Factoring Emerging Markets Into the Relationship Between Global Liquidity and Commodities

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Abstract

Purpose

What caused the mid-2000s world commodity price “bubble” and the recent commodity price growth? Some have suggested that rapid global industrial growth over the past decade is the key driver of price growth. Others have argued that high commodity prices are a result of excessively loose monetary policy. The purpose of this paper is to extend the current research in this area by incorporating emerging economies, the BRIC (Brazil, Russia, India, and China) nations specifically, into global measures.
Design/methodology/approach
The paper uses a vector error correction (VEC) model and computes variance decomposition and impulse response functions (IRFs).

Findings
The empirical analysis suggest that the “demand channel” plays a large part in explaining commodity price growth whether BRIC countries are included or excluded from the analysis. However, excess liquidity may also play a part in explaining price growth. In addition, factoring in BRIC country data leads to the conclusion that unexpected movements in liquidity eventually explain more of the variation in commodity prices than unexpected demand shocks. This specific result is not caught in the sample that only incorporates advanced economies.

Research limitations/implications
Despite the theory of Frankel (1986) and the findings of previous global vector autoregression (VAR)/VEC analyses, interest rates, especially shocks, have a minimal impact on consumer and commodity prices. Perhaps future studies should include an interest rate in their analysis that more closely reflects interest rates associated with information used by commodity consumers, producers, and investors. Some analyses such as Hua (1998) use the LIBOR rate, which is highly associated with developed financial markets in the advanced economies. Data quality and availability in the BRIC countries severely limited the length of the time period analyzed and the frequency of the data. Finding longer sample periods or higher frequency data can help to minimize bias in future research. In this paper, monetary aggregates and short-term interest rates were loosely connected to monetary policy. It would also be interesting to directly examine how special programs like quantitative easing influenced global liquidity.

Practical implications
The results of the IRFs and variance decompositions confirm some of the previous findings reported in Belke et al. (2010), Hua (1998), and Swaray (2008) that suggest that positive shocks to liquidity positively impact commodity prices. In particular, both samples suggest that this is a short-run impact that occurs after two quarters. However, in the sample that includes information about liquidity from BRIC countries, excess liquidity positively affects commodity prices after six and seven quarters as well. The insignificant results of Granger causality tests of the effect of monetary variables on commodity prices suggests that this relationship is limited to movements in liquidity that is unexpected by agents in the system. These “shocks” could be attributed to a number of factors including exogenous monetary policy changes such as the unprecedented responses by the Federal Reserve during and after the 2008 global financial crisis.

Social implications
First, empirical research that claims to analyze relationships at a “global” level needs to account for the growing influence of emerging economies and not simply the advanced economies. Otherwise, results may be biased as they were when too much of the forecast error variance in commodity prices was attributed to shocks to output when it should have been attributed to shocks to excess liquidity. Second, those who criticize expansionary monetary policy in the advanced countries, especially by the Federal Reserve, for pushing up commodity prices should also direct their attention toward monetary authorities elsewhere, especially the BRIC countries, since information on excess liquidity from these countries adds to the influence that global excess liquidity has on commodity prices. Third, monetary policymakers in the advanced countries need to closely monitor liquidity in the BRIC countries, since the discrepancies between the ALL and ADV samples suggests that BRIC excess liquidity affects commodity prices in a way that cannot be captured by examining advanced country data alone.
1. Introduction

Debate will continue to exist for some time in regards to the causes of the 2000s commodity “bubble.” From Q4 2001 to Q2 2008, the S & P GSCI Commodity Index (Figure 1) increased 45.9 percent per year for a total return of 498 percent (ex-energy: 27.5 percent per year for a total return of 264 percent). Given that the bubble coincided with a period of relatively loose monetary policy, this suggests a causal relationship between liquidity and commodity prices. Previous studies discussed below suggest that expansionary monetary policy has a positive impact on commodity prices. However, industrial demand is also a key factor in price movements. This “demand-channel” explanation argues that growing worldwide economic growth is an alternative and more plausible explanation for recent commodity price inflation. Concerns over commodity price inflation are warranted not just because they raise costs for producers of goods and consumers of raw materials, but also because there is evidence to support that they have worked their way into boosting consumer prices overall (Furlong and Ingenito, 1996). Also, movements in commodity prices, which are available in real time giving an advantage over consumer prices indexes, have been suggested as a leading indicator of federal funds rate, inflation, and industrial production (Awokuse and Yang, 2003).

This paper uses a vector error correction (VEC) model to examine the two-way relationships between commodity prices, excess liquidity, interest rates, output, and consumer prices. While past analyses using global aggregates may have passed muster decades ago, modern analyses that expect to be representative of global behavior cannot ignore the role of emerging markets. At the very least, they must show that their results are robust when emerging market data are taken into account. This analysis restricts its inclusion of emerging markets to Brazil, Russia, India, and China – the so-called “BRIC” countries. From Q2 1995 to Q2 2010, the share of world output held by the advanced countries analyzed in this paper shrank by nine-percentage points, while the share held by the BRIC countries increased by an equal magnitude. The BRIC countries’ share of the money supply grew from 6 to 21 percent.

