Excess Liquidity and Commodity Boom$^{\xi}$

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【Abstract】

This paper presents an investigation of whether excess liquidity has been serving as a driving force for the increase in international commodity prices. Increased global excess liquidity exacerbated by the eased monetary policy of economically developed countries after the burst of the IT bubble, coupled with the development of commodity index investment, as well as the prominent economic growth of emerging countries might have promoted the increase in international commodity prices. This study uses a structural VAR model including two global liquidity indicators and the world production index to examine the determinants of international commodity prices.

Results obtained from the empirical analysis are as follows. First, the contribution of TED (an indicator of funding liquidity in the international interbank market) to international commodity prices probably increased after the IT bubble burst when the drastic easing of monetary policy began in economically developed countries, which implies that the lending of tolerant international bankers promoted commodity price increases before the global financial crisis while the international liquidity squeeze brought about their decline after the Lehman Shock.

Gold is exceptional. The impact of a severe liquidity squeeze on the gold price was not confirmed during the Lehman Shock, implying that gold acted as a safe haven during the period of international financial dysfunction.

Results show a negative relation between international commodity prices and the dollar effective exchange rate. The US net external debt has expanded drastically since 2003. From this negative linkage, we presume that fear for the dollar as a key currency caused by expanded net external debt produced a shifted investment demand for commodities from the US dollar.

The prices of industrial metals are more attributable to funding liquidity. The price of crude oil, with a market believed to be more vulnerable to speculative money inflows, has been less dependent on liquidity. It is affected by idiosyncratic factors including geopolitical risk.

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1. Introduction

Volatile movements of international commodity prices have been highlighted. The continued surge of commodity prices during the twenty-first century has been believed to be attributed to the increased demand for commodities, partly deriving from the drastic economic development of developing countries. We have also found that the commodity prices dropped sharply at the global financial crisis of 2008 and the European sovereign crisis. Fluctuating commodity prices might have a negative impact on commodity-consuming countries and commodity-producing countries.

In the 2000s, international commodity futures markets' trade volume has increased considerably, partly because of increased commodity investments. During that period, the percentage of trades made by non-commercial traders such as hedge funds, mutual funds, floor brokers, has been increasing relative to that of commercial traders engaged in business activities hedged by the futures. The increase in the futures trade volume is likely to be linked with the development of investment vehicles such as commodity index funds and commodity ETF, which might stimulate commodity investment by pension funds and sovereign wealth funds.

Institutional investors hold commodity-related products as parts of their respective portfolios. Consequently, commodity futures prices have become more interrelated with prices of traditional financial asset classes such as equities. The increased interdependence between commodity and other assets is defined as "financialization of commodities". Alternatively, the tendency by which futures prices of commodities which constitute major commodity indices have been becoming more interrelated can be referred to as financialization of commodities by portfolio rebalancing across categories of commodities. Tang and Xiong (2010) reported that, concurrent with rapidly growing index investment in commodities markets since the early 2000s, futures prices of different commodities in the US have become mutually correlated to an increasing degree. This trend was more pronounced for commodities in the two popular GSCI and DJ–UBS commodity indices. They also found that such commodity price co-movements were absent in China. The difference of empirical results for the US and China disproves the growth of commodity demands from emerging economies as the dominant driver of commodity price movements. Ohashi and Okimoto (2013) revealed similar results that price co-movement of commodities, adopted as

components of major indices, have become prominent compared with correlation with off-index commodities.

Financialization of commodities has become more pronounced, partly as a result of the development of vehicles of commodity investments, which has stimulated the entry of more institutional investors into commodity futures markets. Furthermore, this can be induced by increased international liquidity resulting from drastically eased monetary policy by major economically developed countries.

Although commodities had been believed to contribute to portfolio risk reduction because of negative correlation of their prices with traditional asset prices, financialization of commodities might degrade that diversification effect. Gorton and Rouwenhorst (2006) showed that commodity futures prices had a negative or non-existent correlation with bond and equity prices, and that they contribute to the improvement of portfolio returns.

The increased speculative money inflows might have a strong impact on commodity futures markets with small transaction volume. The market scale of commodity futures is extremely small compared with that of equity and bonds. Therefore, commodity futures prices are expected to be fragile because of market liquidity risk. For example, in 2011, the annual turnover on financial futures markets transactions around the world was 22.1 billion, whereas the annual turnover on the global commodity futures markets was only 2.5 billion transactions. Similarly, the annual turnover of euro-dollar futures on CME, as an example of major financial futures products, was 560 million transactions, and the annual turnover of WTI futures on NYMEX, which has the largest amount of trade volume in the category of commodity futures, was 170 million transactions[1]. These figures imply that a small portion of portfolio rebalancing by institutional investors has a dominant market impact in commodity futures markets.

Niimura (2009) insists that an impact of speculative transactions on crude oil prices is trivial on the grounds that capital injected in the crude oil market through commodity investment funds for one year is just a few percent of the annual crude oil production estimated by the oil price of 120 dollars per barrel. The Cabinet Office of the Japanese Government (2011) reported that the percentage of the share of non-commercial traders on the global commodity futures markets has been increasing in recent years and that their transactions' share in some commodity classes including crude oil reached 80% before the global financial crisis of 2008. Domanski and Heath (2007) clarified that the volume of exchange-traded derivatives of non-energy commodities such as copper and aluminum, of

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[1] These figures are based on information provided by Mitsuhiro Onozato, executive officer at Tokyo Commodity Exchange.

which transactions on spot markets are few, was around 30 times larger than the physical production of those goods in 2005. They also described that the market liquidity of those markets might become significantly tight because of the rapid increase in the over-the-counter transactions, although the related has not been disclosed sufficiently.

Two scenarios exist to address the prominent upward trend of commodity prices in recent years, although investigators have reached no consensus[2]. The first scenario highlights the balance between physical production and the demand for commodities. The second scenario comes from the explanation by factors unrelated to the balance of supply and demand for the physical markets. Krugman (2008) offered a counterargument against the insistence of supporting the existence of bubble in crude oil prices, by demonstrating that the crude oil price exceeding its fair value might create excess supply and an increased amount of stored oil. He concluded that the drastic increase in the crude oil price resulted from increased demand because no excess stock of oil was observed.

According to Yanagisawa (2011), which attempted to identify determinants of the crude oil price, 40% of the price is explainable by factors unrelated to supply and demand for the physical stock at the peaks such as the time point of June 2008, when the price exceeded 140 dollars per barrel, and the time point of April 2011, when the price resurged rapidly as if it was about to surpass the record before the global financial crisis. Yanagisawa (2011) also detected that the speculative money inflows (trading volume by money managers) as well as depreciation of the US dollar and the expected inflation stimulated by QE2 became dominant factors explaining the rapid rise attributable to factors unrelated to the physical stock.

The source of the increased speculative money might be traced to global excess liquidity. Even though excess stock of commodities was not observed, the overvaluation of commodity prices can emerge because the demand for the physical goods can also be inflated by excess liquidity.

Kawamoto et al. (2011) examined the impact of the low interest rate policy implemented by the major economically developed countries on commodity prices using a structural VAR, and showed the possibility of QE2 conducted by Fed pushing up commodity prices.

Money includes not only currency supplied by a central bank but also deposit money provided by private financial institutions. Therefore, the increased speculative investment in commodity futures markets to push up the commodity prices can be attributed to the quantitative monetary policies as well as expansionary lending by optimistic financial institutions.

