Bank of Japan Working Paper Series

What Has Caused the Surge in Global Commodity Prices and Strengthened Cross-Market Linkage?

Takuji Kawamoto[†]
takuji.kawamoto@boj.or.jp

Takeshi Kimura[‡]
takeshi.kimura@boj.or.jp

Kentaro Morishita[†]
kentarou.morishita@boj.or.jp

Masato Higashi[‡]
masato.higashi@boj.or.jp

No.11-E-3
May 2011

Bank of Japan
2-1-1 Nihonbashi-Hongokucho, Chuo-ku, Tokyo 103-0021, Japan

[†]Financial Markets Department

[‡] International Department

What Has Caused the Surge in Global Commodity Prices and Strengthened Cross-Market Linkage?

Takuji Kawamoto[†], Takeshi Kimura[‡], Kentaro Morishita, and Masato Higashi
Bank of Japan

May 2011

Abstract

Global commodity prices have been on an increasing trend since 2009, while their correlation with stock prices has risen. This paper attempts to identify the main causes of fluctuations in global commodity markets, by using the historical decomposition of VAR models. It then provides quantitative evidence that the post-2009 commodity boom was driven by (1) growing physical demand for commodities amid global economic recovery and (2) globally accommodative monetary conditions. This result contrasts sharply with the commodity boom that occurred up to summer 2008, when a "flight to simplicity" led to substantial capital flows into commodity markets from other asset markets such as securitization and stock markets. Moreover, we find quantitative evidence that an increase in cross-market linkage between commodity and stock markets was caused by the markets' increased comovements due to large fluctuations in the global economy during the financial crisis as well as by the "financialization of commodities," that is, financial investors are increasingly treating commodities as an investment asset class.

Views expressed in the paper are those of the authors and do not necessarily reflect those of the Bank of Japan.

[†] Financial Markets Department, Bank of Japan: takuji.kawamoto@boj.or.jp

[‡] Corresponding author. International Department, Bank of Japan: takeshi.kimura@boj.or.jp

I. Introduction

The purpose of this paper is twofold. First, it quantitatively examines the causes of the recent rise in global commodity prices. Second, it analyzes the factors driving the recent increase in cross-market linkage between commodity and stock markets.

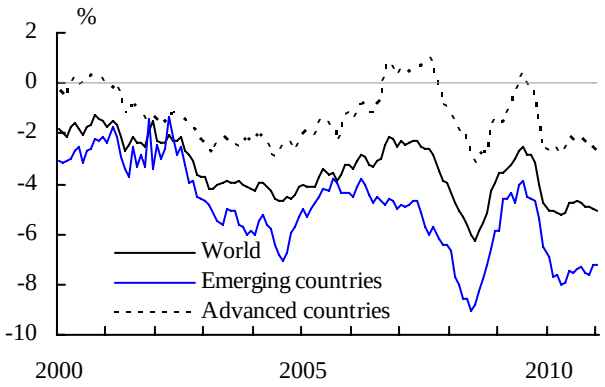
Regarding the first point, the recent rise in global commodity prices appears to reflect many aspects such as (1) growing physical demand for commodities, (2) supply shocks such as adverse weather and geopolitical risks, (3) speculative investments by financial investors, and (4) globally accommodative monetary conditions. Since the desirable policy responses may change depending on which factors matter for the recent commodity boom, we need to quantitatively identify the empirical effects of each factor. For example, if the physical demand for commodities has been boosted structurally by changes in eating habits and economic growth of the low-energy-efficient emerging countries, it is desirable to promote a policy that increases commodity production worldwide and to improve an energy efficiency of emerging countries. However, if rapid growth in physical demand for commodities is caused by globally accommodative monetary conditions, an increase in production of commodities and an improvement of energy efficiency in emerging countries will have only a limited and temporary effect on commodity prices as long as the monetary policy stance remains unchanged. In addition, if speculative commodity investment has been induced by a search for yield under accommodative monetary conditions, the introduction of financial market regulations will lead merely to the circumvention of regulations and may not prevent market fluctuations.

Some policymakers in emerging countries comment frequently that the extended low interest rate policies in the United States and other advanced countries have stimulated investment flows into commodity markets. On the other hand, policymakers in the U.S. and other advanced economies support the view that growing physical demand for commodities propelled by the high economic growth of emerging countries and their monetary easing (under inflexible exchange rate systems) have been the main contributor to a rise in commodity prices. It is difficult to determine which view is correct, and both views appear to have some validity. As is evident in the interest rate gap, monetary conditions remain accommodative both in advanced and emerging countries (Chart 1).[1]

[1] The interest rate gap is the difference between the real interest rate, defined as the nominal short-term interest rate minus headline consumer price index (CPI) inflation, and the potential growth rate of an economy. If the interest rate gap is positive -- that is, if the real interest rate is higher than the potential growth rate -- then monetary conditions are tight. Conversely, if the

Thus, it is important to quantitatively evaluate the extent to which globally accommodative monetary conditions affect the rise in commodity prices.

Chart 1: Interest Rate Gaps



Note: Interest rate gaps are estimated with relevant data obtained from the *International Financial Statistics* and the *World Economic Outlook* of the International Monetary Fund.

With regard to the cross-market linkage between commodity and stock markets, the correlation coefficient of the return between the markets has risen rapidly since the second half of 2008 (Chart 2). It is worth noting that correlation coefficients have increased regardless of data frequencies (daily, weekly, and monthly).[2] It is crucial for central banks to analyze the factors behind cross-market linkage: if shocks leading to the comovements of stock and commodity prices increase their role in driving the business cycles, changes in stock prices will amplify economic fluctuations while increasing the procyclicality of inflationary pressure through commodity price fluctuations. In such a case, central banks will need to conduct their monetary policy with a different reaction to these shocks from the past.

Commodity and stock prices fluctuate, affected by various structural shocks of the time. The correlation coefficient between them can rise when the common shocks hitting both commodities and equities are persistent and dominant, and tends to fall when idiosyncratic shocks for each market prevail. Therefore, to analyze the causes of the

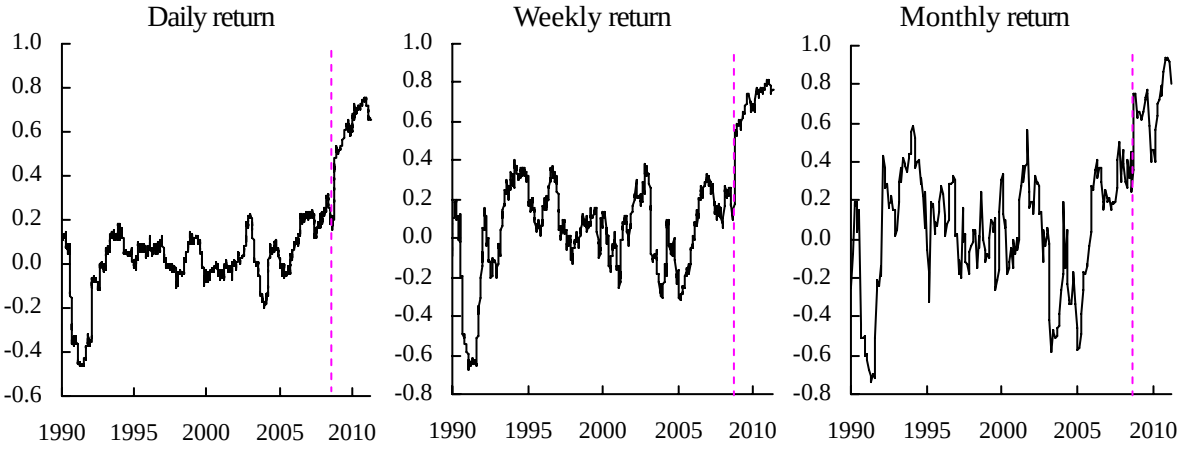
---

interest rate gap is negative, this means that monetary conditions are easy, since the real interest rate is lower than the potential growth rate. The global interest rate gap (and the interest rate gap of advanced and emerging countries) shown in Chart 1 is the weighted average of the interest rate gap in each country with its corresponding GDP used as a weight.

