KIER DISCUSSION PAPER SERIES

KYOTO INSTITUTE
OF
ECONOMIC RESEARCH

Discussion Paper No.895

“Effects of Mineral-Commodity Price Shocks on Monetary Policy in Developed Countries”

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April 2014

KYOTO UNIVERSITY

KYOTO, JAPAN

Effects of Mineral-Commodity Price Shocks on Monetary Policy in Developed Countries*

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April 29, 2014

Abstract

This paper investigates effects of changes in mineral commodity prices on monetary policy. Using macroeconomic data from five developed countries (Australia, Canada and New Zealand as mineral-producing countries, and the US and the UK as non-mineral-resource countries), I estimate the impulse response functions of the policy interest rates and the core consumer price index (CPI) inflation rates to mineral-commodity price shocks. I find that, in response to an unexpected 10 percent increase in mineral commodity prices, the central banks in the mineral-producing countries are estimated to increase their policy interest rates by approximately one percentage point, and they seem to take anticipatory policy reactions to control core CPI variations triggered by these shocks. Thus, mineral commodity prices appear to be important determinants of the monetary policies in the mineral-producing countries. However, the effects of the increase in their policy interest rates on core CPI inflation are different across the examined mineral-producing countries. I also find that the central banks in the non-mineral-resource countries insignificantly respond to mineral-commodity price shocks because such price shocks have little impact on those countries' core CPI inflation.

Keywords: Mineral commodity prices; Systematic monetary policy; Structural vector autoregressions; Impulse responses; Response decompositions; Counterfactual analysis

JEL Classification: E31; E52; Q02

*I would like to thank Takayuki Tsuruga and Hiroshi Teruyama for their useful comments and suggestions. I am also grateful to participants in the macroeconomic and econometric seminars, and the Brown Bag Lunch seminar at Kyoto University for their helpful comments. Moreover, I am thankful to participants of Autumn Meeting of the Japanese Economic Association at Kanagawa University and Autumn Meeting of the Japan Society of Monetary Economics at Nagoya University for their beneficial comments.

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1 Introduction

Commodity prices have been rising since the 1970s. The rise in commodity prices has interested central bankers in developed countries. In Australia, a mineral-producing country, Stevens (2008) expressed concern on the effects of mineral-commodity price shocks on inflation. On the other hand, in the US, a non-mineral-resource country, Bernanke (2011) and Yellen (2011) stated that the effects of comprehensive commodity price shocks on inflation are weak. Thus, there is growing interest in the relationship between nonenergy commodity prices and inflation. Many previous studies have reported the degree of pass-through of commodity price increases to inflation.[1] An increase in mineral commodity prices may increase core CPI inflation in both mineral-producing and non-mineral-resource countries through different channels. For example, in mineral-producing countries, a positive mineral-commodity price shock may increase firms' profits through exports if the price elasticity of demand is low. Moreover, greater profits may trigger a rise in core CPI inflation. In contrast, in non-mineral-resource countries, a positive mineral-commodity price shock may increase production costs of firms and thus trigger cost-push inflation. If mineral commodity prices are nonnegligible inflationary factors, then the commodity prices would need to be considered to implement a sound monetary policy.

This paper explores effects of mineral-commodity price shocks on monetary policy in developed countries over January 1990 – June 2008. It examines central banks in Australia, Canada and New Zealand (mineral-producing countries) as well as those in the US and the UK (non-mineral-resource countries) to address the following questions: How do mineral-commodity price shocks affect core CPI inflation across the five countries? Are mineral commodity prices important determinants of the monetary policies of the central banks? Section 2 shows that the time-series properties of mineral commodity prices differ from those of oil and food prices. Hamilton (2011) and Kilian *et al.* (2011) reported that oil prices have not affected core CPI variations in the US since the mid-1980s. In addition, Evans and Fisher (2011) demonstrated that comprehensive commodity prices, with mineral and food prices weighted appropriately, have likewise not influenced core CPI variations in the US since the mid-1980s . However, the relationship between mineral commodity prices and monetary policy may be strong and may differ across the countries including the US.

In this paper, I seek to apply Kilian *et al.*'s (2011) method to analyze the relationship between mineral commodity prices and monetary policy in the developed countries. This paper seeks to answer three questions. First, I investigate whether the examined central banks respond to mineral-commodity price shocks. Second, I examine whether they respond

[1]See Cecchetti and Moessner (2008), International Monetary Fund (2008, 2011), Rigobon (2010), and Gelos and Utsyugova (2012).

to mineral-commodity price shocks before or after core CPI variations are triggered by the shocks. Third, I study the pure effects of mineral-commodity price shocks on core CPI inflation without considering the policy responses of the central banks. My approach is to estimate the impulse response functions (IRFs) using structural vector autoregressions (SVARs). To answer the first question, I estimate the IRFs to mineral-commodity price shocks and focus on two IRs: the responses of policy interest rates and those of core CPI inflation rates to mineral-commodity price shocks. Further, I organize the results and classify the relationships between the IRs of policy interest rates and core CPI inflation rates to mineral-commodity price shocks into four hypotheses based on Evans and Fisher (2011). To answer the second question, I decompose the responses of the policy interest rates to mineral-commodity price shocks so as to investigate which variable is the main contributor for policy responses to such price shocks. Response decomposition reveals whether each central bank adopts ex-ante policy or ex-post policy to stabilize the core CPI. To answer the third question, I create a counterfactual model based on Bernanke, Gertler, and Watson (1997), henceforth referred to as BGW, to study the pure effects of mineral-commodity price shocks without the policy responses. Because my model includes the policy interest rates of the central banks, I cannot directly observe the pure effects on economic indicators excluding the policy responses. However, a counterfactual analysis of shutting down the policy responses leads to studying the pure effects of mineral-commodity price shocks.

My findings are as follows. First, I find that the Reserve Bank of Australia (RBA), the Bank of Canada (BOC) and the Reserve Bank of New Zealand (RBNZ) as central banks in the examined mineral-producing countries significantly respond to mineral-commodity price shocks. In response to an unexpected 10 percent increase in mineral commodity prices, the central banks in the mineral-producing countries are estimated to increase their policy interest rates by approximately one percentage point. On the other hand, the Federal Reserve and the Bank of England (BOE) as central banks in the examined non-mineral-resource countries insignificantly respond to mineral-commodity price shocks because such price shocks have little impact on those countries' core CPI inflation. Second, I find that the central banks in the mineral-producing countries may take preemptive policy reactions to adjust their policy interest rates before their core CPI inflation rates increase due to mineral-commodity price shocks in order to control the effects of these shocks. Third, I show that, if the RBA and the RBNZ were to hold their policy interest rates in response to mineral-commodity price shocks, these shocks would have more persistent effects on core CPI inflation in those countries. However, such a counterfactual policy response of the BOC would not increase the core CPI inflation rate in that country.

