will analyze in turn.

While commodity prices may have not been affected directly by LSAPs, spill-over effects into currencies and stock markets could have occurred. Indeed, if the transmission mechanism of LSAPs works as suggested by the portfolio rebalancing effect, we would expect to see investors move into commodity currencies other than the USD. That is, if an investor wanted to get exposure to commodities without investing directly in commodities, he could do so through investing in either commodity-heavy equity markets or commodity currencies. Importantly, commodity exporter currency and stock markets remained liquid throughout the crisis, and thus provide an appropriate testing field to study the international spill-over effects of LSAPs. Thus, our analysis includes the reaction of not only commodity prices themselves, but also of commodity exporter currencies and stock price indices.

3. Event Study Methodology and Data

Event Study approach

Assessing the financial market impact of LSAPs is complicated by many conceptual and empirical hurdles, especially those related to identification (Kozicki, Santor, and Suchanek 2011). For example, gauging the effectiveness of individual measures is complicated by numerous identification issues, including:

- **Contemporaneous measures and effects**: The impact of asset purchases on longer-term interest rates may be difficult to gauge owing to contemporaneous financial sector and macro-policy initiatives, and macroeconomic developments. For example, bank guarantees, capital injections and fiscal stimulus measures were also concurrently implemented with LSAPs, complicating identification.

- **Ongoing nature of the crisis**: While many central banks have exited from some unconventional policies, the effects of the crisis (or for the matter, the evolution of the crisis from a financial crisis to a sovereign debt crisis) are still being felt and some unconventional policies are either still in place or have been expanded. Thus, it may be too early to fully evaluate the effects of unconventional policies.

- **Selection bias**: The countries that undertook the most dramatic actions were often those that were the most severely affected by the crisis.

- **Policy lags**: Certain measures might have affected markets with a long lag, due to uncertainty about the features of the measure, skepticism regarding its implementation, and the nature of the transmission mechanism.

- **Fiscal policy**: Unconventional monetary policies and extraordinarily low interest rates may have amplified the effects of fiscal policy.

To identify the effect of LSAPs, we conduct two types of event studies on movements in commodity prices on "announcement dates", i.e. days when the Fed publicly announced intended or actual purchases. The rationale for this approach is that forward-looking financial markets should quickly incorporate all information from a public announcement shortly after the announcement is made. Intuitively, financial markets would not be expected to forego large riskless profitable trading opportunities for more than a few days or even hours, and thus the impact would be reflected in prices within a short period of time following the announcement. Another advantage of event-study analysis over lower frequency regression is that it holds other fundamental drivers of commodity prices, such as supply shocks, essentially constant. By considering changes in commodity prices across a two- or three-day window surrounding the announcement, fundamentals (beyond those associated with the announcement itself) can be argued to change very little.[4,5] Event studies would also appear to avoid endogeneity problems that can arise when using monthly or quarterly data, which can make estimating the effects of LSAPs difficult.

Previous studies have used the event study approach to estimate the impact of announcements on asset prices, and bond and currency markets. For example, Swanson (2010) uses an event-study analysis to estimate the impact of "Operation Twist," as well as QE2, on Treasury yields. Some studies have analyzed the impact of news on commodity prices, but few studies have used an event study to do so (see for instance Roache and Rossi 2009).[6] Glick and Leduc (2011) use an event study to estimate the impact of LSAP on global financial and commodity markets.

Event study methodology

There are two types of event studies, both of which we will use. The first involves *regression methods* where the impact of an event is estimated as a coefficient of dummy variables that correspond to event dates. Second, *constant mean (or market) return models* measure abnormal returns as prediction errors from some benchmark model of normal return.

As for the first approach, we use a GARCH(1,1) model[7] to regress the return R_i of commodity i (or the daily change in) and other international financial variables on a dummy variable Z_t that

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[4] Swanson (2010) argues that this requires that no other major macroeconomic data surprises or announcements occur on the same day as the respective announcement. We are in the process of verifying this assumption by analysing macroeconomic and commodity market related news for LSAP announcement dates.

[5] Swanson (2010) further notes that quarterly regression models have residual standard errors too large to detect small but statistically significant effects of announcements even if the model is correctly specified and the size of those effects is correctly estimated.

[6] Likewise, McKenzie, Thomsen and Dixon (2004) analyze the statistical performance of event study approaches using daily commodity futures returns data.

[7] McKenzie, Thomsen and Dixon (2004) argue that this model is the most powerful compared to OLS and other GARCH specifications.

takes the value one on days of major announcements and other non-event related explanatory variables X_{it} .

$$R_{it} = \alpha_i + \beta_i Z_t + \beta_i X_{it} + \varepsilon_{it} \qquad (1)$$

Note that this approach simply estimates whether the return increased or decreased in a statistically significant way on days of announcements, rather than estimating an abnormal response. Such a response may not indicate that LSAP had an impact on commodity prices over and above normal market functioning but simply reflect responses in line with other financial variables such as interest rates. Thus, to determine whether LSAP disproportionally affected commodity prices or had abnormal international spillover effects, we use the second approach, which estimates the *abnormal* return of financial variables in response to LSAP.

Event studies of the second type typically proceed in three steps. First, a model is used to calculate the *normal return* of a commodity over the event window[8], i.e. the return that would be expected if the event did not take place. We use two types of models to calculate normal returns: a market price model and a constant-mean-return model.[9] The market price model assumes a stable linear relationship between the market return and the commodity return, i.e. the return R_i of commodity *i* is modeled as a function of the market return R_m, where t denotes time:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \qquad (2)$$

The constant-mean-return model assumes that the mean return of a given commodity is constant through time, i.e.:

$$R_{it} = \overline{R\_i} + \varepsilon_{it} \qquad (3)$$

The respective model is estimated over the estimation window (we use an estimation window of 30 days prior to the event).[10] The model can then be used to calculate the normal return $E[R_{it}|X_{it}]$ over the event window, where X_{it} is the conditioning information, i.e. the mean return or the market return, respectively.

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[8] The event window refers to the period over which the commodity prices will be examined, e.g. the day before the announcement to the day after the announcement. We use an event window of 5 days around the actual event, which implies that the effects of LSAPs on commodity prices are less likely to be contaminated by other important news that could move prices.

[9] Alternatively, abnormal returns may be estimated as coefficients of dummy variables that correspond to event days. However, in the current context where series are likely to exhibit structural breaks, the event study approach may yield more precise estimates than would a regression (McKenzie, Thomsen and Dixon 2004).

[10] Under the assumption that commodity returns are jointly multivariate normal and independently and identically distributed through time, the model can be estimated using ordinary least squares. The length of the window is varied in our sensitivity analysis.

Second, the abnormal return can be calculated for each commodity *i* and event date. The abnormal return ε_{it}^* is defined as the actual ex post return of the commodity R_{it} over the event window minus the normal return:

$$\varepsilon_{it}^* = R_{it} - E[R_{it}|X_{it}] \tag{4}$$

In a final step, we test whether the abnormal return on the dates of the events [or the cumulative abnormal return over the event window] is statistically significant.[11] The null hypothesis for our analysis is that announcements related to LSAPs had no effect on commodity returns. A failure to reject the null hypothesis would suggest that there is no evidence that LSAP announcements caused commodity returns to fall or increase.

Data

We use data for the 17 major commodities included in the Bank of Canada commodity price index (BCPI) for which commodity futures contracts price data is available over the period from January 2008 to March 2011 from Bloomberg. The commodities examined include energy, metals, forestry, and agricultural commodities (see Table 1 for details). Futures prices are taken from the nearest contract used as the benchmark for that commodity, most of which are traded on exchanges in the United States. For oil prices, we use the West Texas Intermediate (WTI), which is the benchmark oil price in the US.[12]

Following Roache and Rossi (2009) we focus on the futures market, rather than the spot market, for two reasons. First, the spot market for some commodities, including certain precious and base metals, is dominated by trading in London, which means that official fixing prices have less time to respond to daily developments in the United States due to the five hour time difference. Second, spot prices are often positively correlated with the future with a one-day lag, which indicates that the impact of U.S. announcements on the futures price is likely to affect the spot price the following day. This is consistent with previous research indicating that commodities futures markets lead developments in spot markets (e.g. Antoniou and Foster 1992; Yang, Balyeat, and Leatham 2005). We use daily data which appear to better capture the reaction of markets to news, rather than intra-day data (Payne, 2003). Last, following the event study literature, we use the log change of commodity prices (i.e., the return) to measure announcement effects.