This paper presents an investigation of determinants of commodity prices using a structural VAR model, particularly addressing two liquidity indicators including an indicator of the US

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[2] Irwin and Sanders (2010).

monetary policy stance and an indicator of fundraising liquidity in the Eurodollar market. This study compares results of two subsample periods divided by a time point of 2001 when the emergence of the global excess liquidity was expected to begin influencing on the commodity futures markets. In addition, this paper devotes a great deal of attention to the relation between commodity prices by addressing concerns related to the deteriorating status of the dollar as a key currency for the background of expanding its external net deficits.

Although extensive literature related to the pricing of financial assets has already been published, studies of commodity prices are lacking to date. Furthermore, commodity prices reflect their intrinsic value inherent in physical goods. Gorton, Hayashi and Rouwenhorst (2012) collect inventory data for a broad cross-section of commodities and directly examine the negative relation between inventories and the risk premium. In this paper, prices of various categories of commodity are contained for the analysis to examine the connection between liquidity and the form of the futures curves[3].

2. Empirical Model

This paper presumes that the international commodity price index and its determinants are represented by the following structural VAR model.

$$AX_t = B_0 + B_1X_{t-1} + B_2X_{t-2} + \cdots + B_kX_{t-k} + u_t \tag{1}$$

$$X_t = \begin{bmatrix} WORLDPR_t \\ TED_t \\ COMMODITY_t \\ FFRATE_t \\ FX_t \\ MSCIUS_t \end{bmatrix} \qquad u_t = \begin{bmatrix} u_{worldpr,t} \\ u_{ted,t} \\ u_{commodity,t} \\ u_{ffrate,t} \\ u_{fx,t} \\ u_{mscius,t} \end{bmatrix}$$

Therein, *WORLDPR* specifies world industrial production included in *World Trade Monitor* released by CPB Netherlands Bureau for Economic Policy Analysis[4]. *TED* represents the TED spread, which is the difference between the three-month Eurodollar contract as represented by LIBOR and interest rates for three-month U.S. T-bills. *COMMODITY* is the international commodity price index represented by the DJ–UBS commodity index. This paper adopts the composite index as well as several sub-indices. *FFRATE* and *FX* are, respectively, the U.S. Federal Funds effective rate and the U.S. dollar nominal effective exchange rate. *MSCIUS*

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[3] The form of the futures curves is closely linked with the existence of a positive or a negative risk premium.
[4] World industrial production is created as the weighted average of each nation's industrial production.

denotes the MSCI–US stock price index denominated in U.S. dollars. Matrix A describes the contemporaneous relation among the variables to be considered. Vector u comprises structural shocks of those variables with a variance–covariance matrix $E[u_t u_t'] = I$.

The reduced form of equation (1) is represented as follows.

$$X_t = C_0 + C_1 X_{t-1} + C_2 X_{t-2} + \cdots + C_k X_{t-k} + \varepsilon_t \tag{2}$$

$$C_k = A^{-1} B_k \qquad \varepsilon_t = A^{-1} u_t \qquad E[\varepsilon_t \varepsilon_t'] = \Sigma_t$$

When each element of vector X satisfies stationarity, the VAR model should be invertible. Equation (2) should be rewritten as the following reduced-form VMA.

$$\begin{aligned}
X_t &= \varepsilon_t + D_1 \varepsilon_{t-1} + D_2 \varepsilon_{t-2} + \cdots + D_k \varepsilon_{t-k} + \cdots \\
&= D(L) \varepsilon_t \\
D(L) &= I + D_1 L + D_2 L^2 + \cdots D_k L^k + \cdots
\end{aligned} \tag{3}$$

Equation (3) should be rewritten further as the following structural VMA.

$$\begin{aligned}
X_t &= D(L) \varepsilon_t \\
&= D(L) A^{-1} A \varepsilon_t \\
&= F(L) u_t
\end{aligned} \tag{4}$$

The estimated impulse response functions are presented according to a sequence of the estimated coefficients of $F(L)$.

Because ε_t is represented as $\varepsilon_t = A_0^{-1} u_t$, the variance covariance matrix of ε_t is implied as follows.

$$\Sigma = E[\varepsilon_t \varepsilon_t'] = E\left[A^{-1} u_t u_t' \left(A^{-1} \right)' \right] = A^{-1} \left(A^{-1} \right)' \tag{5}$$

To identify the structural model from an estimated VAR, it is necessary to impose 15 restrictions on the structural model. This paper imposes the following recursive specification on matrix A.

$$A = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 \\
-a_{21} & 1 & 0 & 0 & 0 & 0 \\
-a_{31} & -a_{32} & 1 & 0 & 0 & 0 \\
-a_{41} & -a_{42} & -a_{43} & 1 & 0 & 0 \\
-a_{51} & -a_{52} & -a_{53} & -a_{54} & 1 & 0 \\
-a_{61} & -a_{62} & -a_{63} & -a_{64} & -a_{65} & 1
\end{bmatrix}$$

According to this specification, *WORLDPR* is defined as the most exogenous variable and *MSCIUS* as the least exogenous variable. Among the six variables, *WORLDPR*, *TED* and *COMMODITY* are regarded as world variables and *FFRATE*, *FX* and *MSCIUS* as US variables. Those US variables are presumed to respond endogenously to shocks in the world variables. Here, TED is regarded as a world variable because the U.S. dollar is circulated across the international financial markets as a key currency.

The ordering of the world variables is determined based on the following reasons: 1) world industrial production adjusts with lags to shocks in TED and commodity prices; 2) commodity index prices react contemporaneously to shocks in real-world economic activities; and 3) TED might reflect the credit risk of international financial institutions and the ease of funding U.S. dollar liquidity. The tightened lending caused by the change in financial institutions' perception for credit risk and funding liquidity risk restrict commodity investors conducting leveraged investments.

This paper uses the world industrial production index as an indicator of the world economic business cycle, similar to Kawamoto et al. (2011)[5]. This paper, different from Kawamoto et al. (2011), which adopts the world stock price index as an indicator of risk appetite, investigates the impact of TED on commodity price indices by presuming that TED reflects concerns about the stability of the financial system related to a lack of creditworthiness of financial institutions and investors' perceptions of liquidity tightness. Kawamoto et al. (2011) interprets changes in commodity prices caused by increased capital flows into futures markets as well as an unwinding of investors' positions in commodities as an idiosyncratic shock of the commodity index price. In this paper, a structural shock (or an idiosyncratic shock) of commodities is interpreted as a shock caused by heightened geopolitical risk, climate change, and so forth because a commodity price index is extracted with the impact of TED.