The remainder of this study is organized as follows. Section 2 introduces the charac-

Table 1: Cross correlations of log-differences of the raw industrials subindex with those of the WTI spot oil price and the foodstuff subindex over January 1990 – June 2008

i	0	1	2	3	4	5	6
OIL (-i)	0.19	-0.03	-0.01	0.05	0.06	0.07	0.04
OIL (+i)	0.19	0.19	0.08	0.06	0.08	0.05	0.00
FOOD (-i)	0.25	-0.02	0.00	0.02	-0.02	0.01	0.02
FOOD (+i)	0.25	0.11	0.02	0.10	0.05	0.07	0.17

NOTES: OIL and FOOD stand for log-differences of WTI spot oil price and CRB foodstuff sub-index, respectively. "-i" and "+i" represent lag i and lead i, respectively.

teristics and evolution of mineral commodity prices. It also discusses IRs from SVAR and indicates the results of estimating IRFs by SVAR. Further it decomposes the responses of the policy interest rates to mineral-commodity price shocks and provides the outcome of a counterfactual analysis of holding policy interest rates in response to mineral-commodity price shocks.

2 Estimation and Inference

2.1 Data

Data on commodity prices are obtained from the Commodity Research Bureau (CRB). One of the most comprehensive commodity price indices is the CRB BLS spot index, which weights two types of indices: the CRB BLS foodstuff subindex and the raw industrials subindex.[2] The former includes butter, cocoa, corn, hogs, lard, soybeans, oil, steers, sugar, Minneapolis wheat and Kansas City wheat. The latter includes burlap, copper scrap, cotton hides, lead scrap, print cloth, rosin rubber, steer scrap, tallow, tin, wool and zinc. For oil prices, I use the West Texas Intermediate (WTI) spot oil price.

To motivate use of industrial mineral index in my analysis, I calculate the cross correlations with the oil price and the food price index. Table 1 shows cross correlations of log-differences of the industrial mineral index with those of the oil price and food index. The range of cross correlations between log-differences of the industrial mineral index and the oil price is between -0.03 and 0.19, implying that the relationship between changes in prices of industrial minerals and oil seems small. Moreover, the cross correlation between log-differences of the industrial mineral index and the food index is 0.25 at lag 0, implying that the change of the industrial mineral index appears to differ from the change of the spot index, weighting the raw industrials and foodstuff sub-indices almost equally. Thus, I focus on the mineral commodity prices in this paper because the evolution of mineral commodity

[2]For weights of each commodity, see the CRB's website at http://www.crbtrader.com.

price is quite different from that of both the oil price and the comprehensive commodity price index.

My empirical analysis is designed to explore the relationship between mineral commodity prices and monetary policy in the developed countries using SVAR. My data are monthly and span from January 1990 to June 2008. The benchmark SVAR model includes six variables: percent change in mineral commodity prices, percent change in oil prices, percent change in industrial production (IP), annual percent change in core CPIs, policy interest rates and percent change in nominal exchange rates in the US dollar (excluded for the US). The mineral commodity price index is the CRB BLS raw industrials subindex provided by the CRB. The oil price is the WTI spot oil price. The core CPIs are CPIs minus food and energy. I interpolate the quarterly IP and core CPIs of Australia and New Zealand to obtain the monthly data using linear interpolation.

The policy interest rates are Australia's cash rate, Canada's overnight rate, New Zealand's 90-day bank bill rate, the US federal funds rate and the UK repurchase rate.[3] I include exchange rates as determinants of mineral commodity prices following Chen, Rogoff, and Rossi (2010).[4] I log difference mineral commodity prices, oil prices, IP, core CPIs and exchange rates to obtain the percent changes, which is consistent with the prevailing view that price levels are I(1).[5] Hamilton and Herrera (2004) recommend four periods as the optimal lag when dealing with quarterly data. In the benchmark case, I employ SVAR with 12 lags and an intercept.[6]

I examine mineral-producing and non-mineral-resource countries because they seem to have different channels for transmitting mineral-commodity price shocks. Recall that mineral-commodity price shocks may affect macroeconomic indicators differently in the two types of countries. Mineral-producing countries produce industrial minerals as an output, so an increase in mineral commodity prices may increase exports, causing core CPI inflation variations. In contrast, non-mineral-resource countries consume industrial minerals as a production input, so an increase in mineral commodity prices may increase their core CPI inflation rates.

[3]The official bank rate of New Zealand is official cash rate. However, New Zealand introduced it on March, 1999. To obtain sufficient data for New Zealand, I alternatively use 90-day bank bill rate for New Zealand because the RBNZ shows that 90-day bank bill rate closely follows the official cash rate at the website: http://www.rbnz.govt.nz/monetary_policy/about_monetary_policy/0072140.html.

[4]Chen, Rogoff, and Rossi (2010) demonstrate that exchange rates of Australia, Canada and New Zealand are good regressors for commodity prices.

[5]The unit root test shows that the system is stationary.

[6]I computed Akaike's Information Criterion (AIC) from 0 lag to 24 lags. AIC of 12 lags is very close to the lowest AIC.

2.2 Methods

2.2.1 The benchmark SVAR model

My approach is to estimate IRFs using SVAR. I consider the following reduced form of a standard SVAR(p) model with an intercept:

$$y_t = A_0 + A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + u_t, \tag{1}$$

where $\Sigma_u = E[u_t u_t']$. y_t is a $K \times 1$ vector of dependent variables, and y_{t-i} for $i = 1, 2, \ldots, p$ is a $K \times 1$ vector of independent variables where K is the number of variables of interest. A_0 is a $K \times 1$ intercept vector, and A_i for $i = 1, 2, \ldots, p$ is a $K \times K$ matrix of coefficients.

To compute IRs of policy interest rates and core CPI inflation rates to mineral-commodity price shocks, I assume structural shocks based on the Cholesky decomposition. The ordering of variables is mineral commodity prices, oil prices, IP, core CPI inflation rates, policy interest rates and nominal exchange rates (excluded for the US).[7] I assume that policy interest rates do not affect mineral commodity prices, oil prices, IP and core CPI inflation rates contemporaneously. Instead of the traditional one-standard deviation shocks, I examine 10 percent mineral-commodity price shocks to the policy interest rates and the core CPI inflation rates.