Like Sousa and Zaghini (2007, 2008), Hua (1998), and Belke et al. (2010), the data are weighted averages or sums that represent global aggregates. However, the difference in our paper is that two samples are estimated:

1. ADV – aggregates ten advanced economies and the eurozone economies.
2. ALL – aggregates the BRIC countries in addition to the countries in ADV.

Since the BRIC countries are wielding more economic power and influence, we hypothesize that running a model with each sample will produce different results. Thus, leaving out emerging markets in a “global” analysis will produce bias[1]. As we find, we not only reinforce past research finding a link between global monetary aggregates and commodities, but we find noticeable differences between the ADV and ALL samples. This has important implications for how monetary policy is coordinated globally and how future research with global aggregates should be conducted.

The rest of the paper is organized as follows. Section 2 discusses the previous academic literature surrounding monetary factors and commodity prices, especially those with a global-level analysis. Section 3 outlines the model we test. Section 4 discusses the data and methods of aggregation, and Section 5 reports the results of the unit root and cointegration tests. The empirical results are presented in Section 6. Section 7 concludes.
2. Literature review

The theoretical model of Dornbusch (1976) describes the short-run overreaction of exchange rates to money supply growth in the context of “sticky” manufacturing and consumer prices. Frankel (1986) adopts this model but replaces exchange rates with commodity prices and suggests that although commodity prices adjust to a magnitude similar to that of the movement in the money supply, prices overshoot in the short run before adjusting back to their long-run equilibrium. This holds whether interest rates or the money supply are targeted. Frankel (2008) further theorizes that lowering the real interest rate increases the overall price of commodities through three channels – supply, inventory, and financial – and finds a negative relationship between the interest rate and prices. However, this relationship is unstable and does not hold after 1980. In addition, non-stationarity of the data are not addressed, which Summers and Thomson (2012) do indeed find. They also find a structural break for their commodity price index in the 1985, where the sign of the relationship between the interest rate and the price index is negative for pre-1985 data and positive for post-1985 data. Money supply shocks have been found to increase relative agricultural prices both in the USA (Lapp, 1990) and New Zealand (Robertson and Orden, 1990).

Vector autoregression (VAR) and VEC specifications are often employed in models involving monetary policy due to the endogeneity between macroeconomic variables. Using a VEC, Saghaien et al. (2002) found evidence to support overshooting of agricultural prices in response to monetary shocks and a lack of long-run money neutrality due to the unequal increases of prices and the money supply. However, a retesting of previous VAR models by Isaac and Rapach (1997) with US data found that extending the sample with more recent data produced insignificant relationships between monetary shocks and prices.

One explanation for the 2000s commodity price bubble is that economic growth, especially from resource-hungry emerging markets, and not loose monetary policy was the primary driver. As Hua (1998) argues, increases in output are associated with increases in industrial production, and, all else equal, this will boost demand of raw materials in the form of commodities. In addition, increases in output translate into increases in income, which should boost demand for energy and food as consumer goods. Both Hua (1998) and Swaray (2008) estimate error correction models that confirm this relationship between commodity prices and the aggregated output of 22 industrialized countries. In addition, Hua finds that commodity prices respond negatively to increases in LIBOR from two to six quarters after.

Anzuini et al. (2013) estimate a restricted VAR for the US economy and find a positive relationship between federal funds rate shocks and commodity prices after three months, though the influence of this shock over the long term is limited compared with other factors. While they find evidence that the channels identified by Frankel (2008) are significant in linking monetary growth to commodity prices, their impact is extremely small, suggesting that the indirect channel of increased economic growth and consumer inflation plays a much larger role in affecting commodity prices as a result of a monetary shock.

International markets are so integrated today that the free flow of goods and capital across borders undoubtedly has an effect on domestic variables. Using data aggregated “globally” is one way to capture the international nature of commodity and other financial markets in addition to cross-border spillovers. Baks and Kramer (1999) analyze a weighted average global real stock return against such global variables suggesting that excess global money growth lagged one quarter has a positive and significant effect on real stock returns and that Japanese monetary growth spills over into global asset markets.

Sousa and Zaghini (2008) use a VAR to examine the effects of foreign money or “global liquidity” on the eurozone with particular emphasis on the transmission of global shocks. They find that the result of a positive global liquidity shock is similar to what one would expect would happen to output and prices in light of a shock to a domestic monetary base: output, the domestic monetary base, and the price level all rise. The short-term rate eventually rises, perhaps reflecting a reaction to increased liquidity by the central bank. Variance
decomposition suggests that global liquidity plays the most important role in fluctuations in the price level over longer horizons.