This paper also supposes that the Fed adjusts the target interest rate after observing the effects of changes in commodity prices on domestic prices as well as the effects of the global economic business cycle and Eurodollar market conditions. In this paper, a structural shock (or an idiosyncratic shock) of the US monetary policy is defined as a shock in the FF rate resulting from other causes aside from those endogenous interest rate adjustments. This paper also assumes that the monetary policy is not intended to be implemented for stability of securities markets, and that stock prices and foreign exchange rates respond contemporaneously to a shock in the target interest rate.
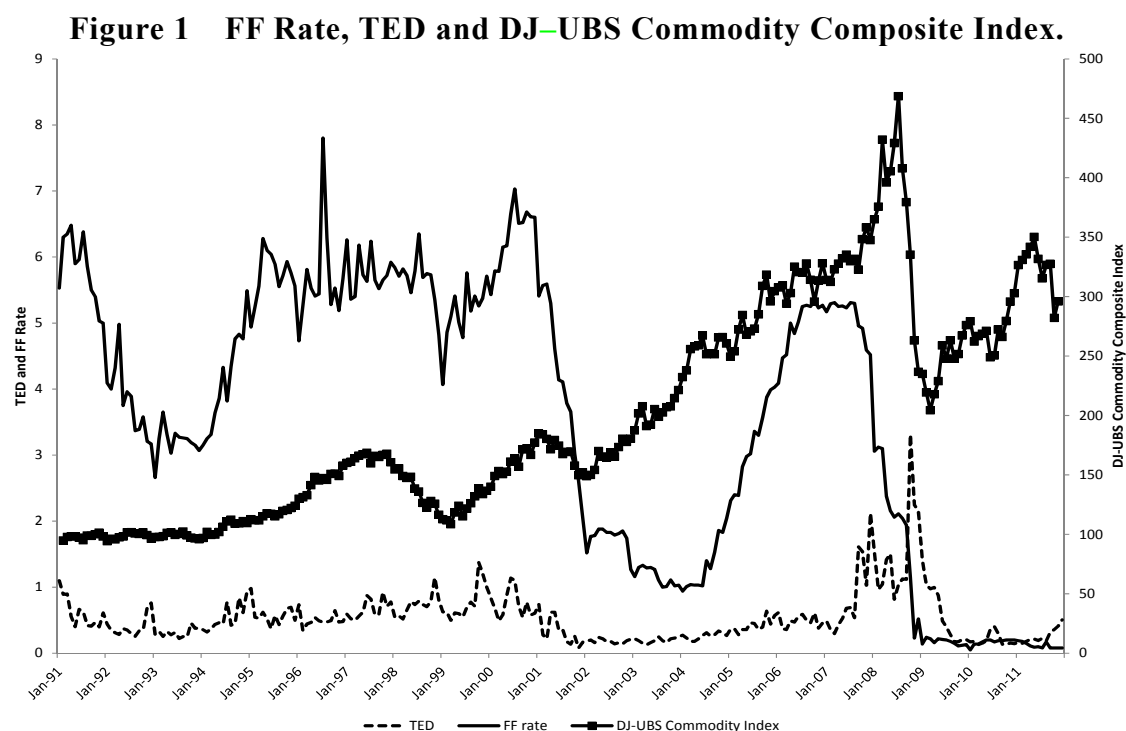
This paper includes TED in addition to the FF rate because the impact of liquidity provided by private financial institutions is discriminated from the impact of liquidity as a result of implementation of monetary policy. The degree of liquidity tightness implied by the changes

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[5] Kilian (2009) disentangles supply and demand shocks in the physical markets of crude oil.

in the target interest rate might differ from that indicated by the interbank interest rate at some moments. Take as an example the period of 2004–2007. It seems apparent from Figure 1 that the commodity price index continued an upward trend. FF rate had been rising continuously to restrain inflation pressure. TED, however, remained at a low level until 2007 when the subprime loan problem became evident.

As another example, it is also apparent that during latter 2007 to the early part of 2008 when the commodity price index shows a sharp increase, TED rose abruptly because financial institutions raised their doubts and fears of one another related to the possibility of bankruptcy, whereas the FF rate started declining to calm the tension of the interbank market. Kawamoto et al. (2011) revealed that the relative contribution of the idiosyncratic shock of commodity prices increased during the period, concluding that the result can be interpreted as the increase in commodity investments led by a "flight to simplicity" triggered by the collapse of securitization markets. This paper presents an examination of whether a "flight to simplicity" can be discovered after controlling the effect of TED on commodities.

Financialization of commodities, or the increased correlation between prices of commodities and securities such as stock, is ascribable to the effect of common factors. This paper adopts TED as well as the world industrial production as common factors and explores whether the commodity futures markets have become more vulnerable to a transition of global liquidity after commodities were regarded as alternative investments, stimulated by the development of commodity investment vehicles.
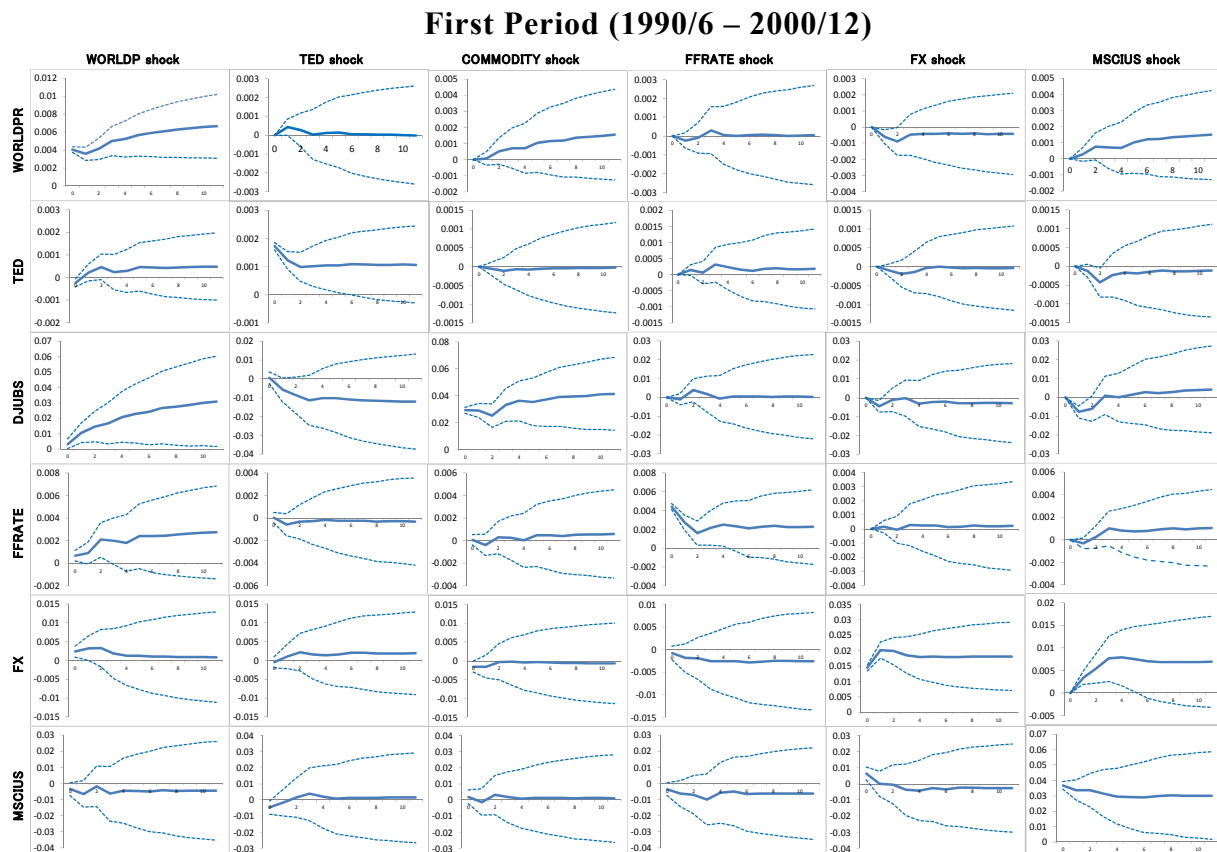
Figure 1   FF Rate, TED and DJ–UBS Commodity Composite Index.