[2] Chart 2 indicates the correlation coefficients of the twelve-month rolling window. The recent increase in correlation is also robust in terms of changes in the rolling window.

recently tightened cross-market linkage, we need to identify the underlying structural shocks to commodity and equity markets by employing econometric methods. Many of the previous studies on the causes of commodity price fluctuations treat fundamentals and financial speculation as mutually exclusive, and few quantitative studies examine the factors behind cross-market linkage under a framework taking into account both fundamental and financial factors. This paper offers the advantage of providing an analysis of the causes of not only the recent commodity boom but also the increase in cross-market linkage under the unified econometric framework.

Chart 2: Return Correlation Coefficient between Commodity Index and Equity Index



Note: The figures show the one-year rolling correlation coefficients between the return of the global equity index (MSCI AC World Index) and that of the commodity index (S&P GSCI).
Source: Bloomberg.

II. Econometric Model and Data

In this paper, we estimate a vector autoregression (VAR) model to analyze factors behind changes in global commodity prices.

VAR Model

Our VAR model consists of four variables; world industrial production (*iip*), global stock prices (*sp*), global commodity prices (*cp*), and the global short-term interest rate (*r*). To identify the shocks, we employ a Cholesky decomposition based on the ordering of variables just listed.[3]

Changes in world industrial production represent business cycle fluctuations in the

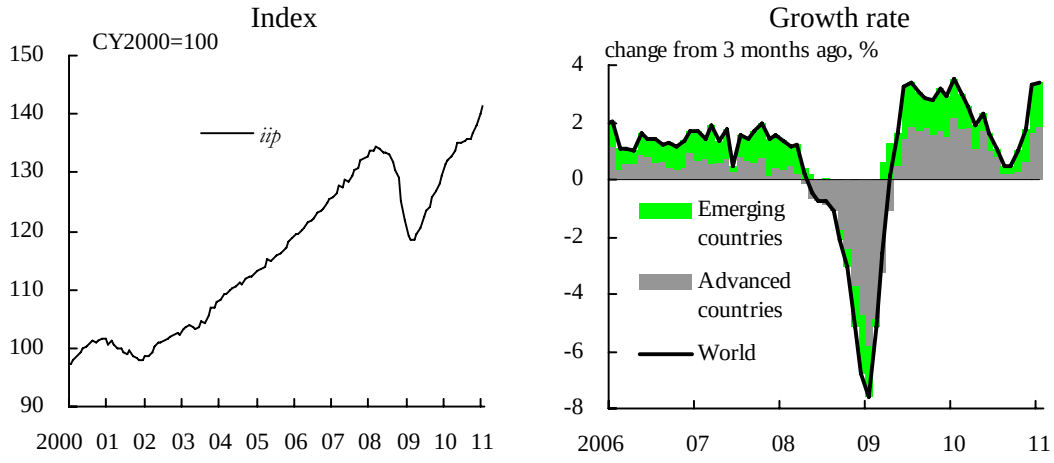
[3] We have also produced the generalized impulse responses that do not depend on the VAR ordering, but the results are almost the same as those obtained by Cholesky decomposition.

global economy. Changes in global stock prices reflect the world economic outlook and investors' risk appetite, and can be interpreted as a common shock to the international financial markets. As global commodity prices are ordered below world industrial production and global stock prices in our Cholesky decomposition, the innovation of global commodity prices can be identified as an idiosyncratic shock to these markets. Such idiosyncratic commodity shocks include supply shocks such as adverse weather and geopolitical risks, and the effects of capital inflows to commodity futures markets arising from investors' portfolio shifts. Since the global short-term interest rate is ordered last in our Cholesky decomposition, the residual could be identified as a monetary policy shock. Specifically, central banks around the world endogenously change their policy interest rates in response to developments in industrial production and the international financial markets (i.e., stock prices and global commodity prices), while at the same time they influence production and financial markets by changing their monetary policy stance in an exogenous way. Such an exogenous change captures monetary policy surprises or shocks.

Data

In our VAR analysis, we use monthly data. World industrial production (*iip*) is obtained from the *World Trade Monitor* released by the CPB Netherlands Bureau for Economic Policy Analysis (Chart 3). The figures include data on both advanced and emerging countries, and aggregate country production data by using each share in world production as a weight. The MSCI AC World Index released by the Morgan Stanley is used for global stock prices (*sp*) (Chart 4). This is a market capitalization weighted index designed to

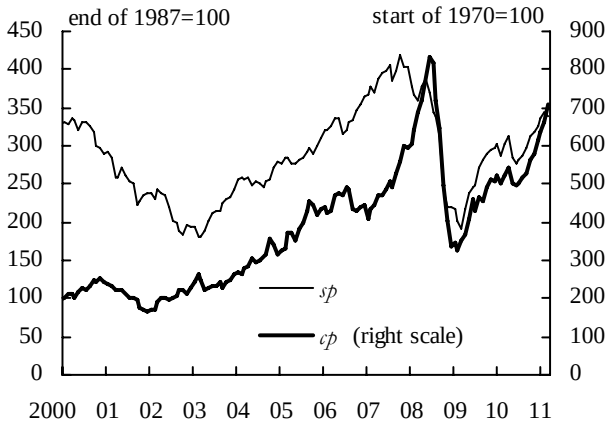
Chart 3: World Industrial Production



Source: CPB Netherlands Bureau for Economic Policy Analysis.

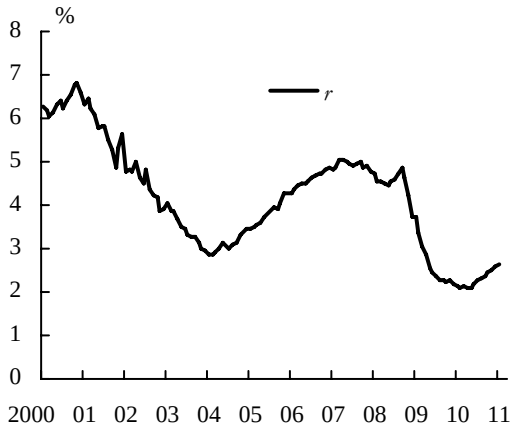
measure the stock market performance of both advanced and emerging markets. The Standard & Poor's Goldman Sachs Commodity Index (S&P GSCI) is used for global commodity prices (*cp*) (Chart 4).[4] Finally, we construct the global short-term interest rate (*r*) by aggregating the interest rates of individual countries, using nominal GDP shares (on a purchasing power parity [PPP] basis) for each year as a weight (Chart 5). The short-term interest rate and GDP for each country are given in *World Economic Outlook* (WEO), released by the International Monetary Fund (IMF). The short-term interest rate (*r*) can be interpreted as an operational variable for the hypothetical "world central bank."