Rüffer and Stracca (2006) analyze domestic outcomes and an aggregated global measure of output and prices. Their global liquidity proxy is a weighted sum of monetary aggregates from the USA, UK, Japan, and Canada divided by an aggregate of output in order to account for expansion of global liquidity out of proportion of an expansion of global output (“excess liquidity”). A real asset price does not respond positively to excess liquidity but does have an inverse relationship with the aggregate interest rate. The response to Japanese, Canadian, and eurozone prices and output to an excess global money shock is similar to that found by Sousa and Zaghini (2008), but the USA seems unaffected by global shocks apart from consumer prices. Only in the eurozone do asset prices increase as a result of a positive shock to excess money.

Belke et al. (2010) find that deviation of commodity prices from consumer prices is positively related to excess global money growth and negatively related to the interest rate. The long-run relationship they find between commodity and consumer prices suggests that any commodity price inflation will have spillovers in consumer prices as well.

Sousa and Zaghini (2007) find that positive commodity price shocks appear to have a negative impact on global output and a positive impact on global consumer prices. After two years, commodity prices explain a growing share of the variation in both output and prices. Shocks to domestic variables perform similarly except in some cases for the USA. This suggests that the impact of money on domestic variables does not significantly differ between countries and that central bank strategies may be similar.

3. Model

The endogenous variables included in the system follows that of Sousa and Zaghini (2007, 2008) and Belke et al. (2010), which are focused specifically on commodity prices and globally aggregated variables. These are (with their variable names in parentheses) output (GDP), consumer price level (CPI), excess liquidity (MON), interest rate (INT), and commodity prices (COM). These variables capture three main markets: the goods, money, and raw materials markets. We must take care to differentiate between monetary effects as indicated by the interest rate and that indicated by “excess liquidity.” The two do not always move in step. For example, since the 2008 financial crisis, the Federal Funds rate has been held nearly constant, while the Fed has injected a large amount of liquidity into the system with various novel asset-purchase programs. The order of orthogonalization follows that of Sousa and Zaghini (2007): first is output, then the price level, excess liquidity, the interest rate, and commodity prices. Most importantly, commodity prices are ordered last, because they are supposed to represent the reaction to fluctuations in the other macroeconomic variables in the system.

Granger causality tests, impulse response functions (IRFs), and variance decompositions are used to analyze the relationships between the endogenous variables in the system. The latter two will help determine the effects of monetary shocks on the rest of the system[2].

4. Data and aggregation methodology

Data were gathered from International Monetary Fund’s (IMF) International Financial Statistics, OECD-Stat, World Bank Development Indicators, the Area Wide Model (AWM) data set from the Euro Business Cycle Network, Eurostat, and Bloomberg. Some data from these sources are available quarterly at best, so this dictates the frequency at which the model is estimated. Most of the data were extracted from the IMF, but there are gaps in the data series that are extrapolated by using the growth rate of a similar variable or the same variable from a different source. For example the AWM short-term interest rate is used for the short-term interest rate for the eurozone, but it is only available until Q4 2009, after which the growth rate of the EURIBOR interest rate is used to extrapolate to Q3 2010. More information on how specific gap in the data were filled is available upon request.
The furthest the data go back for all of the BRIC countries without sacrificing data quality is Q2 1995. Therefore, the ALL sample starts at this date. Data from the advanced countries are available back to the early 1980s, providing a large number of degrees of freedom and the opportunity to examine the ADV sample over the entire “post-Volcker” era. Unfortunately, when testing this sample for cointegration using the Johansen-Juselius (JJ) method, the test reports that five cointegrating vectors existed. Since the system is made of up of five endogenous variables, a result that implies five cointegrating vectors suggest that the model might be misspecified. When restricting this sample to the same period of the ALL sample this result disappears, and no misspecification is suggested[3]. Therefore, we only estimate models using ADV and ALL samples from Q2 1995 to Q3 2010.

Table I displays the shares of Organization for Economic Co-Operation and Development (OECD) and world GDP (adjusted for PPP in current US$) held by certain subsamples[4]. Notice that the ADV sample represents the vast majority of OECD output, suggesting that the countries in the ADV sample account for most of the output from what are considered the richest and most economically powerful countries in the world. However, the ADV's sample as a share of world output dropped by eleven percentage points over the 15-year period. This can mostly be accounted for in the nine-percentage point gain in world output share experienced by the BRIC countries, indicating that they are now much more economically relevant than in years past. Thus, we suspect that previous studies whose samples claimed to represent a “global” aggregate yet left out the BRIC countries may have missed the growing ability of these countries to have a significant effect on commodity prices.

The fact that the share lost by the ADV sample was mostly picked up by the BRIC sample indicates that the non-ADV, non-BRIC countries’ share of world output remained relatively constant. These remaining countries as a whole did not rise in relative economic relevancy over the sample period. In addition data for much of the developing world is either unavailable or of suspect quality. For these reasons, the ALL sample is assumed to be the best representation of “global” variables with available data.