3. Empirical Analysis

3-1. Estimation of Impulse Response Functions

World industrial production data were downloaded from the webpage of CPB Netherlands Bureau for Economic Policy Analysis. Other data were obtained from Thomson Reuters' *Datastream*. Empirical analysis of this paper uses monthly data with sample observations ranging from June 1991 to August 2011, which are divided at 2001 to estimate the structural VAR model described above.
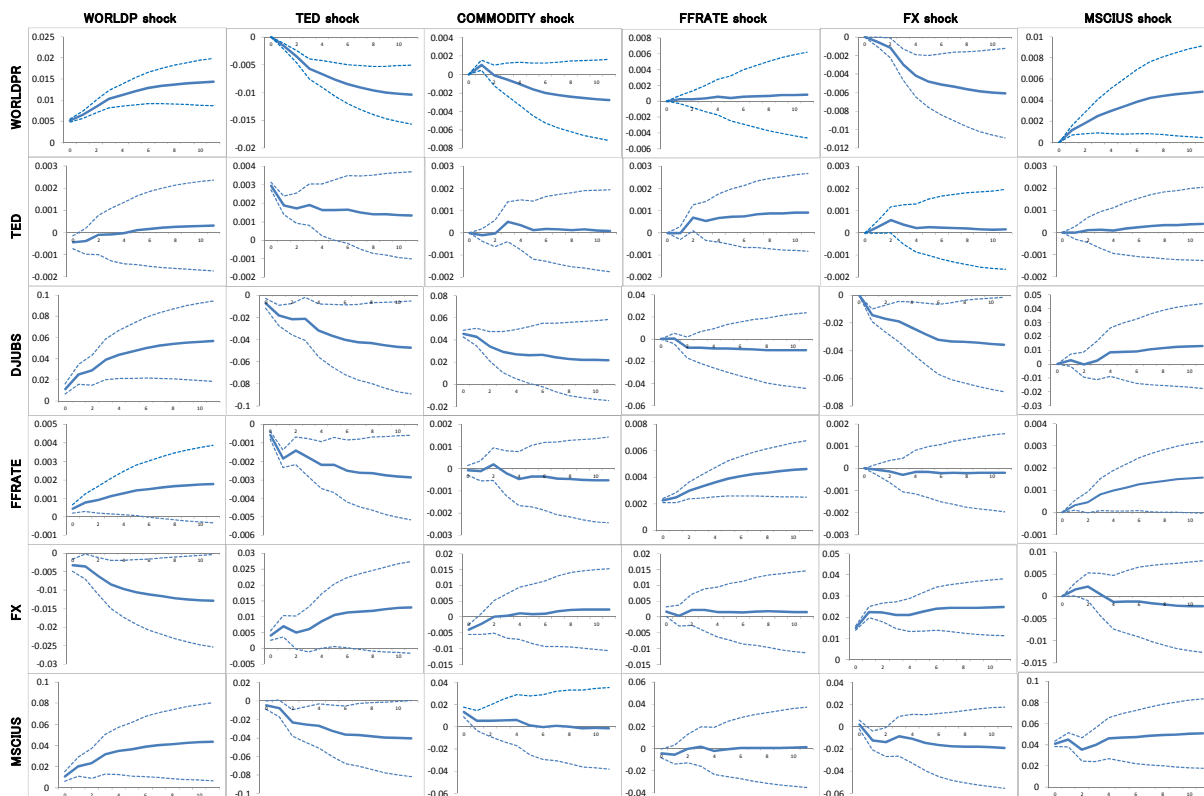
This subsection presents estimation results of impulse response functions. Figure 2-1 and Figure 2-2 respectively show estimation results of impulse response functions for the first period beginning from June 1999 and the second period beginning from January 2001. Solid lines represent the point estimates of impulse responses. Dotted lines show confidence bands measured using one standard deviation with a Monte Carlo simulation. The impulse responses are created by accumulating the estimated coefficients to present the impact of a shock to a level of dependent variables.

Figure 2-1   Results of Impulse Response Functions in applying the DJ–UBS Commodity Composite Index.

First Period (1990/6 – 2000/12)

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Figure 2-2 Results of Impulse Response Functions in applying the DJ–UBS Commodity Composite Index.

Second Period (2001/1 – 2011/8)

By comparing the results of the first and second period, it was confirmed that the impulse responses of all six variables to a shock in TED become statistically significant for the second period. The second period includes a period of an abrupt credit shrinkage after the subprime loan problem became apparent, as well as a subsequent period when the extreme liquidity squeeze occurred in the international interbank markets triggered by the Lehman Brothers bankruptcy. The results presented in Figure 2 suggest that the drying-up of liquidity slowed global economic activities and decreased the prices of commodities and US equities. The result is also consistent with the fact that the Fed reacted to the extreme liquidity squeeze by lowering the target interest rate. The impulse response of the US dollar effective exchange rate reveals a positive response to a shock in TED, implying capital flight to the US dollar as a safe asset led by the liquidity crisis. The possibility that the decline of the FF rate raised the commodity prices is implied, although the impulse response of the commodity price index to a shock in FF rate is not statistically significant. The possibility that lower FF rate calmed down TED is also inferred.

During the second period, responses of the commodity price index and the US stock price index

to a shock in *WORLDPR* are positive and statistically significant. In addition, the magnitude of those responses in the second period becomes higher than that in the first period. The evidence implies that the tendency for expansion (or shrinkage) of the global economic activities to promote the increase in prices of commodities as well as US equities has intensified in recent years. World economic conditions have become an important driving force for the interdependence between commodities and US equities for the following reasons. 1) The globalization of economic activities of US companies has made their values more dependent on world economic conditions. 2) Because of the development of emerging economies, the contribution of their economic condition to world industrial production has increased. Moreover, their greater demand for commodities has caused an upward tendency of commodity prices.

A negative correlation between the commodity price index and the effective dollar exchange rate prevailed during the first period. The negative relation has become more prominent in the second period: depreciation of the US dollar brings about an increase in commodity prices. Because commodity prices are denominated in US dollars, investors outside the United States might be stimulated to make commodity investments by observing cheaper commodities prices denominated in a local currency (Yanagisawa (2008, 2011)) [6]. The higher negative correlation during the second period can be explained by additional reasons. The second period includes a period during which concerns over the US dollar as a key currency arose against the background of expanding US external net debts.

Finally, we can confirm in the second period that a shock in *MSCIUS* causes a positive impact on the world industrial production, implying that an increase in the US equity prices promotes the expansion of the world economic activities. The evidence that the FF rate shows a positive reaction to a shock in *MSCIUS* indicates that the Fed accommodated an equity price plunge during the IT bubble bursting and during the global financial crisis in 2008 by lowering the target interest rate [7].
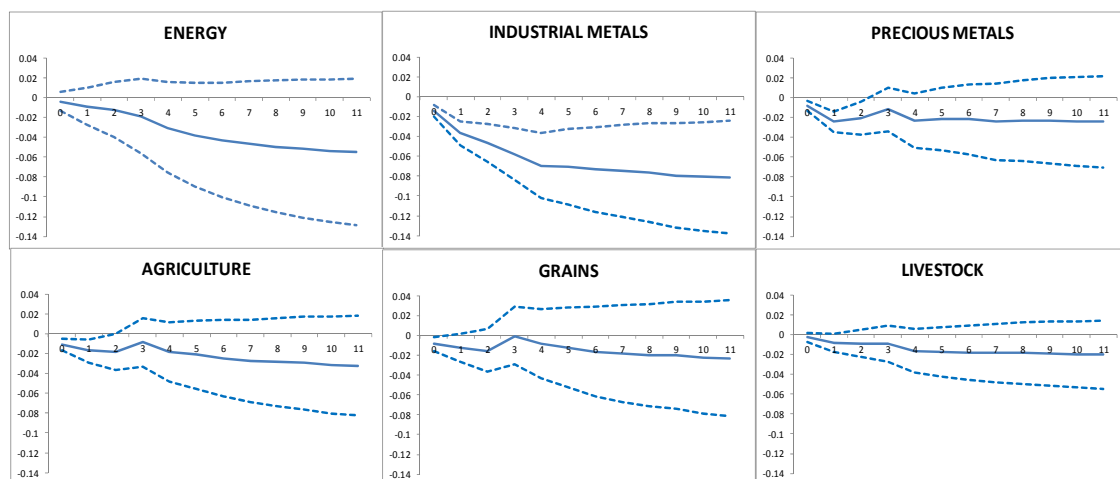
Figure 3-1 presents results of the estimated impulse response functions of the sub-indices of commodities to a shock in TED for the second period. All reveal a negative reaction to TED. The impulse responses of the indices of industrial metals, precious metals, agriculture and grains are statistically significant. The reaction of the industrial metals is exceptionally high