Chart 4: Global Stock and Global Commodity Prices



Note: The MSCI AC World Index and the S&P GSCI are used for *sp* and *cp*, respectively.
Source: Bloomberg.

Chart 5: Global Short-Term Interest Rate



Note: The global short-term interest rate is estimated with relevant data obtained from the *International Financial Statistics* and the *World Economic Outlook* of the International Monetary Fund.

III. Empirical Results

The sample period runs from January 2000 to January 2011.[5] To make variables stationary, we take the first log difference of world industrial production (*iip*), global stock prices (*sp*), and global commodity prices (*cp*), except for the global short-term interest rate (*r*), of which we simply take the first difference. We include up to third lags selected by the Akaike

[4] The results presented below remain basically intact if we employ the Dow Jones-Union Bank of Switzerland Commodity Index (DJ-UBSCI) as an alternative for the S&P GSCI. These two indices have different weights for individual commodities; S&P GSCI has larger weights on energy, while DJ-UBSCI has larger weights on industrial metals and agricultural products.

[5] In emerging countries such as Brazil and Russia, the interest rate level exceeded 100 percent in the 1990s amid the financial turmoil. This causes a large undesirable fluctuation in the global weighted short-term interest rate. To eliminate such episodes, we set the sample period for the VAR model to start from 2000.

Information Criterion (AIC) in our VAR model.

Impulse Reponses

Chart 6 shows the estimated impulse response functions. The first, second, third, and fourth columns respectively represent the dynamic effects of a world industrial production (*iip*) shock on each variable, a global stock price (*sp*) shock, a global commodity price (*cp*) shock, and a global short-term interest rate (*r*) shock. The blue solid line depicts the estimates of cumulative impulse responses over 20 months, and the red dotted lines depict two standard error bands.

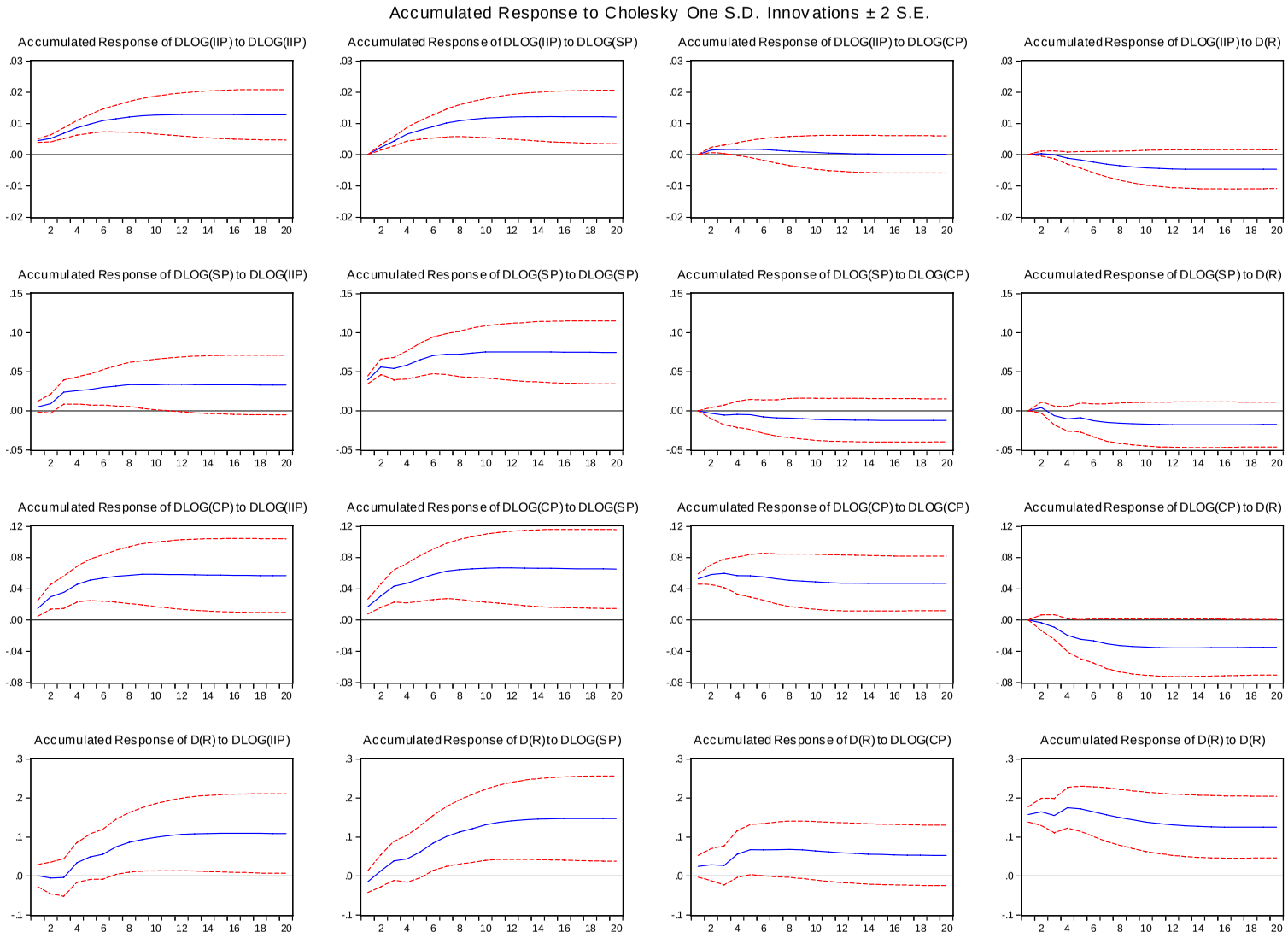
An increase in world industrial production (*iip*) leads to a rise in global stock prices (*sp*) through an improvement in corporate profits, and leads also to a rise in global commodity prices (*cp*) by boosting physical demand for energy and other commodities. In response to this world economic expansion, the world central bank raises the interest rate (*r*).

A rise in global stock prices (*sp*) contributes to an economic recovery through wealth effects and consequently to an increase in world industrial production (*iip*). This results in a rise in global commodity prices (*cp*) by increasing physical demand for commodities. If a positive equity-price shock reflects improvement in the world economic outlook and investors' risk appetite, a rise in global stock prices (*sp*) can readily lead to a rise in global commodity prices (*cp*) by facilitating an increase in commodity futures investment by hedge funds and institutional investors. The world central bank then raises the interest rate (*r*) to stem inflationary pressure arising from an increase in industrial production and commodity prices.

A rise in global commodity prices (*cp*) does not have a statistically significant effect on world industrial production (*iip*). This is because a rise in commodity prices driven by supply shocks and speculation results merely in an income transfer from commodity-consuming countries to commodity-producing ones, and thus is neutral for the world economy as a whole. As this shock does not cause any economic fluctuations, it does not have a statistically significant effect on global stock prices (*sp*) either. Nonetheless, the world central bank raises the interest rate (*r*) to stem inflationary pressure caused by a rise in commodity prices.

Finally, a hike in the interest rate (*r*) by the world central bank reduces world industrial production (*iip*) and exerts downward pressure on global stock prices (*sp*).

Chart 6: Impulse Response Functions based on a VAR with Global Short-Term Interest Rate (*r*) as Monetary Policy Shock



Note: The VAR model includes the first log differences of world industrial production (*iip*), global stock prices (*sp*), and global commodity prices (*cp*), and the first difference of the global short-term interest rate (*r*). The sample period is from January 2000 to January 2011.