One important caveat to consider in this global aggregation is that definitions for macroeconomic variables differ across countries. For short-term interest rates a large majority of rates used are a three-month treasury bill rate, but such rates may not be available for some countries or clearly indicated, so the interest rate closest to a “short-term interest rate” is used. This is not a problem if one assumes that the short-term rate used would move in a similar fashion to that country’s hypothetical three-month treasury bill rate. However, it might be a problem for the measure of excess liquidity. Different countries have different definitions of broad money, and not all countries track the same monetary aggregates (e.g. not all countries in the sample track and report M2). Despite these unharmonized definitions, this method retains some merit. First, taking global money supply and dividing it by global output is arithmetically equivalent to taking a GDP-weighted average of each country’s excess liquidity variable. Second, the broad money definition we choose for each country is assumed to be the “money indicator” monitored by the country’s respective central bank. For example, when the Federal Reserve directs US monetary policy it considers M2 when it gauges movements in US broad money, while the Bank of England tracks the UK’s M4. Therefore, what would be considered excess liquidity to one central bank might not be considered excess liquidity to another. If it is assumed from the results of this paper that policy should be shaped around movements in excess liquidity, a central bank is less likely to respond to movements in a broad money definition that it does not closely track. Thus, we argue that unharmonized definitions will work as proxies for global excess liquidity.

As far as the specific data used for each of the variables in the model is concerned, real GDP transformed into US dollars using PPP exchange rates is used for output. A CPI is used for the price level. Per Rüffer and Stracca (2006), excess liquidity is measured by taking the sum of all countries’ broad money measures and dividing it by the sum of output. For the interest rate, a short-term nominal interest rate that is most similar to a three-month treasury bill is used. The commodity price index used is the Standard and Poor’s GSCI. This index is weighted by
world production and includes commodities with highly liquid and active global markets. Energy commodities account for 66.5 percent of the weighting. We rely on Swaray (2008) to conclude that results using an index highly weighted with energy commodities can still be generalized to non-energy commodities.

All variables except the interest rate are expressed in log form. Where individual country GDP, CPI, and broad money measures are not extracted from their sources already seasonally adjusted, they are adjusted with the X12-ARIMA method. The aggregated variables for both the ALL and ADV samples are provided in Figure 1. GDP took a noticeable dip in 1998 for the ALL sample while growth remained positive for ADV, possibly reflecting the effects on the BRIC countries of the Asian and Russian financial crises during the late 1990s. Beginning around 2004, the gap between the ALL and ADV samples begins to close, reflecting the higher relative rates of growth that the BRIC countries experienced. As the CPI chart shows, when the inflation rates of the BRIC countries are taken into account, the global price level has risen at a faster rate compared with just the advanced countries. The interest rate is consistently higher for the ALL sample than the ADV sample, partially reflecting the higher inflation rates of the ALL sample. In particular, around 1995-1996, Russia experienced interest rates at the 100-300 percent level as it came off of a period of hyperinflation following the breakup of the Soviet Union.

The comparison of measures of excess liquidity across samples displays a peculiar divergence among the liquidity positions of the advanced and BRIC economies. By this measure, the BRIC countries brought down the average in years prior to 2001. This suggests that there was less excess liquidity in the BRIC countries as a whole than the advanced countries. Both series display a clear upward trend throughout the whole sample, but after Q3 2001 excess liquidity was higher for the ALL sample than ADV, suggesting that money supplies in the BRIC countries were expanding above and beyond what was required for economic growth at a faster rate than the advanced countries. The point at which excess liquidity for the ALL sample became higher than the ADV sample also happened to coincide with the beginning of the 2000s commodity bubble.

Finally, a constant is added to the model, and, due to the linear trend in each data series and due to the convention used by Rüffer and Stracca (2006), Belke et al. (2010), and Sousa and Zaghini (2008, 2007), a linear trend is included as well. In all specifications tested in this paper, the trend and constant term are significant in one or more of the equations and is included in the final models.

5. Unit root and cointegration tests

To test for a unit root we employ the Augmented Dickey-Fuller (ADF), Dickey-Fuller GLS (DF-GLS), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. Results are provided in Table II. In general, the tests suggest that the variables are stationary in their first-differences[5].

We employ the JJ test with a trend and intercept and the Pesaran test from Pesaran et al. (2001) to test for cointegration. The Trace method is used to determine rank. Lag lengths for the JJ test are determined by using final prediction error, and Akaike, Schwarz, and Hannan-Quinn information criterion which mostly suggest a lag length of one. However, the models were tested for autocorrelation using the LM test, and the lag length was increased and retested until autocorrelation disappeared. This occurred at two lags for the ADV sample and three lags for the ALL sample. Belke et al. (2010) indicate that “In macroeconomic modeling it is hard to imagine agents using information that reaches back much further than two to four quarters.” In both samples, the JJ test suggests that cointegration exists. However, in the ADV sample the Trace method suggests that four cointegrating vectors exist, while in the ALL sample three cointegrating vectors exist.