To investigate the relationship between the policy interest rates and the core CPI inflation rates to mineral-commodity price shocks, I consider the following four hypotheses based on Evans and Fisher (2011).[8]

- *Weak central bank credibility hypothesis* (H1.1): If mineral commodity prices contribute significantly to core CPI inflation and the policy response is significantly positive but inadequate to control a core CPI variation by a positive mineral-commodity price shock, then the shock could trigger a change in the core CPI inflation rate.

- *Strong central bank credibility hypothesis* (H1.2): If mineral commodity prices significantly affect core CPI inflation and the policy response is both significantly positive and adequate to control a core CPI variation by a positive mineral-commodity price shock, then the shock could trigger an insignificant change in the core CPI inflation rate.

[7] The ordering of variables including comprehensive commodity prices, not mineral commodity prices, is the same as Kilian *et al.* (2011). As in their paper, I also assume that mineral commodity prices do not respond to the other shocks contemporaneously.

[8] Evans and Fisher (2011) propose three hypotheses of relationships between IRs of the federal funds rate and the core personal consumption expenditures (PCE) inflation rate in the US to commodity price shocks: weak central bank credibility hypothesis, strong central bank credibility hypothesis and a generally uninformative indicator hypothesis.

Table 2: Predicted responses of policy interest rates and core CPI inflation rates to positive mineral-commodity price shocks and the four hypotheses

Policy Interest Rate	**Core CPI Inflation Rate**	**Hypothesis**
positive response	sensitive response	Weak credibility hypothesis
positive response	insensitive response	Strong credibility hypothesis
weak response	sensitive response	Delinquency hypothesis
weak response	insensitive response	Uninformative hypothesis

- *Delinquency hypothesis* (H1.3): If mineral commodity prices significantly affect core CPI inflation but the central bank insignificantly responds to a positive mineral-commodity price shock, then the shock could trigger a change in the core CPI inflation rate.

- *A generally uninformative indicator hypothesis* (H1.4): If mineral commodity prices are truly uninformative for the policy interest rate and core CPI inflation, then the IRs of both the policy interest rate and the core CPI inflation rate to a positive mineral-commodity price shock would be insignificant.

The former three hypotheses surmise that mineral-commodity price shocks affect core CPI inflation in a structural manner. The last hypothesis surmises that an economy is somewhat immune to a mineral-commodity price shock.

Table 2 summarizes the predicted responses of policy interest rates and core CPI inflation rates to positive mineral-commodity price shocks and the four hypotheses. The criterion by which I classify the responses into one of the four hypotheses is whether policy interest rates and/or core CPI inflation rates respond positively to a positive shock to mineral commodity prices. If the policy interest rate responds to a positive shock to mineral commodity prices and the core CPI inflation rate responds positively, then I would accept H1.1. If the policy interest rate responds to a positive shock to mineral commodity prices and the core CPI inflation rate remains unchanged, I would accept H1.2. If the policy interest rate does not respond to a positive shock to mineral commodity prices and the core CPI inflation rate responds positively, I would accept H1.3. If neither the policy interest rates nor the core CPI inflation rate responds to a positive shock to mineral commodity prices, I would accept H1.4. The criterion of positive reactions on the part of the IRs of the policy interest rates and the core CPI inflation rates is measured by whether the 95 percent lower bands are positive for more than six months in total.

2.2.2 Response decompositions

Next I study if the examined central banks respond to mineral-commodity price shocks before or after core CPI inflation is increased by the shocks, that is, whether they take ex-ante policy or ex-post policy to stabilize the core CPIs.

I compute the contributions of each variable on the basis of the response decomposition for SVAR(p) with an intercept vector suggested by Kilian *et al.* (2011).[9] First, multiplying both sides of Eq.(1) by A yields

$$Ay_t = A_0^* + A_1^* y_{t-1} + A_2^* y_{t-2} + \cdots + A_p^* y_{t-p} + \epsilon_t, \tag{2}$$

where $\Sigma_\epsilon = A\Sigma_u A'$, which is a diagonal matrix with variances of variables of interest, and $A_i^* = AA_i$ for $i = 0, 1, 2, \ldots, p$ and $\epsilon_t = Au_t$. Adding $(I_K - A)y_t$ to both sides of Eq.(2) gives

$$y_t = A_0^* + Cy_t + A_1^* y_{t-1} + \cdots + A_p^* y_{t-p} + \epsilon_t, \tag{3}$$

where $C = I_K - A$, which is a $K \times K$ lower triangular matrix with zeros on the diagonal. Eq.(3) represents the structural form of SVAR(p) model with an intercept.

Define

$$B = [C \ A_1^* \ \ldots \ A_p^*]. \tag{4}$$

The contribution of variable i to the response of the policy interest rate at horizon h to a mineral-commodity price shock is given by

$$d_{\mathrm{PR},i,h} = \sum_{m=0}^{min(p,h)} B_{5,mK+i}\theta_{i,1,h-m}, \qquad h = 0, 1, 2, \ldots \tag{5}$$

where $\theta_{i,1,h-m}$ represents the $\{i, 1\}$ element of the $K \times K$ IR coefficient matrix at period $h-m$ for moving average representation, denoted by Θ_{h-m} as defined by Lütkepohl (2005). The sum of each contribution of variables, $\sum_{i=1}^{K} d_{\mathrm{PR},i,h}$ is an IR of the policy interest rate to a mineral-commodity price shock at horizon h. By comparing values of $d_{\mathrm{PR},i,h}$, I examine which variable is the main contributor of the policy responses to a mineral-commodity price shock.

I consider two types of policy responses for each central bank by focusing on the periods before and after a core CPI variation triggered by a mineral-commodity price shock.

[9] For simplicity, Kilian *et al.* (2011) decompose an IR of the federal funds rate in the SVAR(p) model "without" an intercept vector.

Table 3: Main contributors of impulse responses of the policy interest rates to mineral-commodity price shocks and the three hypotheses

Main Contributor	**Hypothesis**
COM or PR	Ex-ante policy response hypothesis
CPI inflation	Ex-post policy response hypothesis
OIL or IP or EX	Indifference hypothesis

NOTES: COM, PR, CPI inflation, OIL, IP and EX stand for mineral commodity prices, policy interest rates, core CPI inflation rates, oil prices, industrial production and exchange rates, respectively.