To assess international spillover effects on commodity exporter countries, we use the bilateral exchange rates of commodity exporters vis-à-vis the US dollar (including Australia, Brazil,

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[11] H_0: The event had no impact, i.e. $\varepsilon_{it}^*=0$, or $\sum_{eventdate-2}^{eventdate+2} \varepsilon_{it}^*=0$ for the cumulative abnormal return.
[12] One might argue that WTI prices have diverged from Brent oil prices as an increase in Cushing stocks dampened WTI crude prices. However, using Brent instead of WTI does not significantly change our results.

Canada, Mexico, Norway, New Zealand, and South Africa), broad stock price indices of the latter countries, as well as energy stock indices and metal stock indices where available.[13]

The non-event related explanatory variables used in the GARCH model and as market return variables in the market return model include daily returns on the Commodity Research Bureau (CRB) futures price index, daily returns on the Standard and Poor's (S&P) 500 stock market index, and the JPMorgan broad nominal US effective exchange rate. The CRB index tracks movements in both nearby and deferred futures contracts for 19 commodities.[14] It is important to note that 9 of the 17 commodities examined here are included in the CRB index and hence there is a potential simultaneity problem.[15] Thus, for aluminum, corn, crude oil, gold, hogs, cattle, natural gas, silver and wheat prices only the S&P market index and the effective exchange rate are used as explanatory and market return variables. In contrast, model specifications for the remaining 8 commodities include the CRB index, nominal exchange rate, and the S&P market index as explanatory and market return variables, respectively.

Including exchange rates and a stock market index is intended to capture the correlation of commodity prices to other financial variables. For example, LSAP announcements may exert an indirect influence through a commodity's role as an effective hedge against lower interest rates or a depreciating U.S. dollar. In that case, commodity price sensitivity to announcements would merely reflect a relationship between the commodity and other financial assets, rather than the announcements. Indeed, there is strong evidence that commodity prices have been sensitive to the U.S. dollar over a long period. Following Roache and Rossi (2009), we assume that the causality runs from the U.S. dollar to the commodity price, as recent evidence suggests that exchange rates play the dominant role as a forcing variable. [16]

Event dates

The impact of QE on commodity prices may be measured on days when Fed officials hinted to possible future purchases as well as firm statements of planned purchases, including time-frames and quantities (Neely, 2010). Several FOMC statements and speeches also discussed the objectives and the assessment of LSAPs. Gagnon and others (2010) suggest that there are eight events/announcements associated with the first round of LSAPs that had potentially important information, while Glick and Leduc (2011) suggest six event dates related to the second round

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[13] As a control, we also run regressions on non-commodity currencies, including the Swiss Franc, the Euro, the Yen, and the British Pound. Future work will include the interest rate differential.

[14] Aluminum, cocoa, coffee, copper, corn, cotton, crude oil, gold, heating oil, lean hogs, live cattle, natural gas, nickel, orange juice, silver, soybeans, sugar, unleaded gas and wheat.

[15] Ramsey's (1969) regression specification error test is used to determine whether inclusion of the return on the CRB index is appropriate for the regression models. Test results indicate that a potential simultaneity problem does exist for regressions using the corn futures returns series.

[16] Augmented Dickey–Fuller (ADF) tests indicate that each futures returns series and the three market index returns series are stationary and hence equations (1-2) are estimated in the levels of the data.

of LSAPs (Table 2 for more details, annex); we add three more events for the Maturity Extension program announced in 2011.

LSAPs (Phase 1)

On November 25, 2008, the Fed first announced purchases of GSE debt and MBS, and on December 1, 2008, Bernanke first hinted towards the purchase of longer-term Treasury securities. The anticipation of LSAPs was further reinforced in the December 16, 2008 FOMC press release. But the FOMC disappointed markets because it did not announce any concrete purchases in the 28 January 2009 FOMC statement. Purchases of Treasury securities and an extension of mortgage related securities were finally announced on March 18, 2009.[17]

LSAPs (Phase 2)

The second phase of LSAP began on the FOMC statement of 10 August 2010, when the Fed announced that it would to roll over its holdings of agency securities as they matured into Treasuries, thus avoiding a reduction in the Fed's balance sheet. Bernanke's Jackson Hole speech on 27 August 2010 further reinforced market expectations of renewed purchases, which were finally announced on 3 November 2010.[18]

LSAPs (Phase 3)

The third round of purchases, announced in 2011 (officially named Maturity Extension Program and sometimes referred to as "Operation Twist"), differs from the first two because the purchase of longer-dated government debt will be "sterilized" by the sale of an equal amount of shorter-term debt in the Fed's Treasury portfolio. However, given that the short end of the yield curve is anchored at close to zero per cent because of the Fed's commitment to low rates until mid-2013, the yield curve again flattened (and did not "twist" as would have been the case without anchoring the short end), similar to the effect of LSAP1 and LSAP2. Thus, we can extend our analysis to the third round of purchases, which we refer to as LSAP3 for simplicity.

In terms of the timeline, the Fed's commitment in August 2011 to keep rates low until mid-2013, including its hint towards further easing, can be interpreted as a first announcement of LSAP3. The minutes of 30 August show that FOMC members discussed further options for easing. Finally, sterilized LSAPs were announced in September.

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[17] Over the course of 2009, three announcements related to slower or reduced purchases: On 18 August and 23 September 2009, the Fed announced that the pace of Treasury purchases and mortgage related securities, respectively, would be reduced, followed by the announcement of a slight reduction in the total amount of agency debt to be purchased on November 4, 2009. In this paper, we focus on the announcements that would typically be associated with an increase in asset purchases.

[18] We further consider 3 more dates related to QE2 announcement which are also considered in Glick and Leduc (2011): FOMC statement (9/21/2010), Minutes release (10/12/2010) and Chairman speech, Boston (10/15/2010).

4. Results

This section first discusses results from the dummy regression analysis, followed by results from the mean (market) return model.

a. Regression analysis using dummy variables

Chart 3 shows the response of oil and natural gas prices on the five event dates related to the first round of LSAPs. If LSAPs had a positive impact on commodity prices, we would expect prices to increase on the respective dates. Curiously, oil and natural gas prices rose on only two events, fell on two, and remained roughly unchanged on one event. Similarly, there is no consistent movement in the effective exchange rate, which fell on two events, but remained relatively stable on the other three events. Stock prices rose on three events.

There appears to be no consistent pattern in the reaction of commodity returns on dates related to LSAP2. Chart 4 shows that oil prices fell on the first two dates related to LSAP2, but rose on the actual announcement date in November 2010. The nominal effective exchange rate fell on one event, rose on one, and remained broadly unchanged on the remaining 4 events. Similarly, stock prices fell on the first announcement, remained broadly unchanged on related dates, and rose on the actual announcement of QE2.

Turning to the regression results, Table 3 shows results for the GARCH(1,1) regression of log changes in commodity prices on one dummy variable for all QE events (first two columns) and on separate dummies for QE1, Q2, and QE3 (last 3 columns). The response of oil prices on QE announcement days is negative and statistically significant, but small. Separating QE events shows that the result is driven by a strong (negative) response on QE1 events. However, only few other commodity prices show a statistically significant response, including gold and silver. Results so far thus do not suggest that LSAP fuelled commodities. Results are robust to the specification, e.g. using standard OLS regression or using price changes as dependent and explanatory variables (not shown).

The fact that we do not find a consistently positive response of commodity prices on QE announcement dates could be related to the challenge that the announcement of QE may have two effects working against each other: first, QE announcements may be taken as a signal that economic conditions were worse than previously anticipated and this could dominate the positive effect of the QE monetary ease (Glick and Leduc, 2011). Second, lower interest rates implicitly lower the costs of holding commodity inventories and would thus raise demand and prices. While the first effect would lead to weaker commodity prices, the second would lead to stronger commodity prices, thus partially offsetting each other. In addition, if QE, as intended, affects interest rates further out the yield curve, then it is possible that these interest rates are

less relevant for financing commodity inventories, suggesting that there might not be an effect on spot commodity prices.

b. Mean (market) return model

This section presents results from the event study using a market / mean return model for the first, second, and third round of the LSAPs, respectively.

LSAP round 1

Table 4 shows the R^2 from the normal return regression, the cumulative abnormal return, the two-sided t-test statistic, and the level of significance for each commodity-event combination for the mean return model using the CRB, the S&P500, and the nominal effective exchange rate. Table 5 shows the results for the market return model. We only show statistically significant abnormal returns – results for other event / commodity combinations are spotty, suggesting that not all commodity prices were affected by all the announcements of LSAPs.