Table III provides the results of the Pesaran test. Only one equation in each sample unambiguously suggests that cointegration exists while the result for CPI in the ADV sample is ambiguous. Thus, there is mixed evidence for the presence of cointegration, despite it appearing in similar analyses in the literature. The JJ test suggests cointegration, while the Pesaran test does not strongly suggest it. One reason why this mixed result might exist is that the sample period is relatively short, roughly 15 years. The case could be made that that is not a long
enough period for variables to display a clear return to long-run equilibrium that could be picked up by the Pesaran test even though they might clearly display cointegration if the sample was extended[6].

Omitting these long-run variables could introduce bias, so we will assume cointegration if it improves the fit of the overall model. Table IV reports various gauges of model fit. Excepting the Schwarz Criterion in the ALL sample, the specification with long-run information included (VEC[7]) is a better fit for the data. Given the tests and fit criterion as a whole, the final models are estimated as VECs which included the third and fourth lagged-level variables in the ADV and ALL samples, respectively.

6. Empirical results

Granger causality tests are used to examine short-run effects. Referring to Table V, in the ADV sample commodity prices Granger cause GDP and CPI, but this is not the case for the ALL sample. For CPI especially, this is a peculiar result, since the CPIs in emerging countries are more heavily weighted with commodities compared to advanced countries. Therefore, one would expect that at the very least if commodity prices Granger caused CPI in advanced countries, then it would Granger cause it in a sample that included emerging countries as well. Note, however, that CPI in the ADV sample also Granger causes commodity prices.

In the ADV sample, CPI Granger causes the short-term interest rate. Assuming that this is a positive relationship, this suggests that higher rates of inflation across advanced countries induce central banks to tighten monetary policy through interest rates. In the ALL sample, although each of the other four endogenous variables jointly Granger cause the global short-term interest rate, none of them individually Granger cause the interest rate. It is possible that interest rates respond differently to economic conditions between advanced and emerging economies to a degree that makes aggregation into a single rate less meaningful for global-level analysis.

While excess liquidity does not appear to Granger cause commodity prices in either sample or CPI in the ADV sample, it does Granger cause CPI in the ALL sample. This suggests that while inflation in advanced countries may be unaffected by non-stochastic movements in excess liquidity, an aggregate that includes inflation in emerging countries is sensitive to excess liquidity. The dominant factor in both samples that drives commodity prices appears to be GDP. GDP Granger causes commodity prices at a level of significance greater than 1 percent. This lends support to the theory that short-term fluctuations in commodity prices are highly demand driven, at least in a non-stochastic context.

For long-run effects, we estimate the coefficients of the lagged-level variables from each VEC. For example, to find the long-run impact of CPI on GDP in the ADV sample, the coefficient on the level variable for CPI lagged three quarters is divided by the coefficient on the level variable for GDP lagged three quarters and then multiplied by negative one. Table VI provides the estimated long-run impacts and their directions. Unfortunately, most “long-run” coefficients were not significant (t-stats did not exceed 2), so the direction of their estimated long-run impacts should be interpreted with caution. The only impacts for which both level coefficients were significant were for the long-run impacts of CPI and MON on GDP. Both indicated that increases in the price level and excess liquidity negatively impact the output in the long run. In a long-run context, this suggests that excessively loose monetary policy coupled with inflation has negative effects on economic growth.

IRFs explain reactions of an endogenous variable to a “shock” in the error term of one of the VEC equations. Care should be taken before these shocks are interpreted as movements in economic variables that are truly unexpected by economic agents in the real world (Rudebusch, 1998 explains the limitations of interpreting monetary shocks). Relevant results for the IRFs and variance decompositions are in Figures 2 and 3 [8]. Between the ALL and ADV samples, positive shocks to GDP positively impact commodity prices one and two quarters after the shock. This provides more evidence to support the “demand channel” explanation for part of the rise in
commodity prices. However, while there is a negative reaction to this shock in commodity prices in the fourth quarter in the ADV sample, this effect disappears in the ALL sample.

In the second quarter after an excess liquidity shock commodity prices are positively impacted in both samples, but the effect is smaller and marginally significant in the ALL sample. In addition, prices are negatively impacted in the fourth quarter after the shock and then positively again in the sixth and seventh quarters in the ALL sample. Including the emerging markets into the global aggregate appears to convey non-trivial information about excess liquidity in the BRIC countries that is ignored by excess liquidity shocks in the aggregate with advanced countries alone. This also provides additional evidence to support the idea that excess liquidity shocks can push commodity prices higher and that demand growth, while significant, cannot account for all commodity price inflation.