The first policy response is a preemptive move against potential inflationary pressures by adjusting the policy interest rate before any core CPI variation is triggered by the shock. If a central bank determines the policy interest rate by considering mainly a change in mineral commodity prices themselves and/or pressure to the policy interest rate, then it may change the policy interest rate before any core CPI variation triggered by a mineral-commodity price shock. The second policy response is to adjust the policy interest rate after a core CPI variation triggered by a mineral-commodity price shock. If a central bank determines the policy interest rate by mainly considering the core CPI variation, a change in the mineral commodity prices themselves would have no effect on its monetary policy. Here, I consider the following three hypotheses for possible policy responses to mineral-commodity price shocks.

- *Ex-ante policy response hypothesis* (H2.1): If a central bank mainly responds to a change in mineral commodity prices and/or pressure upon the policy interest rate triggered by a mineral-commodity price shock so as to control the core CPI variation, then the contributions of mineral commodity prices and/or the policy interest rate would be largest. (i.e., $d_{\text{PR,PR}}$ and/or $d_{\text{PR,COM}}$ would be the largest among the six variables of interest.)

- *Ex-post policy response hypothesis* (H2.2): If a central bank mainly responds to core CPI inflation triggered by a mineral-commodity price shock, then the contribution of core CPI inflation would be the largest. (i.e., $d_{\text{PR,CPI}}$ would be the largest among the six variables of interest.)

- *Indifference hypothesis* (H2.3): If a central bank responds mainly to changes in oil prices, IP and the exchange rate, then it may regard the core CPI inflation rate as an unimportant factor. (i.e., $d_{\text{PR,OIL}}$, $d_{\text{PR,IP}}$ and/or $d_{\text{PR,EX}}$ would be the largest among the six variables of interest.)

Table 3 summarizes main contributors of IRs of the policy interest rates to mineral-commodity price shocks and the three hypotheses. The criteria by which I classify the IRs into one of the three hypotheses are as follows. If mineral commodity prices and/or policy interest rates mainly contribute to the IRs of the policy interest rates to mineral-commodity price shocks, then I would accept H2.1. If core CPI inflation is the main contributor of IRs, then I would accept H2.2. Otherwise, I would accept H2.3.

2.2.3 Counterfactual analysis

Following the procedures of Kilian *et al.* (2011), I then examine what would occur if the examined central banks were to hold their policy interest rates in response to mineral-commodity price shocks. In other words, I explore the pure effects of mineral-commodity price shocks on core CPI inflation "without" the policy responses. My model includes policy interest rates as a policy variable of central banks; thus, I cannot investigate the pure effects of mineral-commodity price shocks on core CPI inflation because the policy responses may control a change in the core CPI inflation rates triggered by the shocks. Hence, I create a counterfactual based on BGW. The BGW-type counterfactual assumes that a central bank does not respond to all changes triggered by a mineral-commodity price shock, that is, it holds the policy interest rate in response to the shock; thus, considering the BGW-type counterfactual leads to computation of the pure effects of mineral-commodity price shocks on core CPI inflation.

The procedure of the counterfactual analysis consists of the following steps:

1. Set up initial values of variable j for a 10 percent mineral-commodity price shock, $x_{j,0}$, which are equal to the first column of the structural shocks by the Cholesky decomposition.

2. Compute the hypothetical shock of the policy interest rate that offsets its change triggered by the shock:
$$\epsilon_{\mathrm{PR},0} = -\sum_{j=1}^{K} B_{5,j} x_{j,0},$$
where K is the number of variables of interest in the model.

3. Compute the change of variable j, $z_{j,0}$ using the value of the hypothetical shock:
$$z_{j,0} = x_{j,0} + \frac{\theta_{j,5,0}\epsilon_{\mathrm{PR},0}}{\sigma_5},$$
where σ_5 is standard deviation of the policy interest rate.

4. Compute the contemporaneous response of variable j for $h > 0$, recursively, starting

with $i = 1$ from

$$x_{i,h} = \sum_{m=1}^{min(p,h)} \sum_{j=1}^{K} B_{5,mK+j} z_{j,h-m} + \sum_{j<i} B_{i,j} x_{j,h}, \qquad h = 1, 2, 3 \ldots \tag{6}$$

5. Compute the hypothetical shock of variable j.

$$\epsilon_{\mathrm{PR,h}} = -\sum_{j=1}^{K} B_{5,j} x_{j,h} - \sum_{m=1}^{min(p,h)} \sum_{j=1}^{K} B_{5,mK+j} z_{j,h-m}, \qquad h = 1, 2, 3 \ldots \tag{7}$$

6. Compute the change of variable j by the hypothetical shock:

$$z_{j,h} = x_{j,h} + \frac{\theta_{j,5,0} \epsilon_{\mathrm{PR},h}}{\sigma_5}, \qquad h = 1, 2, 3 \ldots \tag{8}$$

7. Repeat Steps 4 through 6.

By comparing the contemporaneous responses, $x_{j,h}$ in this counterfactual with the IRs in the unrestricted model, we can study the pure effects of mineral-commodity price shocks on core CPI inflation.