A decline in production arising from an interest rate hike reduces physical demand for commodities (a demand channel) and lowers global commodity prices (*cp*). It should be noted that a rise in interest rates lowers commodity prices also through other channels such as (1) a decline in inventory investment in physical commodities due to an increase in inventory holding costs (an inventory channel), (2) an increase in commodity supply (a supply channel),[6] and (3) a decline in commodity futures investment reflecting investors' weaker incentive to search for yield (a financial channel).

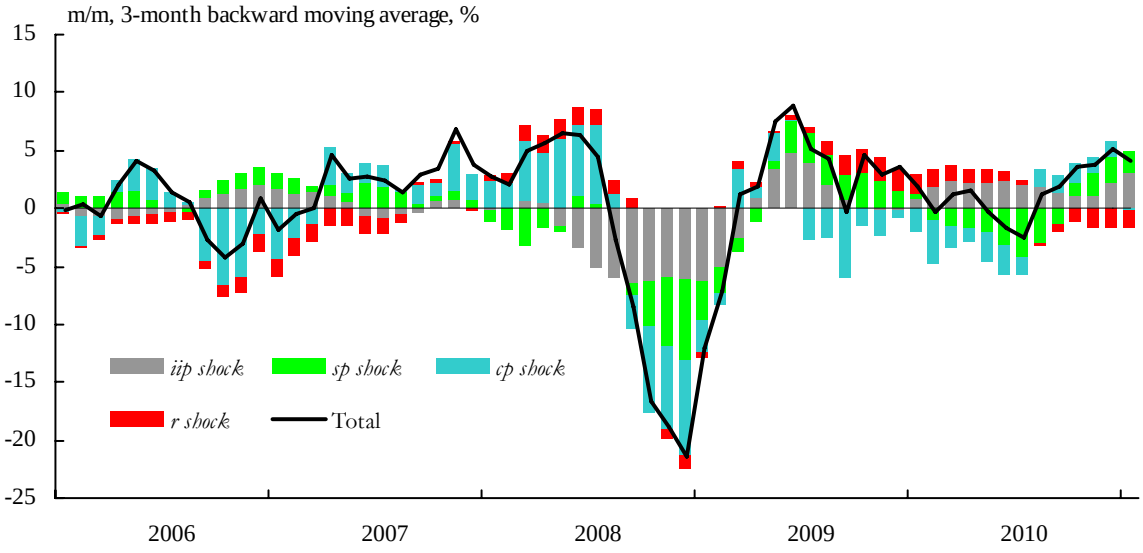
Historical Decomposition

The monthly changes in global commodity prices (Δcp) are decomposed by contributions of the four identified structural shocks. The historical decomposition is performed from January 2006, and Chart 7 reports these results after taking a three-month backward-looking moving average to smooth out high-frequency fluctuations. In what follows, we summarize the results by time period.

From early 2006 to summer 2007: Although successive rate hikes (*r*) put downward pressure on global commodity prices, a rise in commodity prices was led mainly by

Chart 7: Historical Decomposition of Change in Global Commodity Prices

Results based on a VAR with Global Short-Term Interest Rate (*r*) as Monetary Policy Shock



Note: Each bar shows the contribution of identified shocks to the first log difference of global commodity prices (*cp*).

[6] When interest rates are high, oil-producing countries can increase their interest income by investing the earnings from enhanced oil production in financial assets. Thus, oil-producing countries will have an incentive to boost their supply in tandem with interest rate increases. In fact, in the early 1980s, a rise in U.S. real interest rates caused a rise in oil production and a decline in

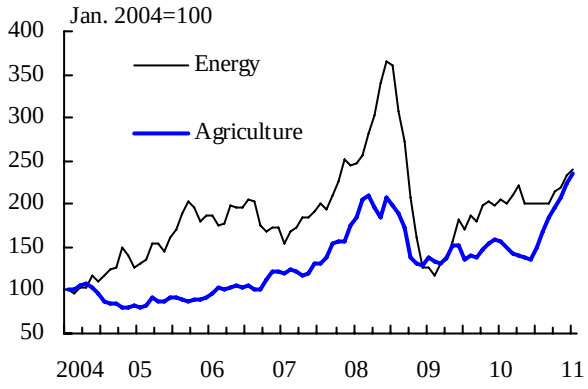
growth in physical demand for commodities associated with an increase in world industrial production (*iip*) and improvement in the world economic outlook and investors' risk appetite implied by a rise in global stock prices (*sp*).

From autumn 2007 to summer 2008: A rise in global commodity prices was driven by the increased inflow of investment funds to the commodity markets, as securitization and stock markets remained weak amid the subprime mortgage problems and the subsequent repricing of risky assets. At this time, investors shifted their funds from complex securitized products to simple products such as commodity futures because of the "flight to simplicity." These commodity-specific shocks made a positive contribution to global commodity prices (*cp*). The accommodative monetary conditions (*r*) in advanced countries in response to the subprime mortgage problems also put upward pressure on commodity prices. Demand effects of an increase in world industrial production (*iip*) made only a small contribution during this period.

From autumn 2008 to early 2009: Following the failure of Lehman Brothers, commodity prices plunged against a backdrop of (1) weaker physical demand for commodities reflecting a production (*iip*) contraction, (2) a deterioration in the world economic outlook and investors' risk appetite implied by a decline in global stock prices (*sp*), and (3) an unwinding of investors' positions in commodities (*cp*) that had been accumulated through a flight to simplicity.

From spring 2009 to summer 2010: Global commodity prices trended upward, reflecting stronger commodity demand due to the global economic recovery (*iip*) driven by emerging economies and globally accommodative monetary conditions (*r*). Improvement in investors' risk appetite -- which was reflected in the contribution of stock prices (*sp*) -- led to a rise in commodity prices toward spring 2010, but then the Greek crisis suppressed investors' risk-taking behavior, putting downward pressure on crude oil prices.

Chart 8: Global Commodity Prices



Note: The figures show the sub-indices of the S&P GSCI.
Source: Bloomberg.

commodity prices. Prices of agricultural products such as corn, wheat, and soybeans came under downward pressure, as the slack in supply and demand conditions was expected to widen reflecting the expected expansion of acreage in the United States for 2009 and world production for 2010 that were announced by the United States Department of Agriculture (Chart 8). Toward summer 2009, hedge funds decreased their positions in agricultural products in response to the new rule of the Chicago Board of Trade (CBOT) to limit positions, which also put downward pressure on their prices. These factors since spring 2010 can be interpreted as commodity-specific supply shocks that would ultimately lower commodity prices (*cp*).

From autumn 2010 to early 2011: Successive rate hikes (*r*) in emerging countries put downward pressure on global commodity prices. However, as world production (*iip*) regained momentum toward the year-end, physical demand for commodities increased in tandem, pushing up the commodity prices. In addition, stock prices (*sp*) rose globally as markets priced in the introduction of a second round of quantitative easing (QE2) in the United States from autumn 2010. Improvement in the world economic outlook and investors' risk appetite -- triggered partly by the expectations of the QE2 -- boosted commodity investment, exerting upward pressure on commodity prices. In addition, from summer 2010, a supply shock of some crops related to the adverse weather also contributed to a rise in commodity prices (*cp*).