The results suggest that LSAPs had no measurable "abnormal" effect on commodity prices - the cumulative abnormal return is significantly different from zero for only 13 out of 80 commodities and events. In five cases, the abnormal return is positive, but in 8 cases it is negative. For instance, the fall in oil prices around the 16 December 2008 FOMC is statistically significant in all three models (a cumulative fall of 9-15% in oil prices), consistent with results from the dummy variable regression. Coal prices reacted both positively and negatively (increasing on December 1, 2008, but falling on December 16, 2008), while gold prices increased on two occasions. For most other commodities, announcement of LSAPs do not appear to have had a measurable effect - no consistent pattern emerges when looking at agricultural products[19] and forestry products. The results appear to be robust to the length of the event window (for instance, estimating the cumulative abnormal return over a 3-day window does not change the results materially); the estimation window, as well as the specification (mean return versus market return model using different explanatory variables).

LSAP round 2

Event study results for QE2, presented in Table 6, suggest that overall LSAP announcement dates did not consistently have a significant positive impact on commodity prices. Again using the CRB, S&P500, and the nominal effective exchange rate as reference variables, most individual cumulative commodity returns are not statistically different from normal returns (i.e. in 75 out of 97 cases). This result is robust to alternative specifications, i.e. using the mean return model or simply one market return variable only (not shown). A few exceptions stand out: First, the rise in oil prices on November 3, 2010 (a cumulative abnormal return of 3 to 3.5

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[19] For instance, on December 16, 2008, canola prices appeared to fall, while wheat prices rose.

per cent) appears to be statistically significant regardless of the specification. Second, natural gas prices appeared to fall on the first announcement (cumulative negative abnormal return of 3.4-3.8 per cent). A few agricultural commodity price returns show statistically significant abnormal returns, but the pattern is not consistent.[20] Overall, about half of the statistically significant abnormal returns are negative. The results are again robust to the length of the event window, the estimation window, and the specification.

Chart 5 shows the cumulative abnormal average return for four commodities around the time of the Jackson Hole announcement. In the case of oil and natural gas, the Jackson Hole announcement did not lead to an increase in abnormal returns: at best, they may have mitigated a declining trend. Interestingly, given the very different supply side conditions affecting these two commodities, and the lack of a clear positive effect, it would seem unlikely that LSAPs were affecting prices significantly. The evidence for wheat reinforces this conclusion, as the announcement did not have any effect. On the other hand, aluminum prices did appear to rebound – however, this may have more to do with demand and supply developments in China, than the stance of U.S. monetary policy.

LSAP round 3

The event study results for the third round of purchases are presented in Table 7. Again, there appears to be very little evidence that commodity prices reacted in a consistently positive way to LSAP announcements. In particular, only coal prices show a statistically significant abnormal return when the Fed first hinted towards another round of easing it its August 2011 statement, whereas other commodity prices did not react. The release of the minutes by the end of August led a statistically significant increase in prices of some commodity prices such as natural gas, but for the actual announcement of QE3 in September most statistically significant responses are negative. To sum, the results for QE3 do not suggest that LSAPs announcement had a significant impact on commodity prices.

Overall, our results are in line with Glick and Leduc (2011). Frankel and Rose(2009), studying the reasons for the run-up in commodity prices until 2008, also find little support for the hypothesis that easy monetary policy and low real interest rates are an important source of upward pressure on real commodity prices, beyond any effect they might have via real economic activity and inflation. The authors conclude that other factors, such as strong demand growth from emerging markets and perhaps speculation, may have contributed to the rise in commodity prices in the 2007-2008 period.

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[20] For instance, corn and wheat prices appear to have fallen on 15/10/2010, while canola and barley prices increased on the announcement of QE2 (03/11/2010).

Robustness

Several extensions are possible to test the robustness of our results. First, instead of using the one month futures price, we use 6- and 12-month commodity futures, as well as the spread of 6- and 12-month futures in the event study to capture the potential impact of LSAP on *expected* commodity prices.[21] Results are qualitatively similar to our previous results. For few commodities and events, LSAP announcements appear to have had a statistically significant impact.

5. International Spill-Over Effects of LSAP Announcements

Using the same methodologies as in the previous section, we analyze the reaction of bilateral exchange rates of commodity exporters' vis-à-vis the US dollar, broad stock price indices of the latter countries, as well as energy stock indices and metal stock indices where available. As explanatory variables and the market return variable, we use the CRB futures price index and the S&P500.

Dummy regression results of log changes in commodity exporter exchange rates on one dummy variable for all LSAP events (first two columns) and on separate dummies for LSAP1, LSAP2, and LSAP3 (last 4 columns) are shown in Table 8. Most statistically significant responses are as expected: commodity currencies appreciated, especially on LSAP1 announcement dates (results are less clear for LSAP2 and LSAP3). This suggests that markets are not segmented, but that there were important spill-over effects into currencies. Thus, while we do not find that commodity prices themselves increased in a consistent way on LSAP announcement days, investors might have sought exposure to commodity-related assets such as commodity exporter currencies instead in response to LSAP announcements. Again, results are robust to the specification, e.g. using standard OLS regression (not shown).

The results suggest that LSAP announcements have been taken as a signal that economic conditions were worse than previously anticipated, implying a weaker US currency in the first place, mechanically leading to an appreciation of other currencies vis-à-vis the US dollar. In addition, for commodity producers, lower US interest rates would lead to stronger commodity prices and an appreciation of commodity currencies. However, signaling weaker US growth could also trigger a downward revision to expectations for commodity exports, partly offsetting the first effect.

Table 9 presents the results of the event study analysis (market return model). In response to the initial announcement of LSAPs in November 2008, all the statistically significant responses are as expected and confirm our results from the dummy variable regression: commodity

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[21] Data is not available for all commodities at longer horizons. In particular, there is no 12-month futures data for lumber, cattle, hogs, wheat, canola and barley.

currencies appreciated. In addition, we find that commodity exporter stock indices, whether broad or commodity specific, increased.[22] This confirms our previous results that there were important spill-over effects into currencies and stock markets. Also, the announcement to increase the size of asset purchases in March 2009 clearly led to an appreciation of currencies and stock indices in commodity exporting countries. As for the second round of LSAP, fewer cumulative abnormal returns are statistically significant (consistent with our results from the dummy variable regression), but most statistically significant responses carry the predicted sign. The overall weaker response to LSAP2 might suggest that the Fed's second round of purchases had less spill-over effects into other currencies. Last, we do not find much evidence for an impact of LSAP3 announcement dates on commodity exporter currencies and stock markets.

6. LSAP vs. non-LSAP and macroeconomic surprises

Another means to analyze whether LSAPs had an impact on commodity process is to compare the response of macroeconomic surprises pre and post LSAP. Under normal economic circumstances, it has been shown that positive macroeconomic surprises lead to increases in some commodity prices, albeit much less than financial assets.[23] This should also be true in the case of macro surprises in an LSAP environment, but with one notable difference. In normal times, a positive macro surprise might also result in a change in the expectations of the future path of monetary policy (i.e. positive surprises should lead to a tightening). Thus, the effect on commodity prices might be partially offset by the expected increase in interest rates. But in the context of LSAPs conducted at the effective lower-bound, a positive macro surprise may not translate immediately into an expected increase in interest rates (or a change in a previously announced plan of asset purchases). Thus in principle, commodity prices could be more responsive to positive macro surprises in an environment of LSAPs.[24]

To test this hypothesis, we use a GARCH(1, 1) model to estimate the effect of macro surprises on oil prices prior to, and since, the introduction of LSAPs. The methodology resembles the approach in the first event study results: the log change in oil prices is simply regressed on a surprise variable over two different sample periods (pre-LSAP: 2005 to October 2008; post-LSAP: December 2008 to March 2011). Surprise variables take the value 0 whenever there was no announcement and the scaled magnitude of the surprise, computed as the z-score (i.e. the actual value announced minus the expected value, divided by the standard deviation of the

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[22] As for non-commodity currencies, responses are significant in far fewer cases, but currencies then also tend to appreciate.
[23] See for instance Roache and Rossi (2009).
[24] In this way, just as fiscal policy may "supercharged" at the effective lower bound, so would the effect on commodity prices.

surprises), on announcement dates.[25] Independent variables include the surprise variables and their lags, as well as the change in the log nominal effective exchange rate. A set of 15 U.S. macroeconomic surprises are considered, including FOMC, GDP, jobless claims, non-farm payrolls, PMIs, and industrial production, among others.