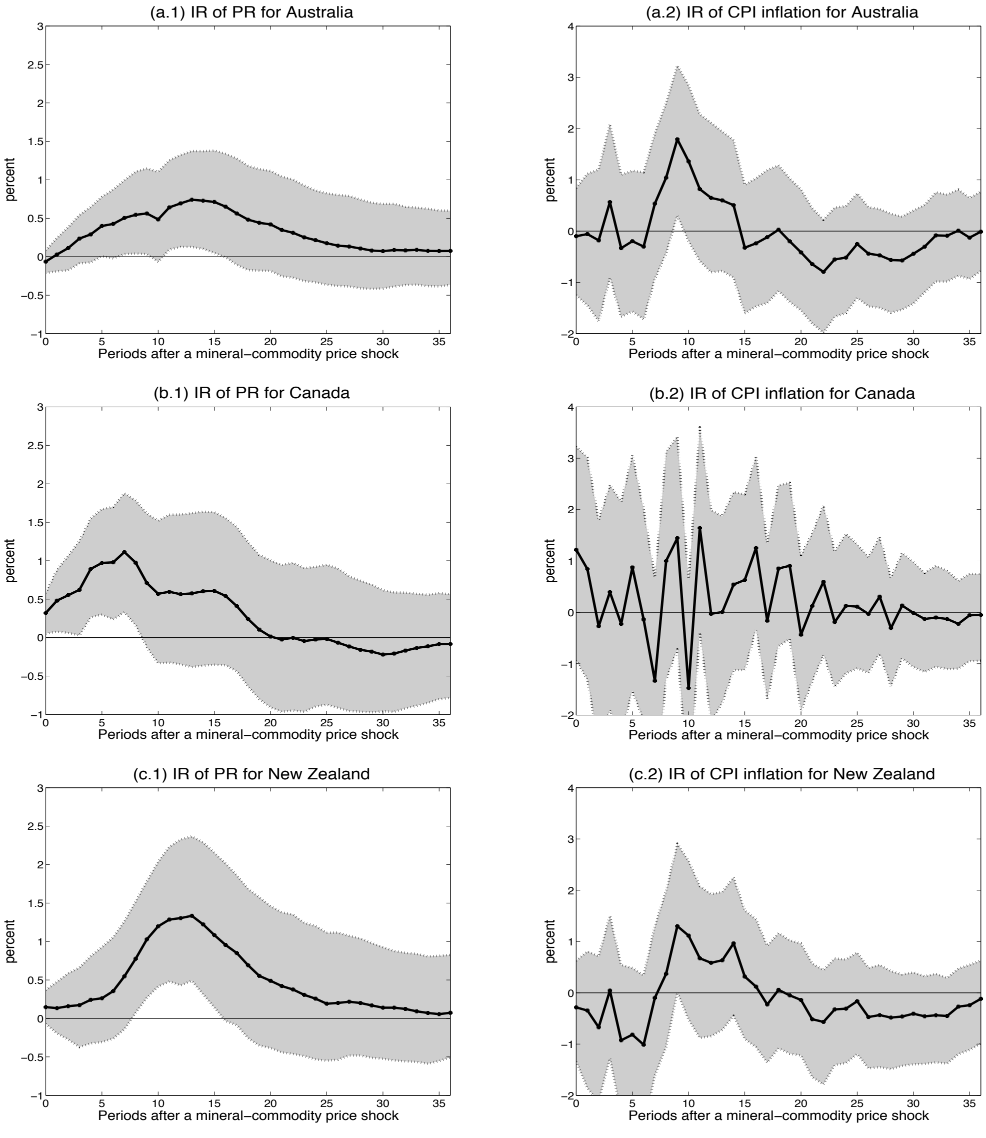
2.3 Results

2.3.1 Do central banks in the developed countries respond to mineral-commodity price shocks?

First, I question whether mineral-commodity price shocks affect core CPI inflation in developed countries; if so, whether the central banks control core CPI variations by adjusting their policy interest rates. To answer this question, I estimated the IRs of the policy interest rates and the core CPI inflation rates to mineral-commodity price shocks using SVAR.

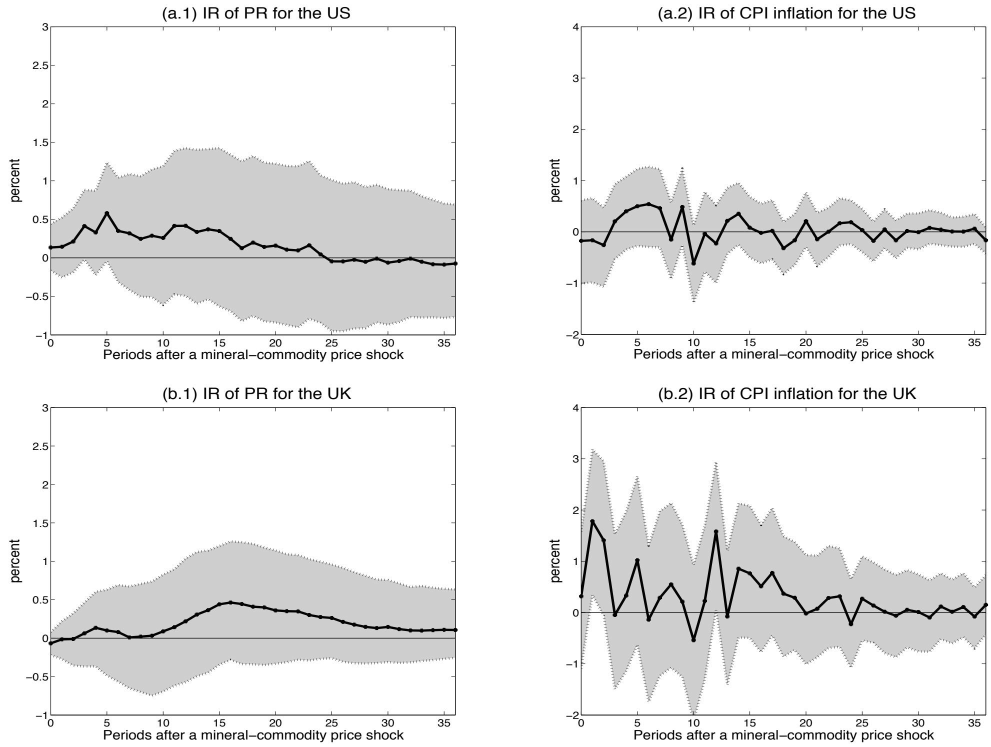
Figures 1 and 2 display responses of both policy interest rates and core CPI inflation rates to 10 percent mineral-commodity price shocks for Australia, Canada, New Zealand, the US and the UK, respectively. First of all, I shed light on the effects of mineral-commodity price shocks on monetary policy in the developed countries. Focusing on panels (a.1), (b.1) and (c.1) of Figure 1 and panels (a.1) and (b.1) of Figure 2, I find that, all of the three central banks in the mineral-producing countries significantly respond to mineral-commodity price shocks because the 95 percent lower bands remain positive for more than six months in total. The maximum magnitude of the policy responses of the central banks of the examined mineral-producing countries is 0.75 percent for the RBA, 1.10 percent for the BOC and 1.32 percent for the RBNZ. In contrast, the Federal Reserve and the BOE insignificantly respond to mineral-commodity price shocks.

Figure 1: Impulse responses of the policy interest rates and the core CPI inflation rates to 10 percent mineral-commodity price shocks for the mineral-producing countries



NOTES: IR, PR and CPI inflation stand for impulse responses, policy interest rates and core CPI inflation rates, respectively. The shaded areas represent the 95 percent confidence intervals.

Figure 2: Impulse responses of the policy interest rates and the core CPI inflation rates to 10 percent mineral-commodity price shocks for the non-mineral-resource countries



NOTES: IR, PR and CPI inflation stand for impulse responses, policy interest rates and core CPI inflation rates, respectively. The shaded areas represent the 95 percent confidence intervals.