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[6] Yanagisawa (2008, 2011) verified a negative impact of the US dollar effective exchange rate on WTI.
[7] A shock in *MSCIUS* is defined as a shock by which a change in the US equity prices cannot be explained by other factors such as the world economic conditions and a liquidity squeeze. If investors' perspective to the future world economic conditions is not reflected to *WORLDPR*, but reflected to *MSCIUS*, the result shown in Figure 2-2 can be interpreted as the Fed implementing a target interest rate reduction to mitigate the equity plummet aggravated by investors' pessimistic forecasts for future economies. The fact of a positive reaction of *WORLDPR* to *MSCIUS* can be interpreted as a self-fulfilling economic slowdown: the expectation for a future economic slowdown to have a negative impact on real economic activities.
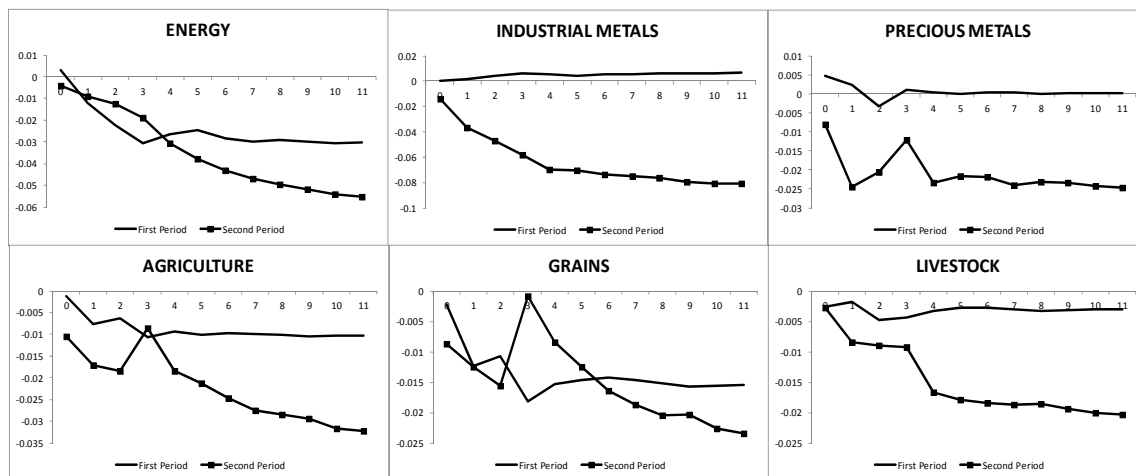
and more lasting. Figure 3-2 compares the impulse responses of those sub-indices to TED between the first and second periods. We can confirm that their responses to TED have been intensifying in recent years and that the sub-index of industrial metals presents a strong response during the second period.

Figure 3-1   Impulse Responses of Sub-Index of Commodities to a Shock in TED.

Estimation Period: January 2001 – August 2011

Figure 3-2   Comparison of Impulse Responses of Sub-Index of Commodities to TED between the First and Second Periods.

The following reasons can be listed as explanations of a marked influence of TED on industrial metals: 1) Because the trading volume of industrial metals on the futures markets is less than that of energy products, the market impact caused by the increased speculative capital inflows might be considerable. 2) Because some of the industrial metal futures prices

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tend to form the futures curve of "backwardation", institutional investors, who are likely to choose "buy and hold" strategy, might prefer to invest in those commodities.
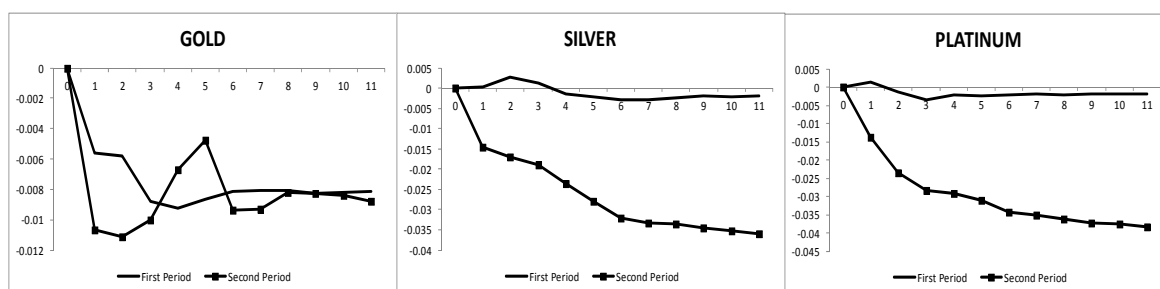
The downward futures curve (backwardation), a situation of the price of a futures contract traded below the expected spot price at contract maturity, creates the roll return. Erb and Harvey (2006) present that the roll return is dominant in the total return of commodity investments, which is an important source of profits of commodities yielding no income return. Fuerte, Miffre and Rallis (2010) demonstrate the profitability of trading strategies combining momentum and term structure and conclude that the double-sort strategy creates an abnormal return of 21.02%.

Morota (2010) lists energy products and copper as candidates of commodities that can form backwardation. Erb and Harvey (2006) also show that the roll returns of heating oil and copper are likely to be positive, although the roll returns of agricultural products and precious metals are likely to be negative. Campbell, Orskaug and Williams (2006) use the price of aluminum listed on the London Metal Exchange during 1997–2006 and reveal that aluminum tends to form an upward futures curve (contango) for 60% of the estimation period, which is consistent with the results presented in this paper, which verifies that TED had the greatest impact on copper and the least impact on aluminum among industrial metals.

Figure 4 presents a comparison of impulse responses of three precious metals to a shock in FX between the first and second periods. For the first period, the response of gold is the most prominent. It is statistically significant among them. For the second period, however, the response of silver and platinum rose and all precious metals show statistical significance.

Gold has been regarded as a safe haven asset for many years. Therefore, gold can be chosen as an alternative asset in a situation where uncertainty to the US dollar emerges. The evidence presented in Figure 4 implies that various commodities, including gold, came to be regarded as alternative assets for the US dollar after commodity investments became more popular for institutional investors.

Figure 4　Comparison of Impulse Responses of Precious Metal Prices to FX between the First and Second Periods.

Estimation Period: January 2001 – August 2011

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3-2. Variance Decomposition

The results of variance decompositions are presented next. Table 1 portrays the variance decomposition for all variables considered in the analyses for the two estimation periods. The numerical values in Table 1 are the averaged contributions of variance of the one-step forecast error through that of the twenty-step forecast error for each component. In this case, the DJ–UBS commodity composite index is used for *COMMODITY*.

The analysis reveals that the relative contribution of TED to FF rate increases greatly in the second period. The evidence might reflect the fact that the Fed accommodated by lowering the target interest rate for the emergency where financial institutions doubt and fear one another for the probability of bankruptcy brought about the dysfunction of the international interbank markets. It also seems readily apparent that the impact of TED on the world industrial production increases in the second period, implying that the extreme liquidity squeeze aggravated the world economic recessions. TED has also become more influential on the US dollar effective exchange rate, the US equity index, and the commodity composite index in the second period. Results show that the impact of *WORLDPR* shock on the indices of commodities and US equities increases in the second period, which is consistent with the results of impulse response functions.