Comparison of Two Commodity Booms: From 2007 to Mid-2008 and from 2009 to Early 2011

Charts 9 and 10 show the historical decomposition results for *cumulative* commodity increases during the recent two episodes, when global commodity prices soared (from January 2007 to June 2008 and from January 2009 to January 2011). We find clearly that the drivers of the surge in commodity prices in these two episodes differed completely.

The surge from January 2007 to June 2008 was caused mainly by *cp* shock. Given the fact that there were no remarkable supply shocks such as adverse weather or geopolitical risk in physical commodity markets during this period, the *cp* shock appears to reflect a massive shift of financial investors' funds from securitization and stock markets to commodity futures markets (a flight to simplicity).

On the other hand, the commodity boom from January 2009 to January 2011 was driven mainly by *iip* shock and *r* shock. Specifically, it resulted from both stronger

physical demand for commodities due to the global economic recovery led by emerging countries and globally accommodative monetary conditions.

Chart 9: Cumulative Change in Global Commodity Prices

Results based on a VAR with Global Short-Term Interest Rate (*r*) as Monetary Policy Shock

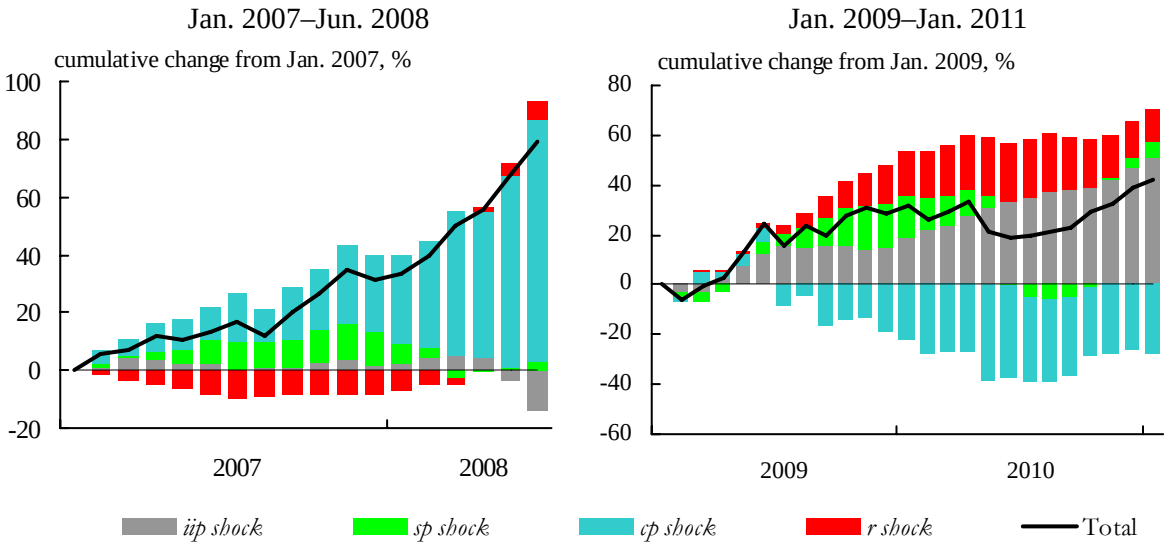


Chart 10: Contribution of Identified Shocks to Change in Global Commodity Prices

Results based on a VAR with Global Short-Term Interest Rate (*r*) as Monetary Policy Shock

		Jan. 2007-Jun. 2008	Jan. 2009-Jan. 2011
iip shock	Physical demand for commodities	-17.7%	+122.1%
sp shock	Future demand for commodities and the effect of investors' risk appetite	+3.8%	+14.2%
cp shock	Supply shock in physical commodity markets and investment flows into financialized commodity markets	+106.4%	-66.7%
r shock	Monetary policy shock	+7.5%	+30.4%
	Total	100%	100%

Drivers of the Cross-Market Linkage

This sub-section examines the factors that have driven up the correlation between global equity prices (*sp*) and global commodity prices (*cp*). Historical decomposition results for each variable (*sp* and *cp*) can be expressed as follows:

$$\Delta cp = \Delta cp^{iip} + \Delta cp^{sp} + \Delta cp^{cp} + \Delta cp^{r}$$

$$\Delta sp = \Delta sp^{iip} + \Delta sp^{sp} + \Delta sp^{cp} + \Delta sp^{r}$$

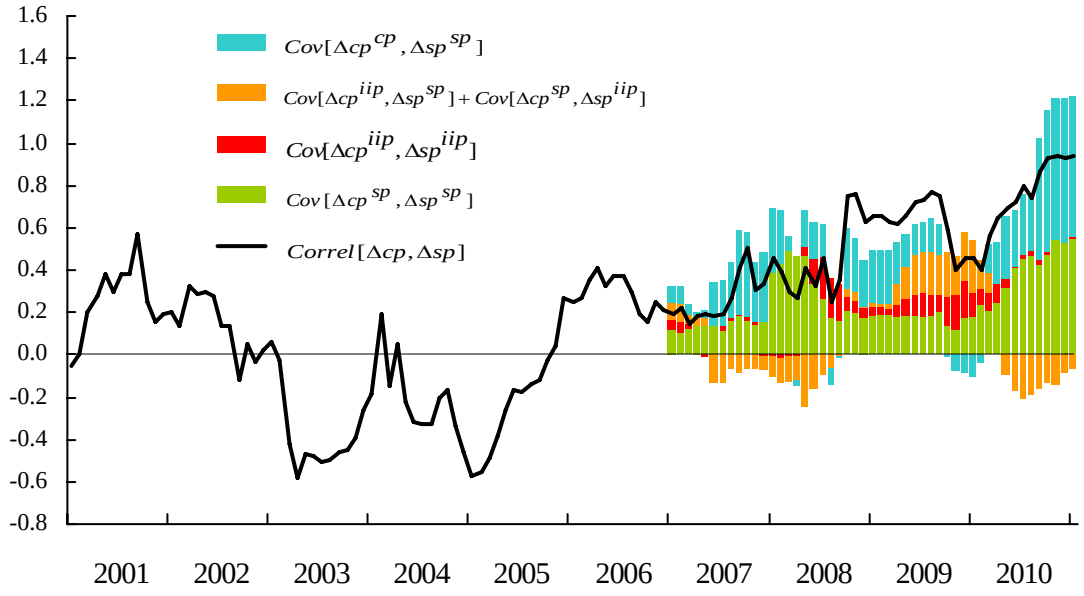
Here, Δcp^{j} and Δsp^{j} represent the contributions of structural shocks indicated by

$j\,(=iip, sp, cp, r)$. The correlation coefficient between Δsp and Δcp, $Correl(\Delta cp, \Delta sp)$ can then be decomposed into the covariances among different combinations of structural shocks as follows:

$$Correl(\Delta cp, \Delta sp) = \frac{Cov[\Delta cp, \Delta sp]}{\sqrt{V[\Delta cp]}\sqrt{V[\Delta sp]}} = \sum_{j,k} \frac{Cov[\Delta cp^{j}, \Delta sp^{k}]}{\sqrt{V[\Delta cp]}\sqrt{V[\Delta sp]}} \quad j,k = iip, sp, cp, r$$

The main covariances which contribute to the increase in $Correl(\Delta cp, \Delta sp)$ are as follows (Chart 11):

Chart 11: Return Correlation Coefficient between Commodity Index and Equity Index



Note: The figure shows the one-year rolling correlation coefficient and covariance.