Impacts of commodity price shocks to CPI are not robust. In the ADV sample, the effect is just barely significantly positive, while in the ALL sample, there is no significant impact. This result is similar to the peculiar result of the Granger causality test, as one would expect that if commodity prices did not affect CPI in the ALL sample, then it should not impact it in the ADV sample.

It is in the variance decompositions that the differences between the ADV and ALL samples are more clearly demonstrated. The share of variation in CPI explained by GDP shocks after two quarters out drops from about 40 percent in the ADV sample to 20 percent in the ALL sample. Excess liquidity shocks explain less than 10 percent in the ADV sample, but this share gradually grows to explaining 40 percent of the variation in CPI in the ALL sample. Most importantly to this analysis, GDP shocks explain roughly 35 percent of the variation in commodity prices in the ADV sample, but this eventually drops to about 20 percent in the ALL sample. Although excess liquidity shocks initially explain relatively very little of the variation in commodity prices in the ADV sample, this influence eventually grows to about 45 percent.

This discrepancy between the two samples suggests that important information is excluded when BRIC data are excluded from an aggregate that is meant to proxy for global fluctuations. Examining only advanced countries misattributes a large portion of the variation in commodity prices to shocks in GDP. When including excess liquidity of BRIC countries into the aggregate, a larger portion of the variation in prices appears to be attributed to excess liquidity shocks rather than output thus diminishing the influence of the demand channel. While the "demand channel" is still relevant, this result supports the idea that unexpected excessively loose monetary policy on a global scale could have been an important driver of the commodity bubble.

With IRFs, we do not find that interest rate shocks significantly impact consumer or commodity prices. In fact, in the ADV sample, interest rate shocks positively impact commodity prices. Along with the Granger causality results, this is in contrast with the previous studies on global aggregates (Belke et al., 2010; Hua, 1998; Swaray, 2008) and the theoretical predictions of Frankel (1986). It could be that monetary effects of the commodity markets are indicated by excess liquidity in the system rather than directly by the nominal interest rate. One could argue that a structural break the relationship between the interest rate and other variables has occurred during the 2008-2009 recession, though this represents a small portion of our data set’s timespan. It is only starting in 2009 that our aggregate interest rate in both samples drops below 2 percent, and it remains there to the end of the sample. At the time of writing, interest rates in the developed world have remained below 1 percent for several years while central banks have undergone novel asset-purchase programs. We leave this as an avenue for future research. As far as data quality is concerned, our aggregation method assumed that the interest rates or individual economies were comparable. To the extent that this is not the case, this could also explain the lack of a relationship.
7. Conclusion and policy implications

The results of the IRFs and variance decompositions confirm some of the previous findings reported in Belke et al. (2010), Hua (1998), and Swaray (2008) that suggest that positive shocks to liquidity positively impact commodity prices. In particular, both samples suggest that this is a short-run impact that occurs after two quarters. However, in the sample that includes information about liquidity from BRIC countries, excess liquidity positively affects commodity prices after six and seven quarters as well. The insignificant results of Granger causality tests of the effect of monetary variables on commodity prices suggests that this relationship is limited to movements in liquidity that is unexpected by agents in the system. These “shocks” could be attributed to a number of factors including exogenous monetary policy changes such as the unprecedented responses by central banks during and after the 2008 global financial crisis.

Despite this monetary influence, our results also point to the positive influence that global economic demand has on commodity prices. This supports the argument that accelerated rates of economic growth in emerging economies is partially responsible for elevated commodity prices in the past decade. Nonetheless, according to the variance decompositions, when BRIC countries are included in the global aggregate the demand channel reduces in importance while excess liquidity rises in importance.

This discrepancy between samples has two implications for research and policy. First, empirical research that claims to analyze relationships at a “global” level needs to account for the growing influence of emerging economies and not simply the advanced economies. Otherwise, results may be biased. Second, criticism of developed world monetary policy might also want to account for emerging market monetary policy. Third, monetary policymakers in the advanced countries need to closely monitor liquidity in the BRIC countries since the discrepancies between the ALL and ADV samples suggests that BRIC excess liquidity affects commodity prices in a way that cannot be captured by examining advanced country data alone.

While the insignificance of the interest rate might seem to contradict Frankel (2008), that research did not empirically test with both the interest rate and a measure of money. We find it more important to address our interest rate findings that are dissimilar to previous global VAR/VEC analyses. This could be due to a structural break in interest rate data or the trouble in using an aggregated rate composed of interest rates with slightly different definitions and uses. Perhaps future studies should include an interest rate in their analysis that more closely reflects interest rates associated with information used by commodity consumers, producers, and investors. Some analyses such as Hua (1998) use the LIBOR rate, which is highly associated with developed financial markets in the advanced economies. Of course, one would have to demonstrate that LIBOR also incorporates information about emerging market economies.