Table 4: Impulse responses of the policy interest rates and the core CPI inflation rates to mineral-commodity price shocks and classification into one of the four hypotheses based on the IRs' results

	AUS	**CAN**	**NZ**	**US**	**UK**
Policy Interest Rate	Positive	Positive	Positive	Weak	Weak
Core CPI Inflation Rate	Weak	Weak	Weak	Weak	Weak
Hypothesis	H1.2	H1.2	H1.2	H1.4	H1.4

NOTES: "Positive" represents the scenario in which the 95 percent lower bands are positive for more than six months. "Weak" represents the situation in which the 95 percent lower bands are not positive for more than six months. H1.1=Weak central bank credibility hypothesis; H1.2=Strong central bank credibility hypothesis; H1.3=Delinquency hypothesis; H1.4=A generally uninformative indicator hypothesis.

Next, I focus on the effects of mineral-commodity price shocks on core CPI inflation paying attention to the effects of the shocks on the policy interest rates. That core CPI inflation rates' weak responses to mineral-commodity price shocks do not necessarily mean that the shocks have no effect on core CPI inflation because a central bank may control any core CPI variation by adjusting its policy interest rate. Panels (a.2), (b.2) and (c.2) of Figure 1 and panels (a.2) and (b.2) of Figure 2 show IRs of the core CPI inflation rates to 10 percent mineral-commodity price shocks. In all of the mineral-producing countries, I found no significant evidence that mineral-commodity price shocks have impacts upon core CPI variations as a result of the central bank's policy responses. Moreover, the results of the non-mineral-resource countries indicate insignificant relationships between mineral-commodity price shocks and core CPI inflation.

Taking both the IRs of the policy interest rates together with the core CPI inflation rates into consideration, the RBA, the BOC and the RBNZ, as the examined central banks in the mineral-producing countries, seem to attain price stability by responding to mineral-commodity price shocks. However, I cannot find evidence that the Federal Reserve and the BOE respond to mineral-commodity price shocks because such price shocks have little impact on core CPI inflation in the US and the UK.

Table 4 displays results of the classification into the four hypotheses. First, focusing on the mineral-producing countries, adequate policy responses of the RBA, the BOC and the RBNZ, and insensitive core CPI inflation rates' responses to mineral-commodity price shocks all support H1.2. Next, I focus on the non-mineral-resource countries. Due to the minor effect of mineral-commodity price shocks on core CPI inflation, the Federal Reserve and the BOE do not respond to such shocks. The weak reactions of the Federal Reserve and the BOE together with inadequate core CPI variations support H1.4. Overall, the three central banks in the mineral-producing countries – with the exceptions of the Federal Reserve and the BOE as central banks in the examined non-mineral-resource countries – significantly respond to mineral-commodity price shocks that seem to trigger changes in

Table 5: Robustness check for the impulse responses of policy interest rates and core CPI inflation rates to positive mineral-commodity price shocks for the benchmark SVAR model (policy interest rates/core CPI inflation rates)

Specification	**AUS**	**CAN**	**NZ**	**US**	**UK**
1	P/W	P/W	P/W	W/W	W/W
2	P/W	P/W	P/W	W/W	W/W
3	P/W	P/W	P/W	-	W/W
4	P/W	P/W	P/W	W/W	W/W
5	P/W	P/W	P/W	W/W	W/W
6	P/W	P/W	P/W	-	W/W

NOTES: Specification 1 denotes the benchmark estimation with six variables (five variables for the US). Specification 2 replaces the CRB raw industrials subindex in Specification 1 with the mineral price index provided by International Monetary Fund. Specification 3 replaces nominal exchange rates in Specification 1 with effective exchange rates. Specifications 4, 5 and 6 exclude oil prices, IP or nominal exchange rates from Specification 1, respectively. "P" represents the scenario in which the 95 percent lower bands are positive for more than six months. "W" represents the situation in which the 95 percent lower bands are not positive for more than six months.

their core CPI inflation rates. Hamilton (2011), Kilian *et al.* (2011), and Evans and Fisher (2011) report that the Federal Reserve has not responded to oil price and comprehensive commodity price shocks since the mid-1980s because of the minor effects of the shocks on core CPI inflation. My results show that, for the same reason, the Federal Reserve also does not respond to mineral-commodity price shocks. However, mineral-commodity price shocks seem to affect central banks' monetary policy in the mineral-producing countries. Thus, mineral commodity prices appear to be important determinants of the monetary policies in the mineral-producing countries. My results imply that, as Stevens (2008) expressed, in the examined mineral-producing countries, concerns on an increase in core CPI inflation by mineral-commodity price increases seem to affect the monetary policies of the central banks, whereas the central banks in the examined non-mineral-resource countries need not pay special attention to mineral-commodity price increases because, as Bernanke (2011) and Yellen (2011) stated, the effects of the increases are weak.

To check robustness for the benchmark SVAR model, I changed model's variables as follows. Specification 1 denotes the benchmark estimation with six variables (five variables for the US). Specification 2 replaces the CRB BLS raw industrials subindex in Specification 1 with the mineral price index provided by International Monetary Fund. Specification 3 replaces nominal exchange rates in Specification 1 with effective exchange rates. Specifications 4, 5 and 6 exclude oil prices, IP or nominal exchange rates from Specification 1, respectively. Table 5 shows the results of robustness for policy responses by the examined central banks to mineral-commodity price shocks for the benchmark SVAR model. The result of Specification 1, which is the benchmark model, is the same as those of the other specifications. Thus, the benchmark model can be considered robust.

Table 6: Decompositions of responses of the policy interest rates to mineral-commodity price shocks and classification into one of the three hypotheses based on the results of the response decomposition

	AUS	**CAN**	**NZ**
Contributor	policy interest rate	policy interest rate	policy interest rate
Hypothesis	H2.1	H2.1	H2.1

NOTES: The results are based on the most influential contributor for each country. H2.1=Ex-ante policy response hypothesis; H2.2=Ex-post policy response hypothesis; H2.3=Indifference hypothesis.