Table 1   Variance Decomposition in applying the DJ–UBS composite index

(a) First Period: June 1991～December 2000

	WORLDPR shock	TED shock	COMMODITY shock	FFRATE shock	FX shock	MSCIUS shock
WORLDPR	90.201	1.277	1.746	1.487	3.084	2.204
TED	9.481	83.463	0.226	2.377	0.792	3.663
DJUBS	7.861	4.233	73.402	2.567	3.089	8.847
FFRATE	7.024	1.529	2.766	84.724	0.663	3.294
FX	2.871	1.436	1.450	0.785	86.616	6.842
MSCIUS	3.490	2.774	1.949	2.695	5.380	83.713

(b) Second Period: January 2001～August 2011

	WORLDPR shock	TED shock	COMMODITY shock	FFRATE shock	FX shock	MSCIUS shock
WORLDPR	62.631	19.500	4.775	0.254	8.364	4.476
TED	2.717	87.900	2.893	4.247	1.980	0.263
DJUBS	13.254	8.917	66.420	2.001	7.725	1.683
FFRATE	4.378	25.450	3.191	63.262	0.530	3.190
FX	5.916	9.463	6.389	2.060	74.068	2.105
MSCIUS	9.292	9.176	8.435	2.102	8.163	62.833

Table 2 presents the variance decomposition of sub-indices of commodities for the second period. We can find that the industrial metals and precious metals are more prone to TED, which is a similar result to that with impulse responses. Copper and platinum are particularly

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affected by TED. Although energy products should be regarded as the core of the commodities investments and although they have a propensity to form the futures curve of backwardation, the relative contribution of TED is not significant.

Idiosyncratic shocks tend to be more dominant for products related to agriculture, grain, livestock and energy. This might result from omission of variables vital to those commodities. Omitted variables might include geopolitical risk and climate changes.

Table 2 Variance Decomposition for commodity price indices

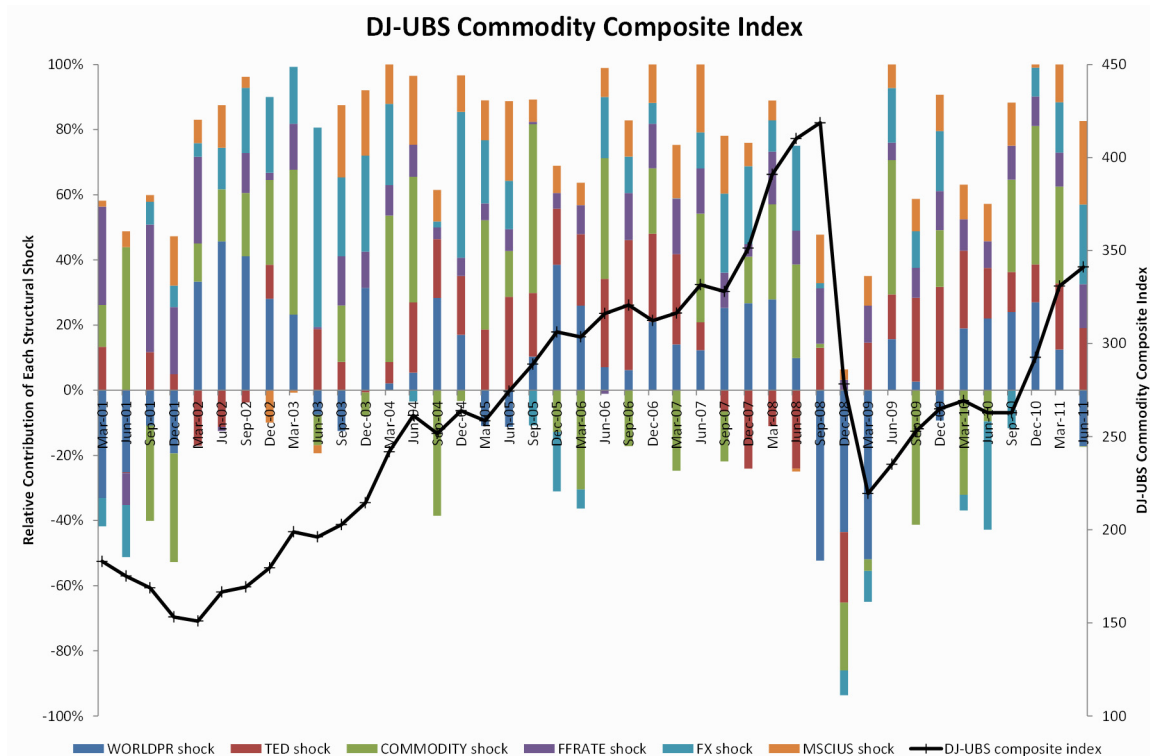**Estimation period: January 2001 – August 2011**

	WORLDPR shock	TED shock	COMMODITY shock	FFRATE shock	FX shock	MSCIUS shock
DJ–UBS Composite Index	13.254	8.917	66.420	2.001	7.725	1.683
Energy	7.596	2.429	82.757	1.886	5.001	0.331
Crude Oil	9.476	3.216	76.925	1.273	7.786	1.323
Heating Oil	7.631	3.486	79.587	1.208	6.431	1.658
Unleaded Gas	6.218	6.205	79.641	0.825	6.115	0.997
Industrial Metals	14.783	16.269	56.819	1.635	7.307	3.188
Aluminum	12.153	10.947	66.155	3.700	4.589	2.457
Copper	9.874	16.972	63.315	1.935	5.303	2.601
Lead	6.074	9.330	77.395	0.968	5.797	0.436
Nickel	11.142	8.226	71.010	1.149	6.117	2.357
Tin	10.393	9.469	74.970	0.770	2.030	2.369
Zinc	8.198	12.543	64.912	2.222	7.629	4.495
Precious Metals	5.860	12.370	74.114	0.453	4.968	2.236
Gold	7.363	13.624	71.295	1.076	4.758	1.884
Silver	3.223	11.514	78.587	0.127	4.279	2.270
Platinum	16.708	17.234	56.496	1.581	4.985	2.996
Agriculture	9.128	7.132	73.188	2.359	3.102	5.091
Cocoa	1.112	6.753	81.223	6.401	1.712	2.799
Coffee	2.407	2.737	91.237	0.291	1.138	2.190
Cotton	6.345	4.816	80.364	1.515	3.263	3.697
Sugar	4.572	4.294	86.345	1.591	2.238	0.961
Grains	7.375	5.396	78.603	1.245	2.177	5.204
Corn	4.299	3.246	85.478	1.577	1.749	3.650
Soybean	6.683	6.023	78.985	2.324	1.969	4.015
Wheat	5.952	4.141	81.854	0.688	1.746	5.619
Livestock	2.453	3.309	89.583	2.710	0.829	1.117
Cattle	4.582	2.732	89.134	1.788	1.050	0.715
Lean hogs	0.679	4.155	90.703	1.745	1.756	0.963

3-3. Historical Decomposition

Finally, the results of historical decomposition are presented in this subsection. This paper specifically examines the commodity price index, the US equity index, and the US dollar.

Figure 5-1 portrays the historical decomposition of the DJ–UBS commodity composite index for the second period. The monthly changes in the DJ–UBS index are decomposed by contributions of the six identified structural shocks. In this analysis, the decomposed structural shocks are accumulated for every year to present each relative contribution for the commodity index. Figure 5-1 also includes the three-month averaged value of the DJ–UBS composite index.

Figure 5-1   Historical Decomposition of DJ–UBS Commodity Composite Index.

DJ-UBS Commodity Composite Index

The world industrial production shock, which functioned as a downward shock at the IT bubble burst, contributed to raise commodity prices in the course of the economic recovery. It is noteworthy that its relative contribution has been declining since the end of 2003, accompanied by the increase in other factors' contributions.