Table 10 shows the regression results for a selection of macro surprises. Overall, we find that oil prices appear to have become more sensitive to macroeconomic surprises during the period of LSAPs, consistent with our priors. In particular, there is a statistically significant response of the change in oil prices to the surprise in the announcement of eight macroeconomic variables during LSAP times, whereas in there is little evidence of a response of oil prices pre-LSAP.[26] Most positive macroeconomic surprises are associated with an increase in oil prices: in six out of eight cases, the log oil price change increases following a positive macroeconomic surprise. In addition, a dummy variable regrouping all surprise dummy variables is now statistically significant and carries a positive coefficient. This suggests that oil prices have become more sensitive to macroeconomic surprises in LSAP times and tend to increase with positive surprises.

Commodity prices and fundamentals

The results give some support to the view that LSAP by the Fed did not have a significant impact on commodity prices. This suggests that other factors were the primary drivers behind the increase in commodity prices that started in mid-2010, including:

- Strong ongoing demand from EMEs across most commodity groups. For example, while there was a slowdown in advanced economy oil demand, EME demand (and Chinese demand in particular), remained robust (Charts 6 and 7).
- Supply constraints meant that the supply responses are limited. Long lag times in bringing new reserves on-stream and unfavorable weather (for agricultural commodities).
- Stocks of crude oil and agricultural products have generally been falling since the summer of 2010 (Yellen 2011).

These fundamental factors, among others, are the most likely reasons why commodity prices rose sharply after March 2009.[27]

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[25] Expected value is the median Bloomberg survey. The surprise variable carries a positive sign for news that are positive in an economic sense (e.g. unemployment rate has an inverted sign).

[26] The fact that we do not find a statistically significant response of oil prices to macroeconomic news is consistent with the literature. See for instance Roache and Rossi (2009).

[27] Some observers argue that the growing financialization of commodity markets has also led to elevated prices, but the evidence is mixed, at best.

7. Conclusion

In this paper, we have studied the response of 17 commodity prices in the BCPI to the Federal Reserve's first, second, and third round of LSAPs. Our analysis does not provide evidence that LSAPs fuelled the rise in commodity prices. Using two types of event studies, we show that abnormal returns of commodity prices were typically not statistically significantly different from zero. If anything, oil prices tended to fall on announcement dates, particularly LSAP1. The results are robust to different specification methods. The results suggest that other factors, such as supply constraints and recovering demand on the back of the global recovery, were most likely the primary drivers behind the increase in commodity prices that started in mid-2010 (Chart 6 and 7).

Nevertheless, results suggest that LSAPs did have spillovers into commodity producing countries, i.e. on commodity currencies and stock indices. This suggests that while investors might not have reacted to LSAPs by directly investing into commodities, they may have increased their exposure to commodities by investing in commodity related assets such as commodity currencies and commodity-heavy equity markets. Last, our results suggest that oil prices have become more sensitive to surprises in macroeconomic announcements during LSAP periods – where positive macroeconomic news tend to be associated with a rise in commodity prices when monetary policy is at the effective lower bound. The latter result does however not suggest that unconventional policy per se contributed to higher commodity prices.

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Tables

Table 1: Commodities included in the event study

Commodity sub-group	Commodity	Units	Mean	Standard Deviation
Energy	Crude oil (WTI)	USD/bbl	81	24
	Natural gas	USD/MMBtu	6	2
	Coal	USD/T	68	25
Metals	Gold	USD/t oz	1049	146
	Silver	USD/t oz	18	2
	Nickel	USD/MT	19727	11154
	Copper	USD/lb	307	73
	Aluminum	USD/MT	2169	540
	Zinc	USD/MT	1935	795
Forestry	Pulp	USD/MT	2024	683
	Lumber	USD/1000 board feet	81	24
Agriculture	Live cattle	USD/lb	92	6
	Hogs	USD/lb	68	8
	Wheat	USD/bu	646	181
	Canola	CAD/MT	480	91
	Barley	CAD/MT	175	35
	Corn	USD/bu	179	24
Explanatory variables	CRB commodity index	CRY index	300	66
	S&P 500	SPY index	1116	177
	NEER	JBXNUSD index	87	4

Table 2: Announcements associated with the LSAP programs

Announcements related to LSAP1		
Date	**Event**	**Announcement**
11/25/2008	Initial LSAP announcement	Fed announces purchases of $100 billion in GSE debt and up to $500 billion in MBS.
12/01/2008	Bernanke Speech	Chairman Bernanke mentions that the Fed could purchase long-term Treasuries.
12/16/2008	FOMC Statement	FOMC statement first mentions possible purchase of long-term Treasuries.
1/28/2009	FOMC Statement	FOMC statement says that it is ready to expand agency debt and MBS purchases, as well as to purchase long-term Treasuries.
3/18/2009	FOMC Statement	FOMC will purchase an additional $750 billion in agency MBS, to increase its purchases of agency debt by $100 billion, and $300 billion in long-term Treasuries.
Announcements related to LSAP2		
Date	**Event**	**Announcement**
08/10/2010	FOMC Statement	Fed will keep constant its holdings of securities at their current level by reinvesting principal payments from agency debt and agency MBS in longer-term Treasury securities.
08/27/2010	Bernanke Speech at Jackson Hole	Bernanke names "conducting additional purchases of longer-term securities" as a tool, "is prepared to provide additional monetary accommodation through unconventional measures ..."
09/21/2010	FOMC Statement	"The Committee [...] is prepared to provide additional accommodation if needed"
10/12/2010	Minutes release	"Several members noted that unless the pace of economic recovery strengthened or underlying inflation moved back toward a level consistent with the Committee's mandate, they would consider it appropriate to take action soon."
10/15/2010	Bernanke Speech in Boston	"Given the Committee's objectives, there would appear--all else being equal--to be a case for further action."
11/03/2010	FOMC Statement (LSAP2)	Fed announces to purchase a further $600 billion of longer-term Treasury securities by the end of 2011Q2, a pace of about $75 billion per month
Announcements related to LSAP3		
Date	**Event**	**Announcement**
09/10/2011	FOMC Statement	Fed will keep low levels for the federal funds rate at least through mid-2013.
08/27/2010	FOMC Statement	Fed will purchase $400 billion of Treasury securities with remaining maturities of 6 years to 30 years and to sell an equal amount of Treasury securities with remaining maturities of 3 years or less. The Fed will now reinvest principal payments from its holdings of agency debt and agency mortgage-backed securities in agency mortgage-backed securities.

Notes: The table describes the 13 events associated with LSAP announcements. The columns denote the date of the announcement, the event type, and a brief description of the event.

Table 3: Dummy regression results for commodity prices

Column1	oil	silver		oil2	gold2	silver2
QE dummy	-0.008*	-0.016**	QE1 dummy	-0.017***	-0.011*	-0.030**
	(-2.12)	(-2.91)		(-4.14)	(-2.31)	(-2.83)
			QE2 dummy	-0.002	-0.003	0
				(-0.19)	(-0.30)	(-0.04)
			QE2 dummy	-0.005	0.033***	-0.019
				(-0.46)	-7.59	(-1.90)
xr	-1.736***	-2.499***	xr	-1.742***	-1.462***	-2.513***
	(-15.42)	(-25.64)		(-15.58)	(-21.68)	(-25.80)
S&P500	0.414***	0.099***	S&P500	0.423***	-0.063***	0.097**
	-14.68	-3.33		-14.96	(-3.48)	-3.28
c	0.001	0.001*	c	0.001	0.001	0.001*
	-1.19	-2.24		-1.17	-1.5	-2.23
ARCH			ARCH			
L.arch	0.282***	0.455***	L.arch	0.283***	0.209***	0.457***
	-8.51	-13.2		-8.37	-6.25	-13.16
L.garch	0.712***	0.116**	L.garch	0.709***	0.663***	0.116**
	-7.31	-2.62		-7.22	-3.62	-2.65
c	0	0.000***	c	0	0	0.000***
	-0.1	-11.17		-0.13	-0.77	-11.17

Notes: dependent and explanatory variables are in log changes. Estimated by a GARCH(1,1). QE dummies take the value 1 on all event dates (see Table 2). XR stands for US nominal effective exchange rate. Results are shown only for commodities where the QE dummy variable carries a significant coefficient. Standard errors in (parentheses). *,**,*** denote significance at the 10, 5, and 1% level.