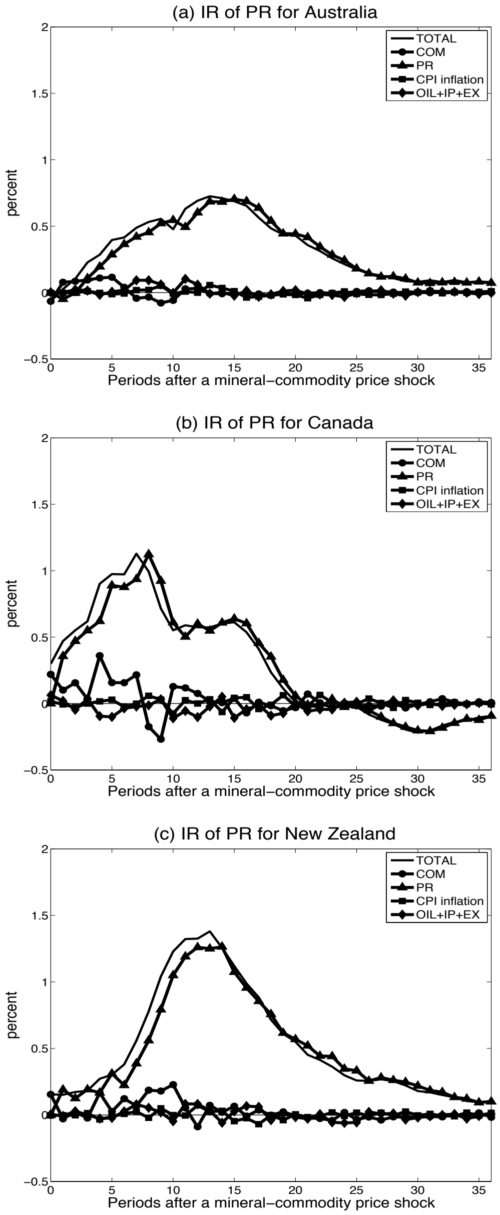
2.3.2 Do the central banks respond to mineral-commodity price shocks before or after core CPI variations triggered by the shocks?

In the previous subsubsection, I showed that the central banks in the mineral-producing countries significantly respond to mineral-commodity price shocks. Next, I question whether they respond to mineral-commodity price shocks before or after core CPI variations triggered by these shocks. To identify the main contributors of the policy responses to mineral-commodity price shocks, I decompose the policy interest rates responses to the shocks.

Figure 3 shows the results of the decompositions of responses of the policy interest rates to mineral-commodity price shocks. Panels (a), (b) and (c) of the figure plot contributions from the three types of policy responses: ex-ante policy responses (COM plus PR), ex-post policy responses (CPI inflation) and indifference policy responses (OIL plus IP plus EX). Total effects, which represent the IRs of the policy interest rates to mineral-commodity price shocks, are also displayed in each panel. The shocks' total effects on the policy interest rates can be computed by summing the six contributions in the vertical direction at each horizon.

Table 6 summarizes the response decompositions, which show the main contributors of the policy responses to mineral-commodity price shocks for the examined mineral-producing countries. The results show that, among the six contributors of the policy responses to mineral-commodity price shocks, policy interest rates are the most influential factors for all the mineral-producing countries. Thus, the policy responses of the RBA, the BOC and the RBNZ support H2.1. All central banks in the examined mineral-producing countries that respond to mineral-commodity price shocks do so directly through pressure in changes to their policy interest rates. The results of the response decompositions suggest that all examined central banks in the mineral-producing countries increase their policy interest rates before core CPI variations triggered by mineral-commodity price shocks. In other words, the central banks seem to respond to mineral-commodity price shocks in expectation of core CPI variations triggered by the shocks. Kilian *et al.* (2011) demonstrate that the Federal Reserve, which responded to oil price shocks during the mid-1960s and the mid-1980s, might take preemptive policy reactions against potential inflationary pressures. In

Figure 3: Response decompositions of policy interest rates to mineral-commodity price shocks for the mineral-producing countries



NOTES: The panels show decompositions of the responses of the policy interest rates to 10 percent mineral-commodity price shocks for the mineral-producing counties. COM, CPI inflation, PR, OIL, IP and EX stand for mineral commodity prices, core CPI inflation rates, policy interest rates, oil prices, industrial production and exchange rates, respectively. TOTAL stands for the sum of the contributions of the six variables in the vertical direction, which equals to the policy interest rates' impulse responses to 10 percent mineral-commodity price shocks. IR stands for impulse responses.

addition, Romer and Romer (2004) show that the Federal Reserve took preemptive policy reactions to stabilize the core CPI during the late 1960s and the mid-1990s. The RBA, the BOC and the RBNZ also appear to take anticipatory policy reactions so as to control core CPI variations induced by mineral-commodity price shocks.

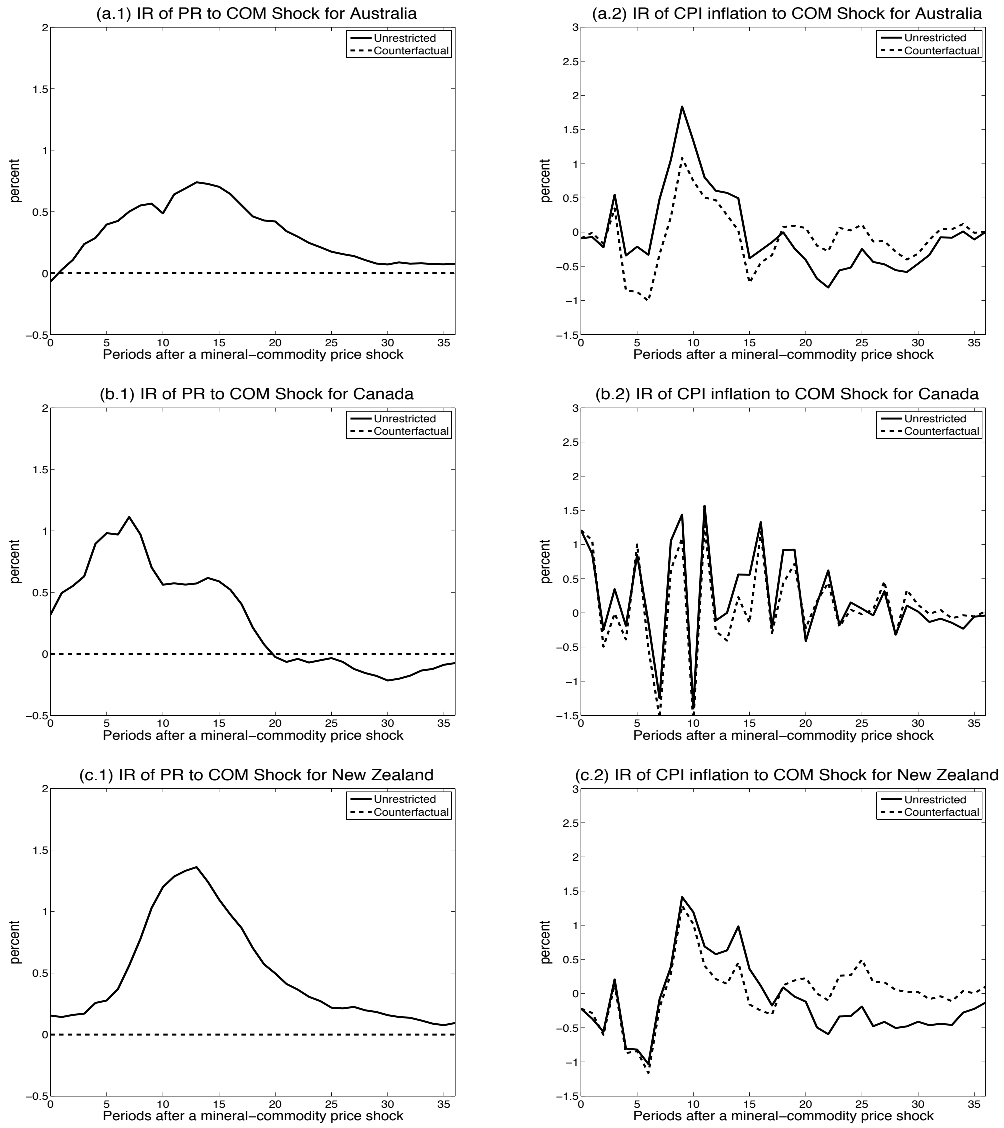
2.3.3 If the central banks were to their policy interest rates in response to mineral-commodity price shocks, how large would the effects of the shocks be on core CPI inflation?