The Fed promptly accommodated the IT bubble burst by conducting a drastic interest rate reduction. The FF rate shock contributing to raising of commodity prices during 2001–2002 is suggested in historical decomposition. The relative contribution of FF rate shock decreased and the contribution of TED shock instead increased afterward. After the fourth quarter of 2004, the contribution of TED shock exceeded the contribution of FF rate shock, which implies the possibility of the expansion of loans by financial institutions, which became more optimistic, thereby pushing up commodity prices.

From the third quarter of 2007 when the subprime loan problems surfaced, the TED shock started acting as a downward shock[8]. This negative impact lasted until the fourth quarter of 2008: the Lehman Shock[9]. After the subprime loan shock was actualized, the world industrial

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[8]   On 9 August 2007, a major French Bank, BNP Paribas, acknowledged the impact of the subprime loan crisis by closing two funds exposed to it (so-called Paribas Shock). This was the start of the credit crisis, and the fact that losses related to the depressed real estate markets were diversified via the securitized products across the world came to light. Then, TED jumped from 0.5% to 1.6%.

[9]   During one month from 1 September to 1 October in 2008, TED jumped from 1.12 percent up to 3.31 percent.

production index continued an upward trend until the second quarter of 2008, during which the WORLDPR shock contributed to raising of the DJ–UBS index. The period from the third quarter of 2007 to the second quarter of 2008 is a period of rapid rise of the commodity index [10]. The evidence of historical decomposition suggests that the world demand for physical commodities as well as idiosyncratic shocks as major force to push up commodity prices. This analysis also reveals that the interest rate reduction starting in July 2007 contributed to the increase of commodity prices.

WORLDPR shock acted as a negative shock for the period from the third quarter of 2008 to the first quarter of 2009, lowering commodity prices. From July 2008, at a time the commodity index reached the peak, to March 2009 at a time it plunged to the bottom, the DJ–UBS commodity index dropped 83 percent. This paper verified that this drop was caused not only by the TED shock but also by the WORLDPR shock. Furthermore, the impact of the shrink in the world industrial production outstripped the impact of the liquidity squeeze for the period from the second quarter of 2008 to the first quarter of 2009.
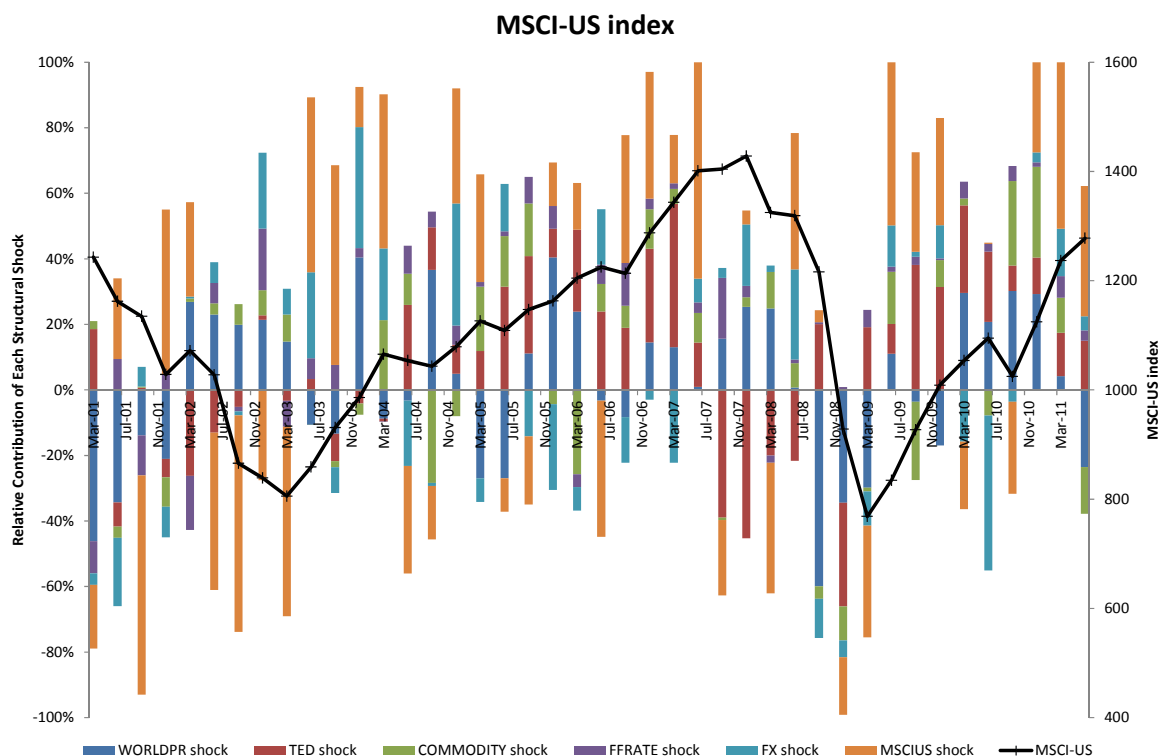
TED recovered stability in 2009 and restarted its upward drive. In 2010, the WORLDPR shock also contributed to the increased commodity index.

The relative contribution of the US dollar effective exchange rate to the commodity index increased during 2002–2005, when uncertainty of the US dollar surged along with the expansion of the US external net deficit. This finding indicates that concerns about the key currency promoted a shift from the US dollar to commodities.

Figure 5-2 depicts historical decomposition of MSCI US index. The FF rate shock and TED shock worked to raise US equity prices after the IT bubble crash. It is also apparent that the commodity was influenced by the expansionary monetary policy and the increased tolerance of financial institutions at the earlier stage than the US equities. The possibility also exists that money injected by the eased monetary policy did not promptly flow in equity markets, but in commodity futures markets as an alternative investment opportunity.

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[10] The DJ-UBS index, which was quoted at 322.68 on September 1 2007, soared to 468.63 on July 1, 2008.

Figure 5-2   Historical Decomposition of MSCI–US index.

MSCI-US index

Regarding the impact at the financial turmoil in 2007 and 2008 and at the recovery in 2009, we can confirm similar features to those of the result shown in Figure 5-1. The TED shock negatively affected the MSCI–US index during the subprime loan crisis and the following financial market dysfunction and turned out to be a positive factor in 2009. The WORLDPR shock had a negative impact on MSCI–US index for the period from the third quarter of 2008 to the first quarter of 2009. The simultaneous drop in prices of assets including commodity futures and equities might result from the extreme liquidity squeeze as well as the world scale depressed economic activities shrinking at blistering speed.

Figure 5-3 presents the historical decomposition of the US dollar effective exchange rate. Although the TED shock has been acting as a negative factor for the US dollar for most of the estimation period, it functioned as a positive factor during 2007 and 2008. From this, the presumption that "speculators investing in commodity futures and equity markets under the easy money period fled to the US dollar as a safe asset is implied. It is also apparent that an idiosyncratic shock has been dominant for the whole period. This can be interpreted as showing that uncertainty to the US dollar on the background of its expanding external debt was a vital factor in creating a downward trend.

Figure 5-3   Historical Decomposition of US Dollar Effective Exchange Rate.