Table 4: LSAP1: Results from mean return model

Commodity	R2	Event date	Cumulative abnormal return	Test Statistic	Level of Significance
hogs	0.0078162	25/11/2008	0.02281	3.89535	***
silver	0.0217664	25/11/2008	0.06930	1.66002	*
aluminum	0.0797786	01/12/2008	-0.03527	-2.00080	**
barley	0.087223	01/12/2008	0.10343	2.13053	**
canola	0.0653916	01/12/2008	-0.04199	-1.79499	*
coal	0.0413445	01/12/2008	0.06603	3.61900	***
nickel	0.1994001	01/12/2008	-0.02250	-1.67604	*
coal	0.0442617	16/12/2008	-0.08193	-4.73894	***
corn	0.0670919	16/12/2008	0.08334	2.67141	***
gold	0.0597401	16/12/2008	0.03102	1.87312	*
oil	0.0633068	16/12/2008	-0.09077	-2.70922	***
pulp	0.0724146	16/12/2008	0.00886	8.57358	***
wheat	0.0698388	16/12/2008	0.08684	10.25605	***
barley	0.0333332	28/01/2009	0.09686	5.05206	***
aluminum	0.0159392	18/03/2009	0.04361	1.79580	*

Notes: Shaded areas denote that the sign of the cumulative abnormal return is as expected (only results that are statistically significant are shown). *,**,*** denote significance at the 10, 5, and 1% level

Table 5: LSAP1: Results from the market return model

Commodity	R2	Event date	Cumulative abnormal return	Test Statistic	Level of Significance
hogs	0.033	25/11/2008	0.029	3.844	***
aluminum	0.350	01/12/2008	-0.036	-2.167	**
barley	0.378	01/12/2008	0.090	1.875	*
canola	0.283	01/12/2008	-0.051	-1.948	*
coal	0.441	01/12/2008	0.057	3.372	***
aluminum	0.224	16/12/2008	-0.026	-1.978	**
coal	0.328	16/12/2008	-0.117	-3.009	***
copper	0.635	16/12/2008	-0.077	-1.836	*
gold	0.080	16/12/2008	0.026	2.152	**
oil	0.273	16/12/2008	-0.150	-3.031	***
pulp	0.265	16/12/2008	0.013	1.883	*
wheat	0.323	16/12/2008	0.043	1.737	*
hogs	0.050	18/03/2009	-0.013	-2.250	**
pulp	0.067	18/03/2009	0.015	3.550	***

Notes: Regressions use CRB, S&P500, and nominal effective exchange rate as the market return; and only the latter two for commodities included in the CRB index, see text. Only results that are statistically significant are shown. *,**,*** denote significance at the 10, 5, and 1% level.

Table 6: LSAP2: Results from the market return model

Commodity	R2	Event date	Cumulative abnormal return	Test Statistic	Level of Significance
canola	0.292	10/08/2010	-0.055	-2.949	***
cattle	0.383	10/08/2010	0.014	2.693	***
coal	0.149	10/08/2010	-0.010	-2.036	**
copper	0.512	10/08/2010	0.013	1.791	*
gas	0.018	10/08/2010	-0.034	-1.762	*
cattle	0.016	27/08/2010	-0.010	-2.387	***
pulp	0.121	27/08/2010	-0.001	-2.703	***
barley	0.054	21/09/2010	-0.087	-5.332	***
coal	0.056	21/09/2010	0.019	2.118	**
gold	0.028	21/09/2010	0.010	1.769	*
pulp	0.004	21/09/2010	0.003	2.161	**
wheat	0.040	21/09/2010	-0.044	-1.978	**
barley	0.373	12/10/2010	-0.131	-2.999	***
lumber	0.080	12/10/2010	0.049	2.290	**
nickel	0.489	12/10/2010	-0.017	-1.704	*
pulp	0.051	12/10/2010	0.002	2.196	**
silver	0.256	12/10/2010	0.024	2.104	**
corn	0.063	15/10/2010	-0.031	-4.979	***
nickel	0.220	15/10/2010	-0.013	-1.850	*
pulp	0.002	15/10/2010	0.003	4.240	***
wheat	0.002	15/10/2010	-0.036	-2.598	***
barley	0.141	03/11/2010	0.022	2.654	***
canola	0.088	03/11/2010	0.035	1.977	**
cattle	0.007	03/11/2010	-0.009	-2.688	***
coal	0.205	03/11/2010	0.009	2.105	**
oil	0.067	03/11/2010	0.030	3.715	***
pulp	0.041	03/11/2010	-0.004	-3.215	***

Notes: Regressions use CRB, S&P500, and nominal effective exchange rate as the market return, and only the latter two for commodities included in the CRB index. Only results that are statistically significant are shown. *,**,*** denote significance at the 10, 5, and 1% level.

Table 7: LSAP3: Results from the market return model

Commodity	R2	Event date	Cumulative abnormal return	Test Statistic	Level of Significance
gas	0.186	30/08/2011	0.030	2.197	**
lumber	0.073	30/08/2011	0.030	2.137	**
aluminum	0.263	30/08/2011	0.010	1.766	*
pulp	0.028	21/09/2011	0.020	2.911	***
nickel	0.107	21/09/2011	-0.050	-2.219	**
hogs	0.004	30/08/2011	-0.010	-2.644	***
wheat	0.081	21/09/2011	-0.020	-1.747	*
coal	0.193	09/08/2011	0.010	1.647	*
barley	0.004	21/09/2011	0.000	-6.444	***
corn	0.045	21/09/2011	-0.040	-2.227	**

Notes: Regression uses CRB, S&P500, and nominal effective exchange rate as the market return, and only the latter two for commodities included in the CRB index. Only results that are statistically significant are shown. *,**,*** denote significance at the 10, 5, and 1% level.

Table 8: Dummy regression results for commodity exporter exchange rates

	XR_aus	XR_nor		XR_aus	XR_bra	XR_can	XR_mex
d_all	-0.005**	-0.004*	d_qe1	-0.011***	-0.008	-0.011***	-0.013***
	(-2.61)	(-2.33)		(-3.32)	(-1.61)	(-3.79)	(-7.33)
			d_qe2	-0.006	0	0.001	-0.009**
				(-1.34)	(-0.01)	-0.39	(-2.70)
			d_qe3	0.013*	0.027***	0.025	0.019*
				-2.32	-4.65	0	-2.5
d_log_spx	-0.235***	-0.368***	d_log_spx	-0.233***	-0.180***	-0.148***	-0.163***
	(-24.62)	(-22.26)		(-23.46)	(-13.63)	(-8.85)	(-7.21)
d_log_cry	-0.249***	-0.198***	d_log_cry	-0.253***	-0.207***	-0.03	-0.013
	(-13.87)	(-9.03)		(-14.29)	(-9.78)	(-1.30)	(-0.44)
c	0	0	c	0	0	0	0
	(-1.24)	(-0.67)		(-1.32)	-0.58	-0.52	(-0.85)
ARCH	0	0	ARCH	0	0	0	0
L.arch	0.427***	0.112*	L.arch	0.424***	0.328***	0.197**	0.037
	-5.05	-2.31		-5	-7.24	-2.92	-0.84
L.garch	0.296	0.802	L.garch	0.301	0.889***	0.947**	6.414
	-1.87	-1.81		-1.92	-9.13	-2.94	-0.82
c	0.000*	0	c	0.000*	-0.000**	0	-0.001
	-2.2	-0.23		-2.18	(-3.19)	(-0.58)	(-0.70)

Notes: dependent and explanatory variables are in log changes. Estimated by a GARCH(1,1). QE dummies take the value 1 on all event dates (see Table 2). Results are shown only for commodities where the QE dummy variable carries a significant coefficient. Standard errors in (parentheses). *,**,*** denote significance at the 10, 5, and 1% level. XR denotes exchange rates (up is a depreciation), aus denotes Australia, nor Norway, bra Brazil, can Canada, and mex Mexico.

Table 9: Impact of LSAP announcements on commodity exporter exchange rates and stock indices