- $Cov[\Delta cp^{sp}, \Delta sp^{sp}]$: *sp* shock increases the comovement between global commodity prices and equity prices. Specifically, changes in the global economic outlook and investors' risk appetite reflected in the *sp* shock lead to an increased correlation between commodity and stock markets. This is because global investors begin to treat commodities as an alternative asset class for traditional assets such as equity as a consequence of the "financialization of commodities."[7]
- $Cov[\Delta cp^{cp}, \Delta sp^{sp}]$: Comovement between a series of supply shocks hitting agricultural

[7] As their balance sheets deteriorate, financial investors have an incentive to sell risky assets in their portfolios. On the other hand, when investors' risk appetites improve, they tend to increase holdings of risky assets in their portfolios. Consequently, global commodity prices increasingly correlate with other risky financial assets such as equities in response to fluctuations in investors' risk-taking abilities.

commodity markets after late 2009 (*cp* shock) and the concurrent stock-market shocks (*sp* shock) contributed significantly to an increase in correlation among these two markets. In particular, this covariance rose noticeably after autumn 2010. As heightened expectations toward the start of the QE2 pushed up global equity prices (*sp*) during this period, investors with improving risk appetites shifted their funds rapidly to commodity markets, where a series of supply shocks (*cp*) drove up the prices of agricultural products. These two events -- the QE2 and concurrent commodity supply shocks -- pulled up both commodity and equity prices, with investors' risk-taking abilities improving during this period.

- $Cov[\Delta cp^{iip}, \Delta sp^{iip}]$: *iip* shock contributed to an increase in commodity-equity comovement over the recession period following the Lehman shock and the subsequent recovery period. During these periods, unprecedentedly large economic fluctuations amplified the comovement between the two variables.
- $Cov[\Delta cp^{iip}, \Delta sp^{sp}]$, $Cov[\Delta cp^{sp}, \Delta sp^{iip}]$: The increased correlation between shocks to the current global economic activity (*iip* shock) and shocks to its future outlook (*sp* shock) contributed to the commodity-equity comovement.

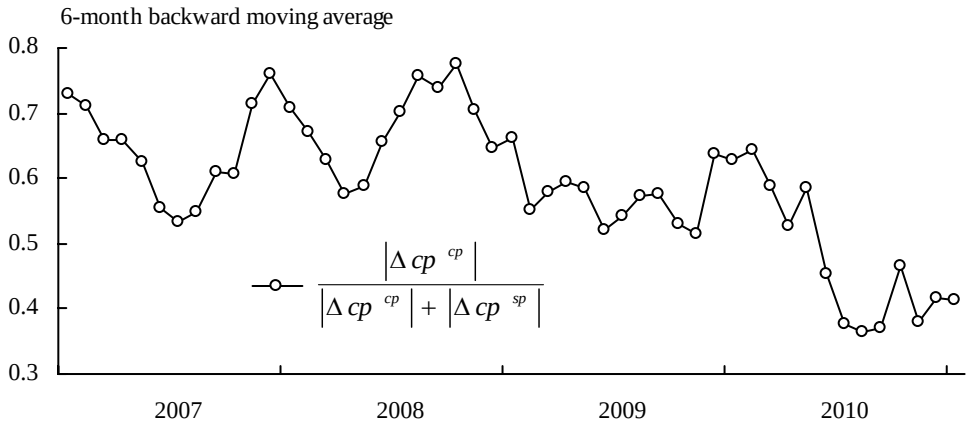
Among the set of covariances that appeared in the decomposition above, increases in $Cov[\Delta cp^{iip}, \Delta sp^{iip}]$, $Cov[\Delta cp^{iip}, \Delta sp^{sp}]$, and $Cov[\Delta cp^{sp}, \Delta sp^{iip}]$ reflected large-scale economic fluctuations after the Lehman shock to some extent, and thus there is no good reason to expect these covariances to remain at high positive levels. Indeed, these covariances have been decreasing since late 2010. On the other hand, an increase in $Cov[\Delta cp^{cp}, \Delta sp^{sp}]$ can be interpreted as a concurrence of commodity supply shocks and equity shocks. It is likely that commodity prices will continue to increase in tandem with equity prices, when commodity supply shocks co-exist with the improvement of investors' risk appetites in bull equity markets. $Cov[\Delta cp^{sp}, \Delta sp^{sp}]$ is also expected to increase further in the near future, given the recent progress in the financialization of commodities.

Institutional investors such as pension funds and insurance companies -- which have steadily increased their commodity-index-tracking investments in recent years -- have paid relatively less attention to the fundamentals of demand and supply conditions in individual physical markets of commodities than have commercial investors such as producers and consumers. As commodities have been increasingly treated as an asset

class for financial investment rather than as consumption goods, commodity prices have grown more susceptible to portfolio shifts by financial investors, and the price effects of traditional commodity-specific shocks (e.g., supply shocks) have become relatively smaller.

Indeed, a comparison of the contribution of *cp* shocks and *sp* shocks on commodity prices shows that the contribution ratio of the former has declined gradually since 2009 (Chart 12). This implies that commodities now show price behavior that differs from traditional commodities as consumption goods, which increases their correlations with other financial assets such as equities.

Chart12: Contribution of *cp* shock and *sp* shock to Change in Global Commodity Prices



IV. Effects of Globally Accommodative Monetary Conditions: Robustness Check

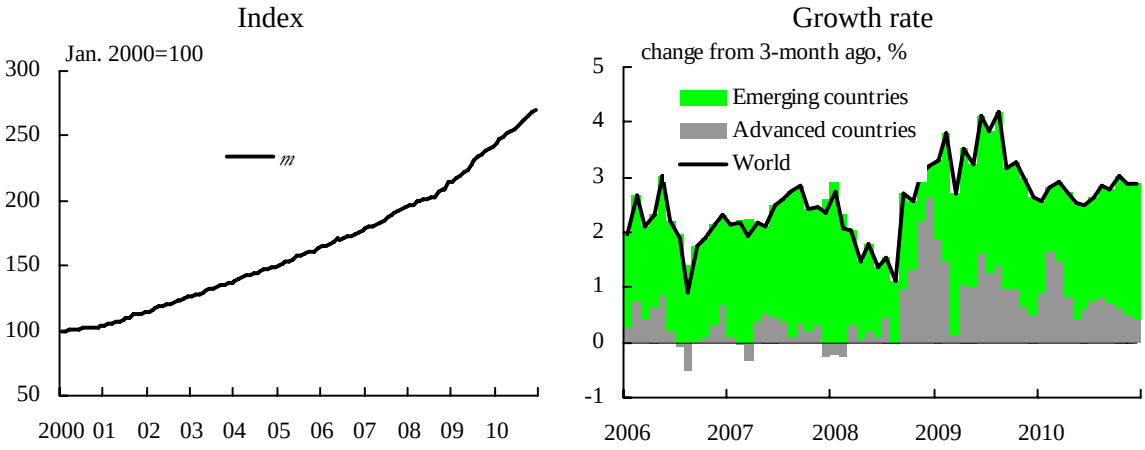
Some emerging countries such as China control their lending and money growth by employing administrative measures such as window guidance. In these countries, it is not enough to measure their stance of monetary accommodation solely in terms of interest rate levels; it is also necessary to examine money stock as a complementary measure. In response to continuing economic expansion, central banks in emerging economies have gradually raised their interest rates. Money and lending growth, however, have accelerated or remained at high levels, and monetary conditions measured by these quantities appear to have remained accommodative.