The above two subsubsections demonstrate that three of the five examined central banks, except for the Federal Reserve and the BOE, respond to mineral-commodity price shocks and their policy responses are dominated by direct responses to these shocks. Recall that an IR analysis in my model cannot show the pure effects of mineral-commodity price shocks because the policy responses may control core CPI variations triggered by the shocks. To investigate the pure effects, I create a counterfactual based on BGW, which assumes that a central bank holds the policy interest rate in response to such a shock.

Figure 4 displays results of the BGW-type counterfactual comparing unrestricted IRs for the mineral-producing countries. Panel (b) of the figure shows that, under the BGW-type counterfactual, the IR of the core CPI inflation rate for Canada is almost the same in comparison with the IR obtained in the unrestricted model. This implies that holding the policy interest rate in response to a mineral-commodity price shock would not increase the core CPI inflation rate in Canada. In contrast, panels (a) and (c) of the figure show that such counterfactual policy responses for Australia and New Zealand would increase their core CPI inflation rates even after 18 periods.

If the RBA and the RBNZ were to hold their policy interest rates in response to mineral-commodity price shocks, these shocks would have more persistent effects on core CPI inflation in those countries. Hence, we could say that the policy responses of the RBA and the RBNZ may control core CPI variations by mineral-commodity price shocks. Kilian *et al.* (2011) demonstrate that, even if the Federal Reserve had not responded to oil price shocks during the period from the mid-1960s to the mid-1980s, the counterfactual policy response would not have caused an increase in the core CPI inflation rate in the US. My result of the counterfactual responses of the BOC is consistent with that of the Federal Reserve during the period between the mid-1960s and the mid-1980s, whereas those of the RBA and the RBNZ are not.

Figure 4: Counterfactual analysis of holding policy interest rates in response to mineral-commodity price shocks for the mineral-producing countries



NOTES: The panels show IRs of the policy interest rates and the core CPI inflation rates to 10 percent mineral-commodity price shocks for the mineral-producing countries. IR, PR, CPI inflation and COM stand for impulse responses, policy interest rates, core CPI inflation rates and mineral commodity prices, respectively.

3 Conclusion

This paper investigated effects of mineral-commodity price shocks on monetary policy in five developed countries: Australia, Canada and New Zealand (mineral-producing countries), and the US and the UK (non-mineral-resource countries). My findings are as follows. First, mineral-commodity price shocks significantly affect monetary policy of the central banks in the mineral-producing countries. I find that, in response to an unexpected 10 percent increase in mineral commodity prices, these countries' central banks are estimated to increase their policy interest rates by approximately one percentage point. In contrast, the central banks in the non-mineral-resource countries insignificantly respond to mineral-commodity price shocks. Second, the central banks in these mineral-producing countries seem to respond to mineral-commodity price shocks before core CPI inflation is increased by these shocks. In other words, the central banks may take anticipatory policy reactions to stabilize the core CPIs. Thus, mineral commodity prices appear to be important determinants of the monetary policies in the examined mineral-producing countries. Third, I show that, if the RBA and the RBNZ were to hold their policy interest rates in response to mineral-commodity price shocks, these shocks would have more persistent effects on core CPI inflation in those countries. However, such a counterfactual policy response of the BOC would not increase the core CPI inflation rate in that country.

This paper does not have a theoretical model that explains mineral commodity prices. So building a theory of mineral commodity prices for mineral-producing and non-mineral-resource countries remains for future research. Moreover, I could study further relationships between mineral commodity prices and monetary policy in developed countries. It is possible that core CPI variations may be influenced mainly by a net increase in mineral commodity prices, as discussed by Hamilton (2011), who reported that in the US, a net oil price increase affected core CPI variations in the pre-Volcker period.

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Appendix: Data Sources

The data used in this study are as follows:

- **Commodity Prices:** Commodity Research Bureau (CRB). Raw Industrials Subindex, which is one factor of the CRB BLS Spot Price Index. In this paper, I use the values given in the Raw Industrials Subindex as commodity prices, seasonally adjusted using X12. For robustness check, I use the Mineral Price Index (seasonally adjusted using X12) provided by International Monetary Fund.

- **Oil Prices:** Federal Reserve Economic Data (FRED). West Texas Intermediate (WTI) spot oil price and seasonally adjusted using X12.

- **Exchange Rates:** FRED. US Dollar/Australian Dollar for Australia, US Dollar/-Canadian Dollar for Canada, US Dollar/New Zealand Dollar for New Zealand and US Dollar/Pound Sterling for the UK.

- **Effective Exchange Rates:** FRED. Real Effective Exchange Rates Based on Manufacturing Consumer Price Index for all of the examined countries except for the US.

- **Industrial Production Index:** FRED. Industrial Production Index for the US, and Production of Total Industry for the other countries and seasonally adjusted using X12.

- **Consumer Price Index:** FRED. Consumer Price Index for All Urban Consumers: All Items Less Food and Energy for the US, and Consumer Price Index: All Items Less Food and Energy for the other countries.

- **Policy Interest Rates (Short-Term Interest Rates):** FRED. Cash Rate for Australia, Overnight Rate for Canada, 90-day Bank Bill Rate for New Zealand, Federal Funds Rate for the US and Repurchase Rate for the UK.