Data quality and availability in the BRIC countries severely limited the length of the time period analyzed and the frequency of the data. Finding longer sample periods or higher frequency data can help to make future research more robust. In this paper, monetary aggregates and short-term interest rates were loosely connected to monetary policy. It would also be interesting to directly examine how special programs like quantitative easing influenced global liquidity.

Notes

Alternatively, one could estimate a VAR with nine endogenous variables (a set of four macro variables with averaged advanced country data, a set of four macro variables with averaged BRIC country data, and the commodity price index). This might be able to separate the impacts of the advanced and BRIC country economies. However, doing so would greatly reduce degrees of freedom in the model.

See Li et al. (2010) for a discussion of the nature of monetary surprises.
Originally, an ADV sample restricted to the same period as the ALL sample was going to be estimated anyway in addition to the ADV sample going back to 1980.

In the ADV sample representing the most important advanced economies, ten countries and the eurozone are aggregated which include Australia, Canada, Denmark, Japan, Norway, South Korea, Sweden, Switzerland, the UK, and the USA. These are the countries selected by Belke et al. (2010) because they represented a large enough share of world GDP and an even larger share of world financial markets. The ALL sample includes every country in the ADV sample and the four BRIC countries.

For the INT variable in the ALL sample, the tests disagreed with each other and with past literature. The ADF test suggested stationarity in first differenced form, while the DF-GLS and KPSS tests both suggested that a unit root existed in the level and first difference. Because the other variables are stationary in first-differences and because authors in the previous literature have estimated VARs all in first-differences, INT will be estimated in its first difference as if it were stationary in that form. However, the reader should be aware that this variable exhibited this peculiar characteristic. It might be worthwhile to test for unit roots over a sample period from 1995 Q2 to 2008 Q3 in order to avoid the structural break that may have occurred during the financial crisis, but this is not pursued.


Computationally, the VEC models were run as unrestricted VARs with the lagged-level variables included as if they were “exogenous” parameters.

Results for the remaining variables are available on request.

Appendix. Global aggregation method

First, country currencies were converted into US dollars at PPP exchange rates. This method accounts for differences in the purchasing power of one dollar in different countries. Specifically, the formula, adapted from Sousa and Zaghini (2007, 2008) adjusts the nominal market exchange rate, $E$, for the level of inflation in country $i$ relative to the USA. The formula is as follows:

$$E_{\text{currency in country } i \text{ per USD}} \times \frac{CPI_{it}/CPI_{it-1}}{CPI_{UST}/CPI_{UST-1}}$$

While output and excess liquidity were aggregated into global variables by summing GDPs and broad money supplies, CPI and the interest rate were calculated by taking a weighted average of each variable using GDP of country $i$ relative to the GDP of the entire sample as weights. For example for CPI in the ALL sample at time $t$:

$$\text{Global } CPI_{ALL,t} = \sum_{i=1}^{15} \frac{GDP_{it}}{GDP_{Total \text{ in ALL sample},t}} \times CPI_{it}$$

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References


Further reading


Acknowledgements

**JEL Classification** — E30, E52, Q01

The authors are indebted to Andrea Zaghini for sharing the methodology for how the PPP exchange rates were calculated in Sousa and Zaghini (2007, 2008).

**Figures, Tables, and Equations**

**Figure 1.** Global aggregates 1995Q2-2010Q3
Figure 2. Impulse response functions
Figure 3. Variance decomposition

Table I. GDP shares
<table>
<thead>
<tr>
<th></th>
<th>1995 (%)</th>
<th>2009 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADV as a % of OECD</td>
<td>92</td>
<td>889</td>
</tr>
<tr>
<td>ADV as a % of world</td>
<td>61</td>
<td>50</td>
</tr>
<tr>
<td>BRIC as a % of world</td>
<td>15</td>
<td>24</td>
</tr>
<tr>
<td>ALL as a % of world</td>
<td>76</td>
<td>74</td>
</tr>
</tbody>
</table>

Source: World Bank Development Indicators

Table II. Unit root tests

<table>
<thead>
<tr>
<th>Level</th>
<th>ADV sample</th>
<th>All sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADF</td>
<td>-1.7079(^a)</td>
<td>-2.4926(^a)</td>
</tr>
<tr>
<td>DF-GLS</td>
<td>-1.8675(^a)</td>
<td>-2.3819(^a)</td>
</tr>
<tr>
<td>KPSS</td>
<td>0.1672(^d)</td>
<td>0.0952(^b)</td>
</tr>
</tbody>
</table>

First difference

<table>
<thead>
<tr>
<th>Level</th>
<th>ADV sample</th>
<th>All sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADF (no trend)</td>
<td>-3.4685(^g)</td>
<td>-3.8276(^h)</td>
</tr>
<tr>
<td>DF-GLS</td>
<td>-3.7162(^g)</td>
<td>-5.4366(^h)</td>
</tr>
<tr>
<td>KPSS</td>
<td>0.0717(^b)</td>
<td>0.1077(^b)</td>
</tr>
</tbody>
</table>

Second difference

<table>
<thead>
<tr>
<th>Level</th>
<th>ADV sample</th>
<th>All sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF-GLS</td>
<td>-3.1907(^g)</td>
<td>-1.6456(^a)</td>
</tr>
<tr>
<td>KPSS</td>
<td>0.1077(^b)</td>
<td>0.0866(^b)</td>
</tr>
</tbody>
</table>

Notes: p-Values are in parentheses. Stationarity indicated in italics. COM is the same for both samples.