To check the robustness of our analysis, here we estimate the VAR model again by using global M1 (*m*) as an alternative of monetary policy measure for the global short-term interest rate (*r*). We calculate global M1 (*m*) by aggregating M1 of individual countries

with their nominal GDP shares (on a PPP basis) as a weight for each year (Chart 13). M1 and GDP for each country are taken from the WEO released by the IMF. We assume that the hypothetical world central bank influences global M1 (*m*) in our VAR system.

To make variables stationary, we take the first log difference of world industrial production (*iip*), global stock prices (*sp*), global commodity prices (*cp*), and global money M1 (*m*).[8] We include up to second lags selected by the AIC in our VAR model.

Chart13: Global M1



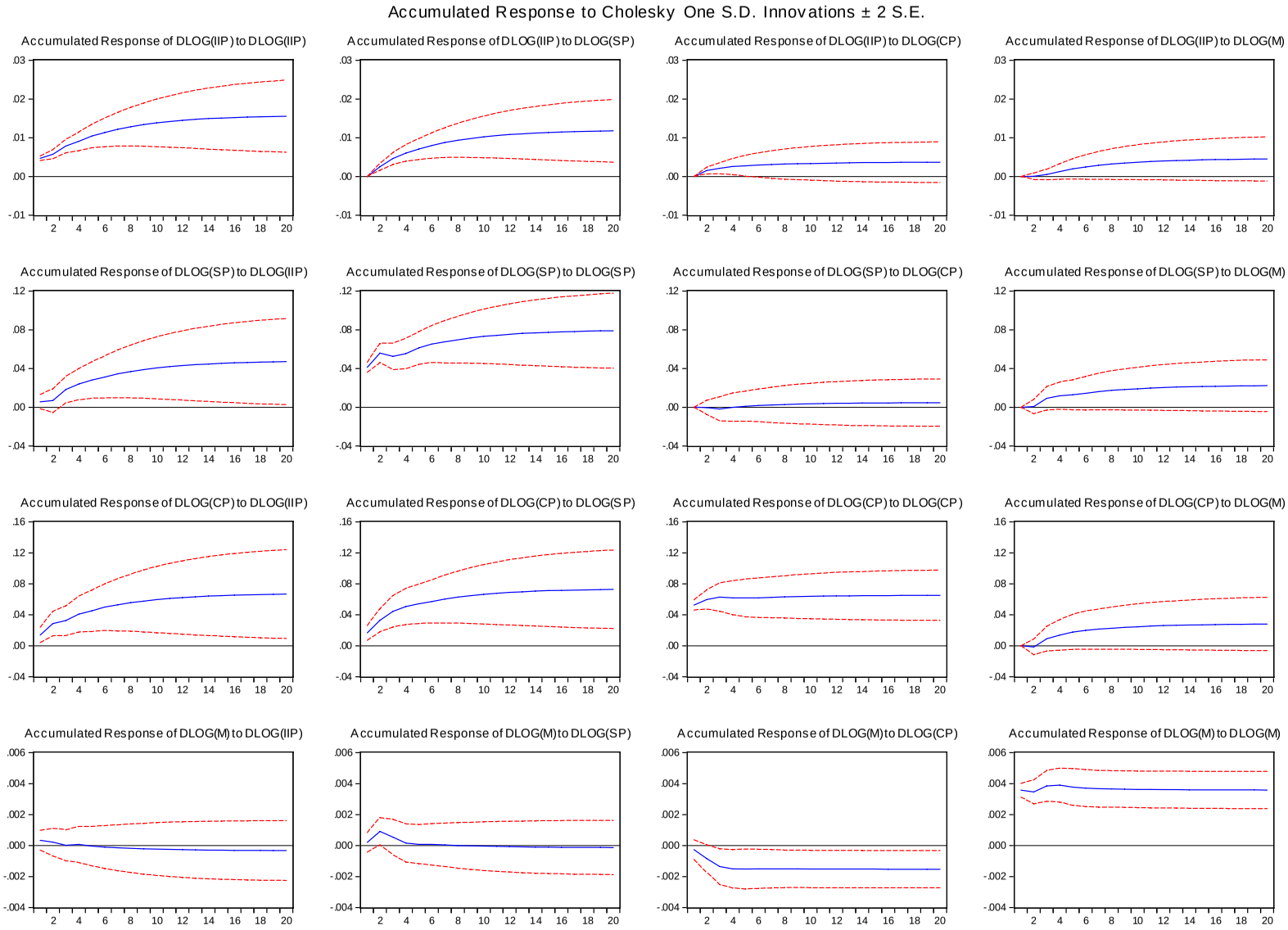
Note: Global M1 is estimated with relevant data obtained from by the *International Financial Statistics* and the *World Economic Outlook* of the International Monetary Fund.

Impulse Reponses

Chart 14 shows the impulse response functions derived from the estimated VAR. The results basically remain unchanged from the case of the global short-term interest rate (*r*). Specifically, when the world central bank increases M1 (*m*) to provide monetary policy accommodation, world industrial production (*iip*), global stock prices (*sp*), and global commodity prices (*cp*) increase as expected. When global commodity prices (*cp*) rise, the world central bank tightens its monetary policy stance to decrease M1 (*m*). It should be noted that M1 (*m*) does not show a statistically significant response to an increase in world industrial production (*iip*) and global stock prices (*sp*). This is because transaction demand for money increases during an economic expansion, while any resulting monetary tightening (i.e., a rate hike) by the world central bank dampens speculative demand for money.

[8] Data on M1 in the 1990s for China, a major emerging country, are not available. Therefore, we set the sample period to run from 2000, as in the previous section.

Chart 14: Impulse Response Functions based on a VAR with Global M1 (*m*) as Monetary Policy Shock



Note: The VAR model includes the first log differences of world industrial production (*iip*), global stock prices (*sp*), global commodity prices (*cp*), and global M1(*m*).

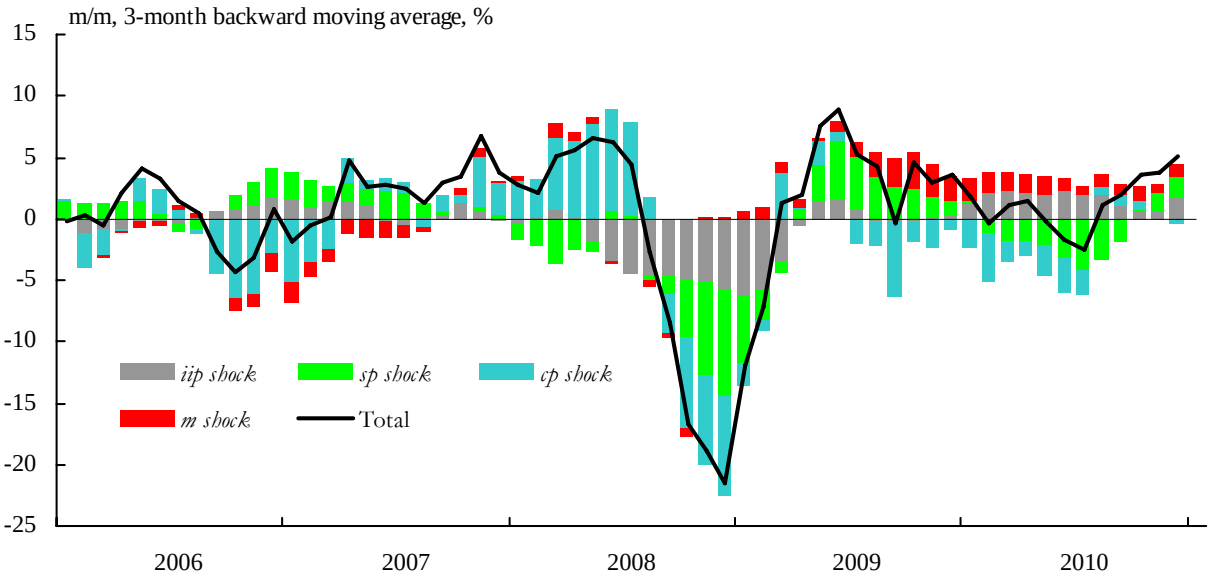
The sample period is from January 2000 to December 2010.