	Commodity	R2	Event date	Cumulative abnormal return	Test Statistic	Level of Significance
QE1	AUS_ENER	0.05958	25/11/2008	0.05807	1.9858	**
	AUS_MTL	0.07105	25/11/2008	0.09141	1.6742	*
	AUS_XR	0.10209	25/11/2008	-0.01897	-2.3467	***
	BRA_SPX	0.06007	25/11/2008	0.11249	3.4285	***
	CAD_ENER	0.00200	25/11/2008	0.09353	3.4116	***
	CAN_SPX	0.00324	25/11/2008	0.08685	4.3618	***
	MEX_SPX	0.03742	25/11/2008	0.07275	2.9248	***
	MEX_XR	0.04546	25/11/2008	-0.04037	-2.5940	***
	NOR_SPX	0.04363	25/11/2008	0.12246	2.3929	***
	NZL_SPX	0.09091	25/11/2008	0.10035	2.7855	***
	ZAF_SPX	0.06262	25/11/2008	0.02213	3.9233	***
	BRA_XR	0.19073	16/12/2008	-0.01112	-1.9271	*
	CAN_SPX	0.02699	16/12/2008	0.03813	2.5773	***
	MEX_XR	0.01757	16/12/2008	-0.01856	-2.7033	***
	NOR_SPX	0.00100	16/12/2008	0.04181	2.1749	**
	ZAF_XR	0.20583	16/12/2008	-0.01973	-1.8703	*
	AUS_ENER	0.33191	28/01/2009	0.02509	2.3832	***
	AUS_MTL	0.01435	28/01/2009	0.02485	4.8300	***
	ZAF_SPX	0.30730	28/01/2009	0.01614	3.3711	***
	AUS_XR	0.10957	18/03/2009	-0.02570	-2.7723	***
	BRA_SPX	0.11467	18/03/2009	0.04987	2.3831	***
	CAN_SPX	0.10440	18/03/2009	0.04194	1.8938	*
	MEX_SPX	0.04712	18/03/2009	0.03960	1.8079	*
	NOR_SPX	0.03889	18/03/2009	0.04349	1.7460	*
	NZL_XR	0.13988	18/03/2009	-0.03272	-2.6812	***
QE2	NOR_ENER	0.00000	10/08/2010	-0.02047	-2.0531	**
	NOR_XR	0.00285	10/08/2010	0.01420	1.6670	*
	AUS_MTL	0.06232	27/08/2010	-0.01178	-2.7145	***
	NOR_SPX	0.00254	27/08/2010	0.02675	1.9224	*
	NOR_XR	0.00326	27/08/2010	-0.01433	-1.9248	*
	MEX_XR	0.00001	21/09/2010	-0.00648	-2.0531	**
	BRA_SPX	0.07949	12/10/2010	-0.00592	-1.6995	*
	AUS_MTL	0.15203	15/10/2010	0.01855	1.7437	*
	AUS_ENER	0.06417	03/11/2010	0.01354	1.8767	*
	NOR_ENER	0.51354	03/11/2010	-0.02536	-1.7090	*

Notes: AUS stands for Australia, BRA for Brazil, CAN for Canada, MEX for Mexico, NOR for Norway, NZL for New Zealand, ZAF for South Africa. _XR stands for the bilateral exchange rate vis-à-vis the US dollar. A negative figure denotes depreciation. _SPX stands for the country's stock market index, _ENER stands for the country's energy stock index, _MTL stands for the country's metal stock index. The blue shaded cells indicate that the response is as expected. Only results that are statistically significant are shown. *,**,*** denote significance at the 10, 5, and 1% level.

Table 10: Impact of macroeconomic announcements (surprise) on oil prices, pre- and post LSAP

Macro surprise	Pre-LSAP	LSAP
Initial Jobless Claims		+
Initial Jobless Claims (lag)		+
Trade balance (lag)		+
Philadelphia Fed PMI		-
ISM		+
Unemployment (lag)		+
Housing starts (lag)		-
Industrial production		+
All announcements		+
All announcements (lag)		+
Notes: The impact is shown only where it is statistically significant.		

Charts

Chart 1: Commodity prices and stock prices around LSAP announcement dates
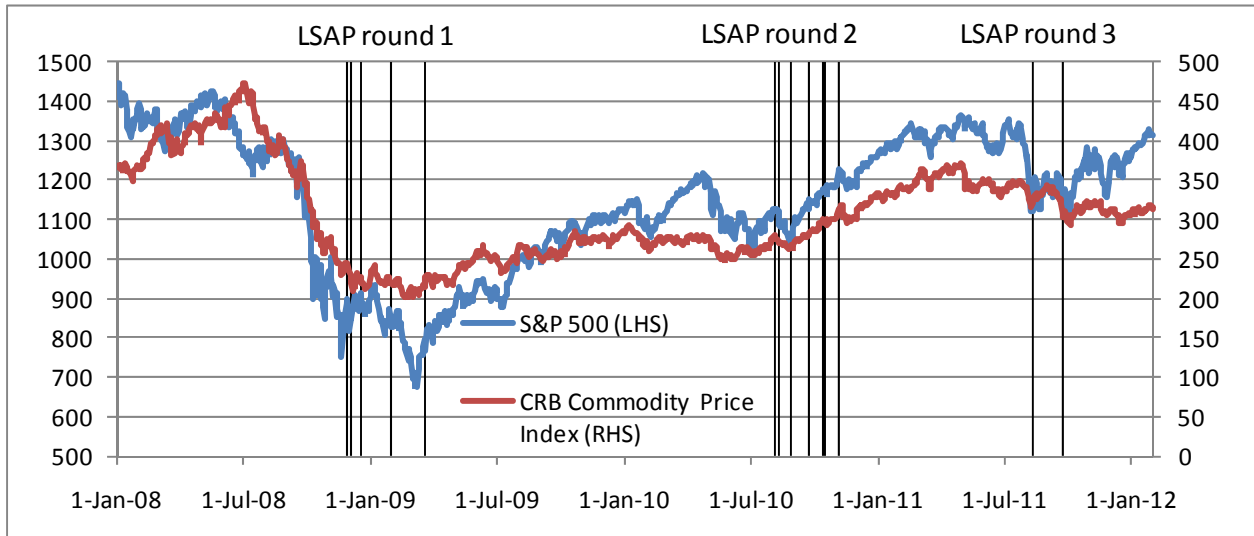
Source: Bloomberg

Notes: the time line bars refer to LSAP 1, LSAP 2, and LSAP 3 announcement dates, see Table 2

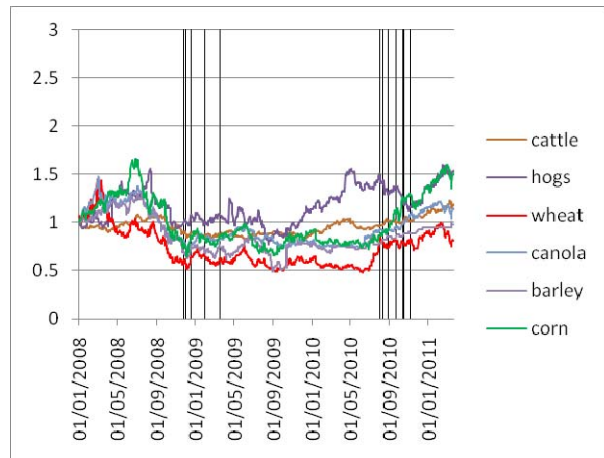## Chart 2: Commodity prices 2008 - 2011

Energy prices
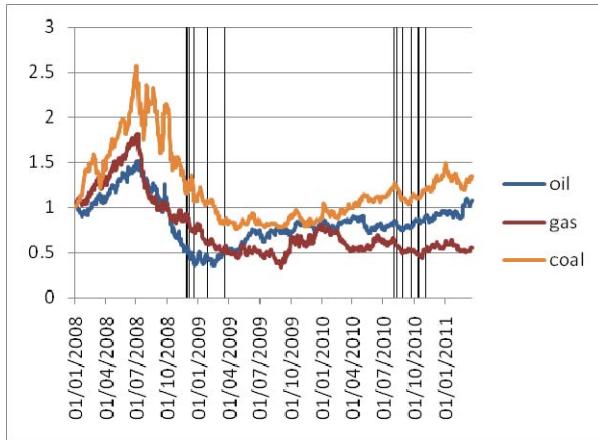
Metals
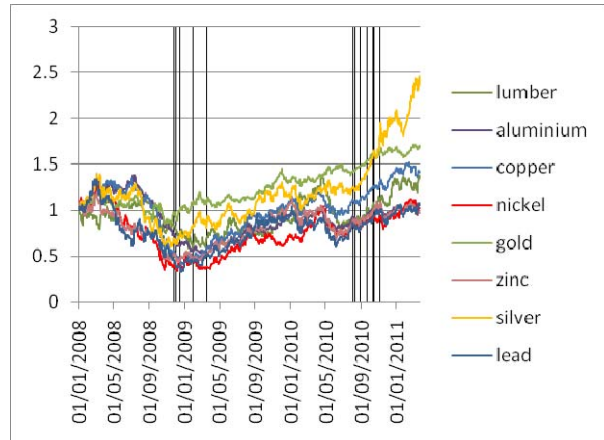
Forest products
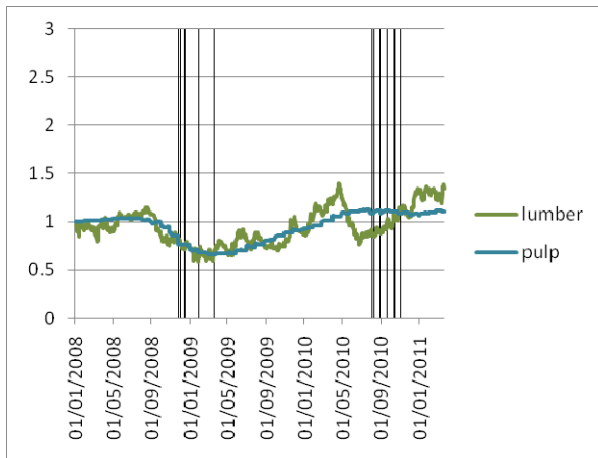
Agricultural products

Source: Bloomberg
Notes: prices are from the nearest futures contract and have been normalized to 1 on January 1, 2008. Bars denote events related to the first and second round of LSAP as described in the text.