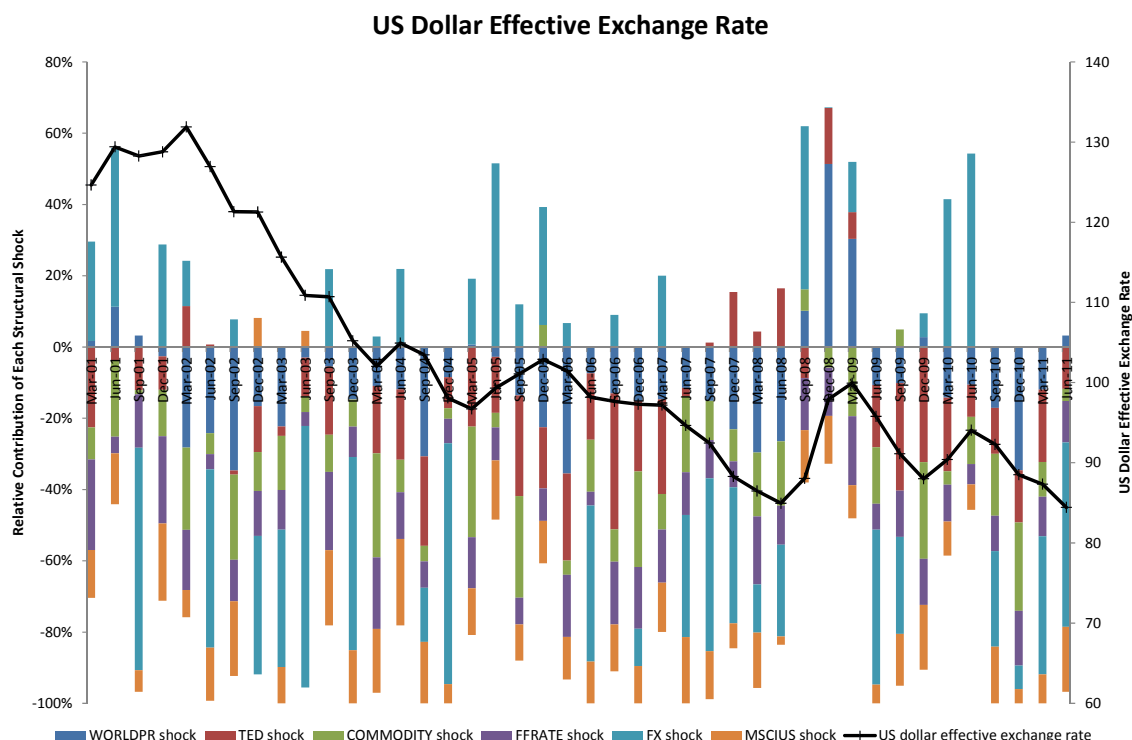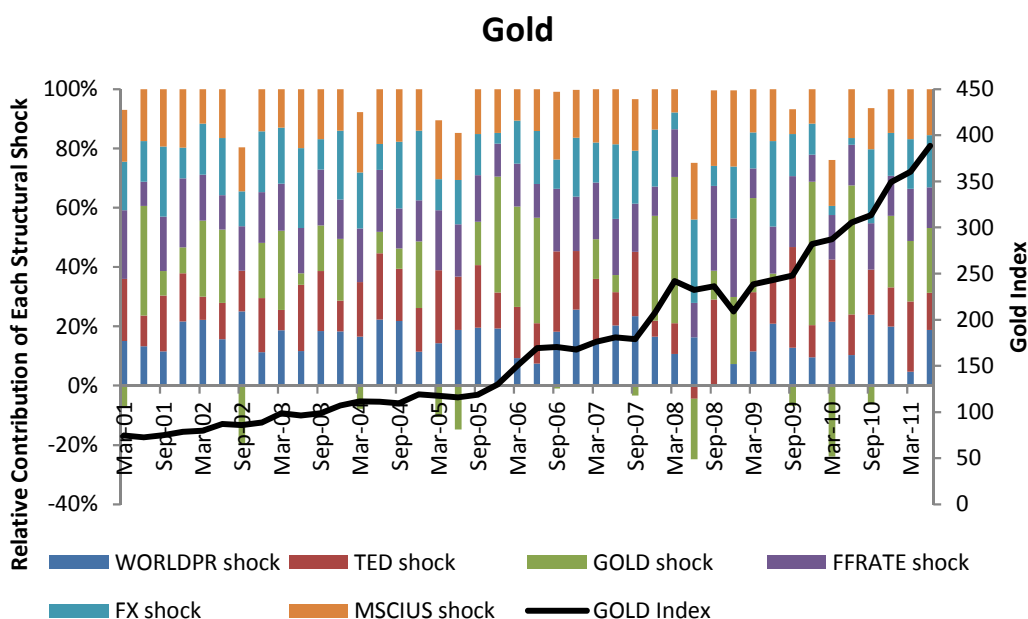

US Dollar Effective Exchange Rate

Figure 6 depicts the historical decomposition of gold. Among the commodities considered in this analysis, only gold was not affected significantly by the TED shock in 2007 and 2008. Even in the fourth quarter of 2008 immediately after the Lehman Shock, the impact of TED was negligible. Under the extreme liquidity crunch, gold was possibly chosen in a strategy of "flight to safety".

Figure 6   Historical Decomposition of Gold Index.

Gold

4. Conclusion

The following describes conclusions of the empirical analysis of this study.

This paper highlights the impacts of liquidity conditions represented by an indicator of monetary policy stance and an indicator of private financial institutions tolerance on commodity futures prices, and investigates what determinants have been dominant for those prices.

We confirmed that the influence of liquidity on commodity futures and US equity prices had become significant after 2001 when drastic easy monetary policies were implemented by economically developed countries, which suggests that "financialization of commodities" promoted by the development of commodity investment vehicles attracting institutional investors, coupled with the expansion of global liquidity, has been proceeding.

Immediately after the IT bubble burst, the easing of monetary policy by lowering the target interest rate had a greater impact on prices of commodity futures as well as US equities. Over the course of time, a tolerant stance of financial institutions for lending had been becoming dominant for asset prices. During 2007–2008, however, the TED shock served to drive asset prices down. This tendency was confirmed for all commodities except for gold, which was chosen as the sole safe asset under the extraordinarily severe financial turmoil. Another "flight to liquidity", flight of speculative money to the US dollar market, was also observed with an enormous amount of market liquidity.

Even though the subprime loan crisis was actualized in 2007, the commodity price index accelerated. The upsurge of the commodity prices is explainable by real economic factors. The decline of the world industrial production index in latter 2008 lowered the commodity prices. The magnitude of its impact exceeded that of TED. The robustness of this result should be confirmed.

Results show that commodities including industrial metals such as copper and precious metals such as platinum, which tend to form the futures curve of backwardation, are more susceptible to liquidity conditions. This result implies that investments by institutional investors who prefer a buy and hold strategy had a sufficient impact on commodities with smaller market size.

Energy products, which are regarded as the core of the commodity investments, are not strongly influenced by TED. Further studies should be undertaken for a detailed examination of the relation between liquidity and the form of the futures curve[11].

Depreciation of the US dollar, which lowers commodity prices denominated in a local

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[11] Sano (2006), Nogami (2006), and Morota (2010) reported that the futures markets of energy products became contango markets around 2005.

currency, might induce investments in commodities. The tendency was verified for the whole sample period, but the dollar impact was intensified in the second period. This might be partly true because uncertainty related to the US dollar based on its expanding external net deficit produced flight to commodities as alternative investment opportunities.

The following presents remaining issues for this avenue of study.

The target interest rate has been regarded as an indicator of the policy stance of a central bank by many researchers and policymakers. Under circumstances by which the zero interest rate policy is implemented, the target interest rate cannot fully reflect the policy stance. Therefore, an alternative indicator such as a quantitative variable should be used. As an indicator of tolerance of private financial institutions, not only TED but other variables including the amount of bank loans should also be applied.

This paper adopts the FF rate and TED, denominated in the US dollar, because 1) the Fed's expansionary monetary policy after the IT bubble burst was symbolic and was regarded as the start of the excess global liquidity and because 2) short-term government bond yield data of European countries are not available. Liquidity supply by countries including Europe and Japan applying a fixed exchange rate regime might have a strong impact on commodity prices. Studies should be conducted using an indicator of monetary policy stance and using an indicator of tolerance of financial institutions of the whole world.

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