Historical Decomposition

Qualitatively, historical decomposition results using global M1 (*m*) in Chart 15 are basically the same as those using the global short-term interest rate (*r*) in Chart 7.[9] When focusing on the quantitative impacts (Charts 16 and 17), however, the positive effects of globally accommodative monetary conditions on commodity prices increase in the case of M1, particularly from 2009. It is unclear whether global M1 (*m*) or the global short-term interest rate (*r*) is more appropriate as a measure of global monetary conditions, but it is safe to say that globally accommodative monetary conditions have driven up global commodity prices since 2009 to some extent.

Chart 15: Historical Decomposition of Change in Global Commodity Prices

Results based on a VAR with Global M1 (*m*) as Monetary Policy Shock



Note: Each bar shows the contribution of identified shocks to the first log difference of global commodity prices (*cp*).

V. Conclusion

Previous empirical studies on commodities, such as Kilian (2009), which employ a structural VAR, identified growing physical demand associated with high global economic growth as the main driver of the rise in commodity prices toward summer 2008.[10] On the

[9] We also confirmed that there is no significant difference in factors driving an increase in correlation between commodity and stock prices when we use global M1 (*m*) instead of the global short-term interest rate (*r*).

[10] See Lutz Kilian, "Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market," *American Economic Review*, 99 (3), 2009, pp. 1053-1069.

Chart 16: Cumulative Change in Global Commodity Prices

Results based on a VAR with Global M1 (*m*) as Monetary Policy Shock

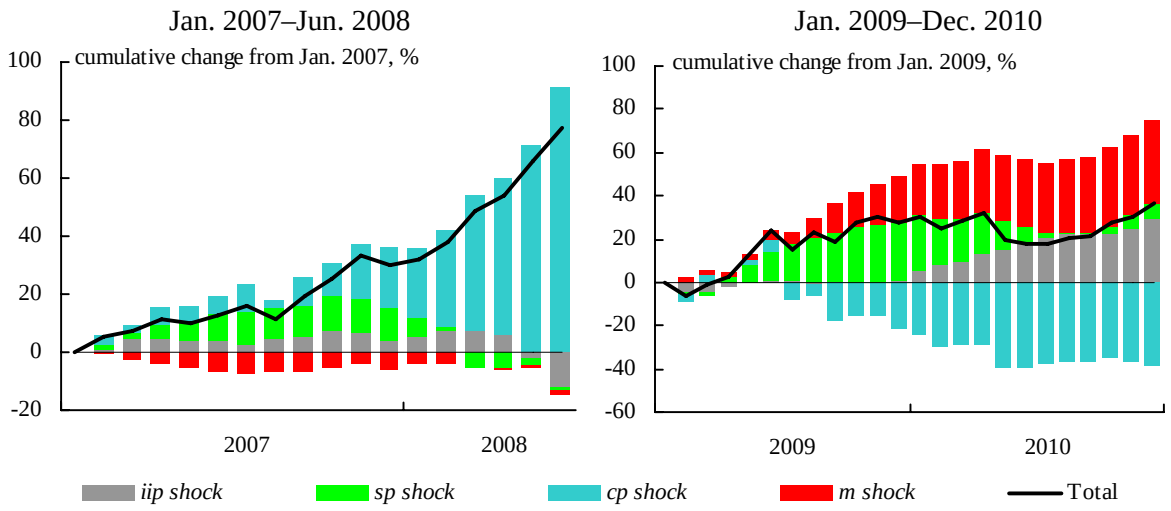


Chart 17: Contribution of Identified Shocks to Change in Global Commodity Prices

Results based on a VAR with Global M1 (*m*) as Monetary Policy Shock

		Jan. 2007-Jun. 2008	Jan. 2009-Dec. 2010
iip shock	Physical demand for commodities	-15.5%	+78.9%
sp shock	Future demand for commodities and the effect of investors' risk appetite	-1.7%	+20.6%
cp shock	Supply shock in physical commodity markets and investment flows into financialized commodity markets	+118.7%	-103.8%
m shock	Monetary policy shock	-1.4%	+104.4%
	Total	100%	100%

other hand, our analysis suggests that the rise in commodity prices during this period was driven mainly by an inflow of investment funds to commodity markets (a flight to simplicity), and the contribution of physical demand related to fundamentals was relatively small reflecting the fact that world economic growth was already slowing.

How do we account for the difference between the results of Kilian (2009) and our own? One possible explanation is that Kilian (2009) focused mainly on identifying supply and demand shocks separately in the crude oil physical market and thus excluded financial variables such as monetary policy and stock prices from his VAR system. Thus, it is highly likely that the identified physical demand shocks in Kilian (2009) and in our paper are conceptually different. For example, we identify capital inflows to commodity markets as a commodity-specific shock, while the demand shock identified by Kilian (2009) and

other studies might encompass such a financial effect broadly.[11]

We include variables of monetary policy and equities in our empirical analysis in order to quantitatively assess the effects on commodity prices of the financialization of commodities from the mid-2000s and globally accommodative monetary conditions following the financial crisis. By including these financial variables, we attempt to analyze the factors that drive commodity price fluctuations and those that increase cross-market linkages simultaneously under the unified analytical framework. Given that the commodity boom and strengthened cross-market linkage are both crucial characteristics of recent years, our analysis sheds light on such important phenomena by employing a new empirical method.

Of course, our analysis has limitations. For example, due to the limited availability of monetary policy variables (the global interest rate and global M1), the sample period is shorter than in previous research. Therefore, we cannot compare developments in episodes during the 1970s oil shocks and those in the 2000s.[12] Although we have conducted a robustness check by employing money stock as an alternative for the interest rate, we will need to empirically reassess the drivers of the increase in cross-market linkage (an increase in the correlation coefficient) when additional data become available.

[11] Another possible explanation is that the difference in a physical demand variable between this paper and Kilian (2009) may affect the empirical results. As a variable of the global economic activity determining physical commodity demand, this paper employs world industrial production while Kilian (2009) uses ocean freight rates. Thus, when emerging economies with *lower* energy efficiency than advanced economies are the main driver of global economic growth, as in recent years, this paper might have some bias toward underestimating the effects of growing commodity demand, neglecting the difference of energy efficiency among countries.

[12] The increased importance of emerging economies in the 2000s suggests that their effects on commodity prices are quantitatively different from the past. Furthermore, the financialization of commodities has intensified noticeably in the 2000s, which might affect commodity prices differently from previous years. Taking these facts into consideration, it is not necessarily appropriate to estimate a VAR system with fixed parameters for a sample period longer than in this paper. Therefore, it makes sense to set the sample period to start from 2000 to correctly reflect the recent structural changes in the global economy and financial markets.