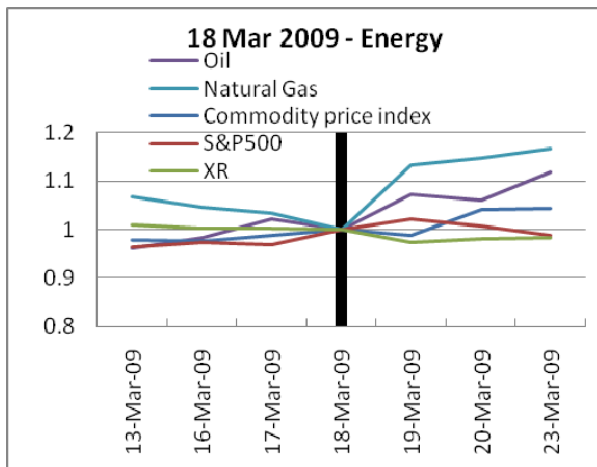**Chart 3: Movement in selected commodity prices on LSAP1 announcement dates**
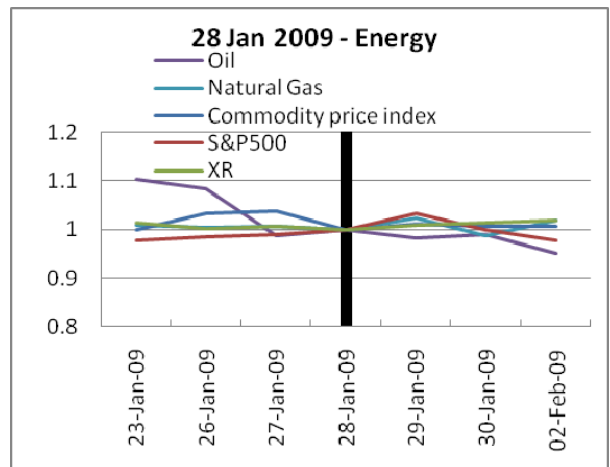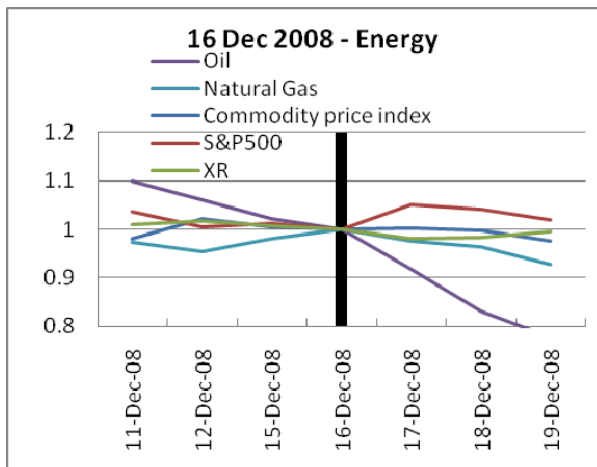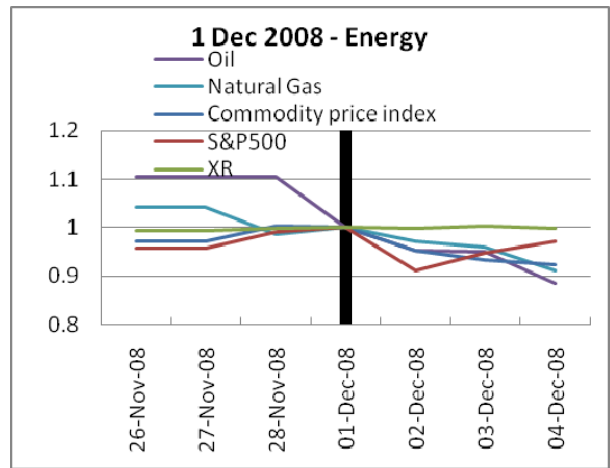

25 Nov2008 - Energy
- Oil
- Natural Gas
- Commodity price index
- S&P500
- XR (RHS)

deprecation

1 Dec 2008 - Energy
- Oil
- Natural Gas
- Commodity price index
- S&P500
- XR

16 Dec 2008 - Energy
- Oil
- Natural Gas
- Commodity price index
- S&P500
- XR

28 Jan 2009 - Energy
- Oil
- Natural Gas
- Commodity price index
- S&P500
- XR

18 Mar 2009 - Energy
- Oil
- Natural Gas
- Commodity price index
- S&P500
- XR
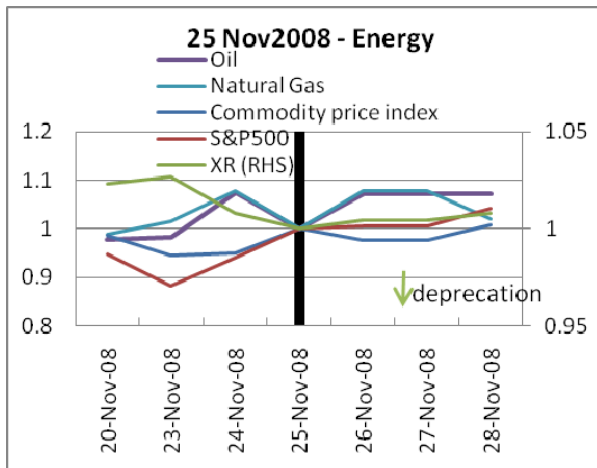
Chart 4: Movement in selected commodity prices on LSAP2 announcement dates