\(^a\) Failure to reject the null of unit root at the 10 percent level; therefore series is non-stationary.

\(^b\) Failure to reject the null of unit root at the 10 percent level; therefore series is stationary.

\(^c\) Rejection of the null of unit root at the 10 percent level; therefore series is stationary.

\(^d\) Rejection of the null of unit root at the 5 percent level; therefore series is non-stationary.

\(^e\) Rejection of the null of unit root at the 10% level; therefore series is stationary.

\(^f\) Rejection of the null of unit root at the 5% level; therefore series is stationary.

\(^g\) Rejection of the null of unit root at the 1% level; therefore series is stationary.

Table III. Pesaran test

<table>
<thead>
<tr>
<th>Dep. variable</th>
<th>ADV sample F-stat</th>
<th>Result</th>
<th>ALL sample F-stat</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔRGDP</td>
<td>2.251</td>
<td>No cointegration</td>
<td>ΔRGDP</td>
<td>2.340</td>
</tr>
<tr>
<td>ΔCPI</td>
<td>2.972</td>
<td>Ambiguous</td>
<td>ΔCPI</td>
<td>3.697</td>
</tr>
<tr>
<td>ΔMON</td>
<td>3.672</td>
<td>Cointegration</td>
<td>ΔMON</td>
<td>1.708</td>
</tr>
<tr>
<td>ΔINT</td>
<td>2.352</td>
<td>No cointegration</td>
<td>ΔINT</td>
<td>1.104</td>
</tr>
</tbody>
</table>
ΔCOM | 1.064 | No cointegration | ΔCOM | 1.700 | No cointegration

**Note:** Critical values at 10% LOS

### Table IV. Comparison of model fit

<table>
<thead>
<tr>
<th>Dep. variable</th>
<th>ΔRGDP</th>
<th>ΔCPI</th>
<th>ΔMON</th>
<th>ΔINT</th>
<th>ΔCOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-R included</td>
<td>0.629</td>
<td>0.581</td>
<td>0.639</td>
<td>0.556</td>
<td>0.575</td>
</tr>
<tr>
<td>Not included</td>
<td>0.578</td>
<td>0.492</td>
<td>0.534</td>
<td>0.491</td>
<td>0.572</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Akaike information criterion</th>
<th>Schwarz criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-R included</td>
<td>-29.247</td>
</tr>
<tr>
<td>Not included</td>
<td>-28.277</td>
</tr>
</tbody>
</table>

**ALL sample**

<table>
<thead>
<tr>
<th>Dep. variable</th>
<th>ΔRGDP</th>
<th>ΔCPI</th>
<th>ΔMON</th>
<th>ΔINT</th>
<th>ΔCOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-R included</td>
<td>0.554</td>
<td>0.584</td>
<td>0.652</td>
<td>0.413</td>
<td>0.562</td>
</tr>
<tr>
<td>Not included</td>
<td>0.481</td>
<td>0.447</td>
<td>0.622</td>
<td>0.406</td>
<td>0.525</td>
</tr>
</tbody>
</table>

### Table V. Granger causality tests

Table for ADV sample and All sample with excluded and dependent variables for ΔRGDP, ΔCPI, ΔMON, ΔINT, ΔCOM.
### Table VI. Implied long run impacts

<table>
<thead>
<tr>
<th>Impact of variable</th>
<th>GDP</th>
<th>CPI</th>
<th>MON</th>
<th>INT</th>
<th>COM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADV sample</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔRGDP</td>
<td>13.95</td>
<td>0.0009</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔCPI</td>
<td>9.726</td>
<td>0.0077</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔMON</td>
<td>3.336</td>
<td>0.1885</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔINT</td>
<td>2.398</td>
<td>0.3014</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>45.136</td>
<td>0.0000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ALL sample</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔRGDP</td>
<td>19.770</td>
<td>0.0002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔCPI</td>
<td>1.655</td>
<td>0.6469</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔMON</td>
<td>1.959</td>
<td>0.5808</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔINT</td>
<td>5.323</td>
<td>0.1496</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>50.904</td>
<td>0.0000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Italics numbers indicate both coefficients have t-stats greater than two and are therefore significant.