10 August 2010 - Energy

27 August 2010 - Energy

21 September 2010 - Energy

12 October 2010 - Energy

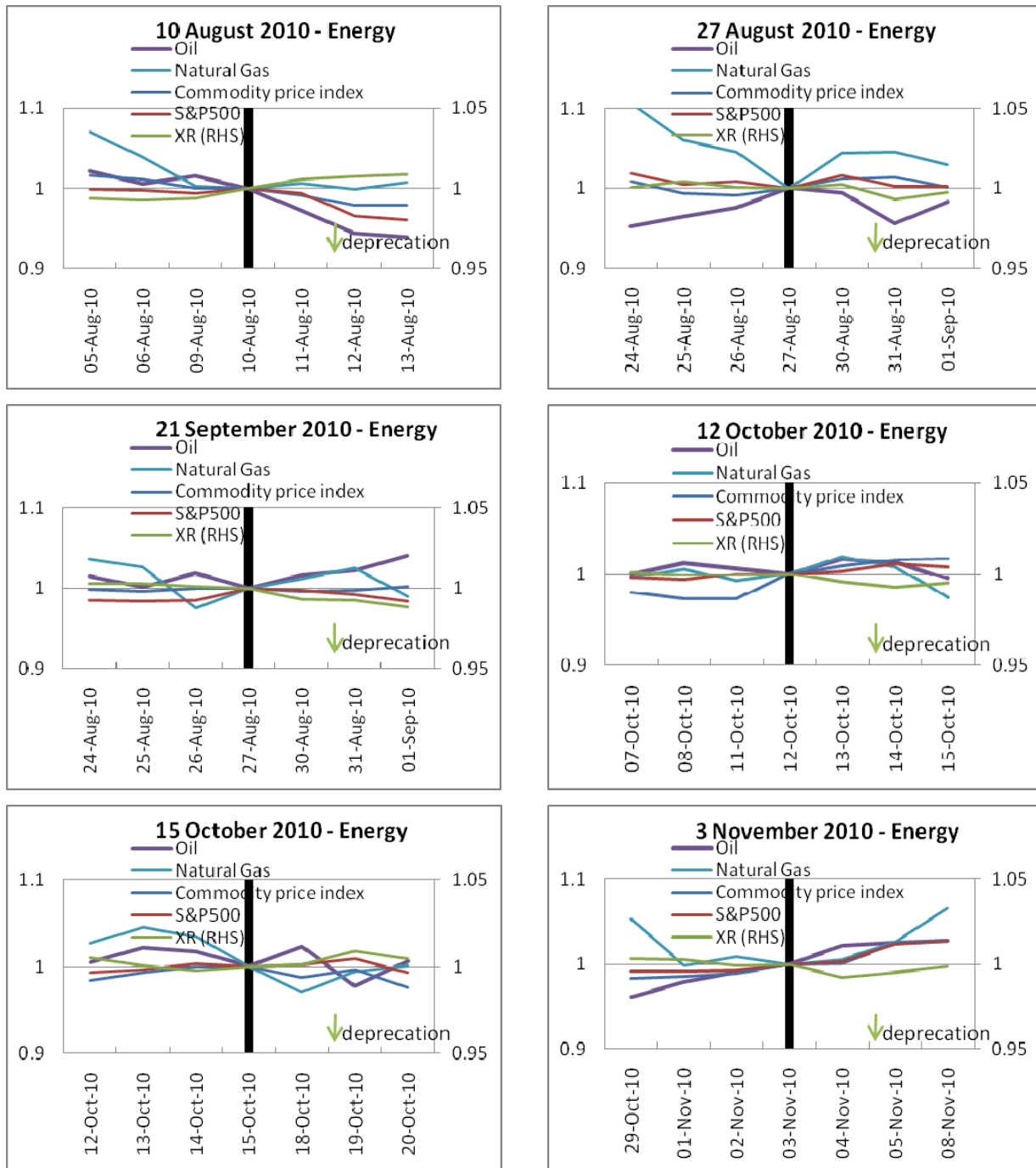15 October 2010 - Energy

3 November 2010 - Energy

Chart 5: Cumulative abnormal returns for selected commodities (Jackson Hole Speech event)

Cumulative abnormal return for oil prices (Brent)
Jackson Hole speech (27/08/2010)

Cumulative abnormal return for gas prices
Jackson Hole speech (27/08/2010)

Cumulative abnormal return for wheat prices
Jackson Hole speech (27/08/2010)

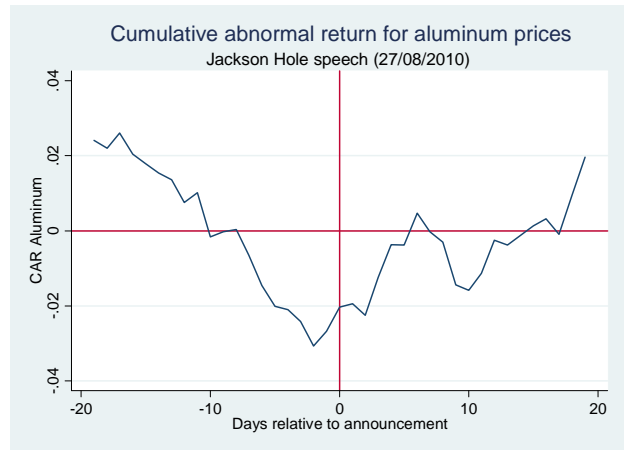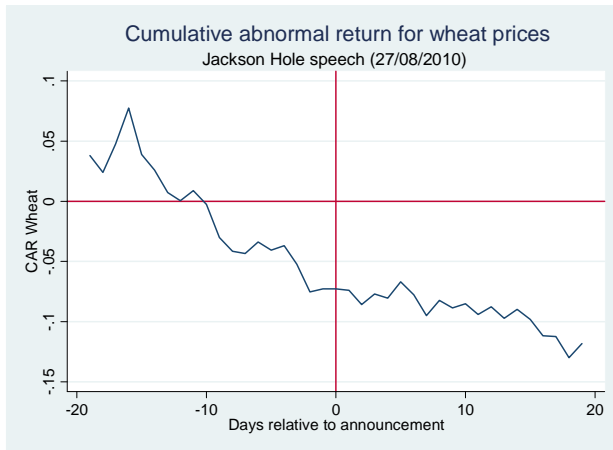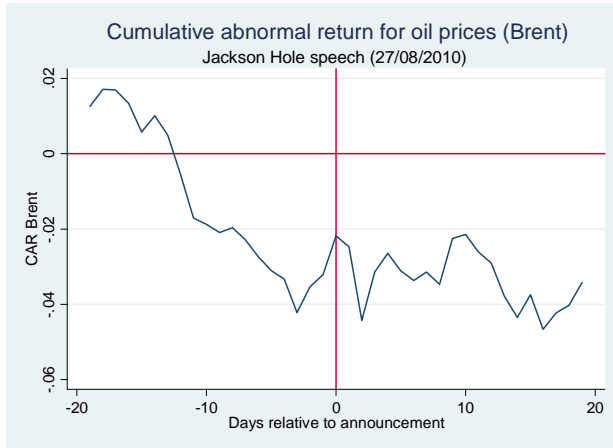Cumulative abnormal return for aluminum prices
Jackson Hole speech (27/08/2010)
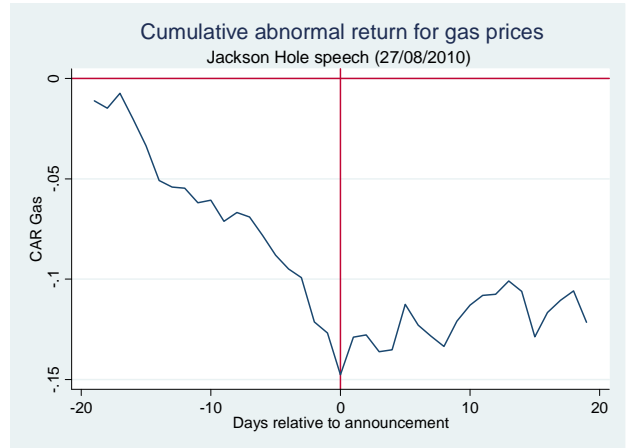
Chart 6: Change in oil demand, emerging versus developed countries

Marginal contributions to global oil demand growth

Million barrels per day

■ China   ■ Other EMEs   ■ OECD

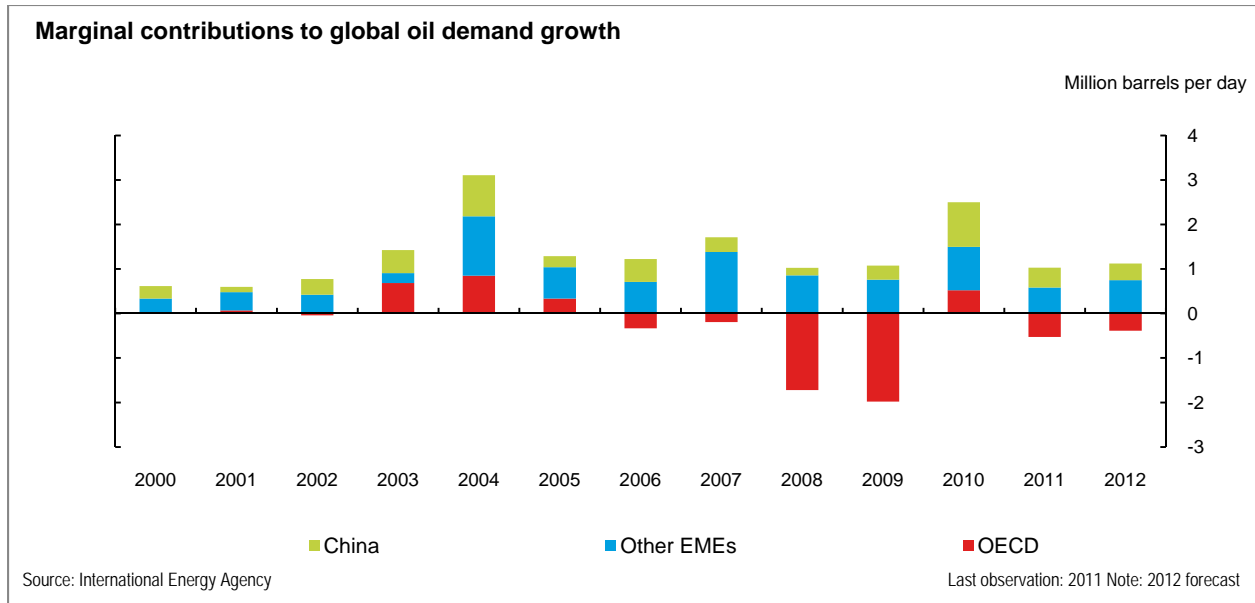Source: International Energy Agency

Last observation: 2011 Note: 2012 forecast

Chart 7: Chinese oil demand is driving prices

Cumulative Marginal Oil Demand Since 2002

constant 2005 USD/bbl

million barrels per day

—— WTI (LHS)   —— United States   —— China   – – Linear (WTI (LHS))

Source: International Energy Agency, IMF World Economic Outlook September 2011, US Bureau of Economic Analysis

Last observation: Forecast Q1-Q4 2012