



Industrial transmission effect of international metal price shocks in perspective of industry chain

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Abstract: Based on a new perspective of industry chain and selecting monthly data from February 2006 to December 2015, this paper chooses eight Chinese industrial sectors to construct a SVAR model reflecting internal relationships among metal chains, analyzes the direct effects and indirect effects of international metal prices on output of various links in metal chains, then it investigates the main transmission path of international metal price shocks through decomposing the inflation pressure sources in metal chains. The results show that international metal price shocks not only affect industrial output in a direct way, but also indirectly affect the growth of output through the increased pressure on industrial inflation and then triggering a tightening of monetary policy implementation. Affected by factors such as the lack of market demand and the price transmission mechanism blocking, the direct effects of international metal price shocks mainly impact the upstream and midstream industry, while the downstream industry is mainly affected by indirect effects; in addition, the international metal price shocks have spillover effects on the industrial inflation, and transmit along the industry chain from upstream to downstream, and their strength weakens in sequence.

Key words: international metal prices; industry chain; SVAR model; transmission effect

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1 Introduction

Metal resources are important material bases in the construction of national economy [1–3]. As the second largest economy in the world, China's rapid development is supported by the consumption of staple commodities such as metals. In 2015, the total production of 10 main nonferrous metals (copper, aluminum, lead, zinc, nickel, tin, antimony, mercury, magnesium and titanium) was 51.56×10^6 t,

and the apparent consumption of these nonferrous metals was a total of 55.60×10^6 t [4]. China has already been the largest production and consumption country of nonferrous metals in a continuous 13 years in the world. As a super-country of metal production and consumption, China naturally aspires international metal prices to remain stable, while in reality, nonferrous metal resources are limited, and the demand of nonferrous metals changes rapidly. Especially with the increasingly apparent financialization trend of

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staple commodities in recent years, speculative behaviors and price manipulation in the process of financialization lead to the distortion of nonferrous metal supply and demand. Spurt and collapse in metal prices has become a new phenomenon in global metal markets. Though China has long implemented the strategy of taking full advantage of “home and overseas resources and markets”, which relieves the bottleneck problem of metal resources supply shortage to some extent, it contributes to high external dependence on major metal resources. Under the high dependence, due to the internationalization of metal resource markets, fluctuations of international metal prices will directly influence the cost of relative industries in China, which takes metals as major raw materials through the function of price transmission mechanism. However, such impact is not equably distributed to each sector in industrial systems and it gradually transmits to other sectors from interrelated industry chains, and ultimately influences the gross output and price level. Hence, under such background, deeply analyzing the effects of international metal price shocks on China’s industries, especially clarifying the interrelations and main transmission path between industrial prices from a perspective of industry chain has great practical significances to effectively avoid imported risk of prices, adjust and optimize the industrial structure, and then ensure the steady growth of the economy and insure economic security in China’s “new normal” economy.

From the existing literatures, scholars studied the price shocks transmission mechanism of staple commodities mainly from the perspective of macro-economy or industries. At the macroeconomic level, the focus of researches are mainly on the effects of price shocks on a country’s economic growth and inflation. For example, HAMILTON [5] firstly applied VAR model to test the relationship between international oil prices and American GNP, and the results showed that international oil prices will negatively affect economic growth. The study of CUNADO et al [6] focused on the influences of oil price shocks on industrial output and CPI in 14 European countries. WU et al [7], CAO [8], ZHAO et al [9] and WEI et al [10] have studied the impacts of oil price shocks on China’s macro-economy. AHMED et al [11] concluded that each country in a study group responded differently to oil price

shocks. Given the important role of coal in the production and consumption structure of primary energy, DING et al [12] studied the effect of coal price fluctuations on China’s GDP, and found that coal price fluctuations had relatively negative effects in the short term, while had positive effects in the long term. Besides, some scholars decomposed price shocks of staple commodities into supply shocks, aggregate demand shocks and specific demand shocks, and then did research on the influence of different types shocks on macro-economy. For instance, KILIAN [13] figured out that oil prices increased by demand shocks have greater effects on American GDP and inflation than by supply shocks. LIPPI et al [14] discovered that domestic demand shocks in America could explain 20% of oil prices change; the increase in oil price led by the decrease in oil supply reduced domestic output, and the increase in oil price caused by the increase in aggregate demand had positive and continuous influence on GDP. HOU et al [15] found that the increase in oil prices pushed by oil supply shocks and preventive demand shocks was negatively related to China’s economic growth, while economic demand shocks can promote economic growth. CUNADO et al [16] pointed out that oil supply shocks had less impacts on four major energy consuming countries in Asia (Japan, South Korea, India and Indonesia) and demand shocks were positively related to the economy of these countries. SEK et al [17] noted that oil supply shocks could be a determinant to inflation in oil importing countries but oil demand shocks had very limited effects on explaining inflation in most countries. CROSS et al [18] concluded that oil supply shocks and oil-specific demand shocks generally produced negative effects on China’s GDP growth while oil demand shocks had positive effects.

Because there are differences in industrial structures, production technologies and consumption habits among various industries, many scholars found out that price shocks arose by staple commodities have industrial differences. Thus, in recent years, a number of scholars have done relative researches from a perspective of sub-sectors. The study of LEE et al [19] showed that when oil prices went up, output prices of some industries would be pushed up; while in other industries,

output prices would go down. JIMENEZ [20] did an empirical research on six OECD countries, whose results also verified that the influences of oil price shocks were different in various industries. LIU et al [21] pointed out that price fluctuations of international crude oil had significant impacts on high energy-consuming industries. QIAN et al [22] discovered that the effects of oil prices shocks on upstream industries mainly manifested as cost effects, while downstream industries were mainly affected by demand shocks. TAN et al [23] investigated how structural shocks of oil price fluctuations from 1998 to 2015 affected China's industrial sectors, and the results of this study showed that oil price fluctuations were arose by specific demands and aggregate demands in economy, and supply factors had less effects than them. TSAI [24] put forward that stock returns of manufacturing industries with high energy intensity were affected more than those with lower energy intensity after the international financial crisis in 2008. SU et al [25] applied GVAR model to analyze short-term effects of price shocks of external resources on output and prices of industrial sectors, the results showed that influences of crude oil price shocks concentrated on energy, chemical and basic raw material sectors, and influences of price shocks of international industrial raw materials concentrated on metallurgical industries and the key industries in national economy. Using the linear and nonlinear autoregressive distributed lag (ARDL) models, SEK [26] showed that the impact of oil prices on PPI may vary across sectors.

Though the effect of commodity price shocks has been discussed extensively, there are some shortcomings in the previous studies. Firstly, limited by the high dependence of China's economy on energy resources (such as coal and oil), recent researches mainly focus on effects of international staple commodities like coal and oil on China's macro-economy. But studies about relationships between nonferrous metal resources and macro-economy are rarely to be seen [27]. Secondly, existing researches particularly emphasized on the impacts of price fluctuations of staple commodities on macro-economy and sub-sectors, without analyzing with specific industry chains of staple commodities, so problems like what are the differences in influences of price shocks of staple commodities on various links in industrial chains

and transmission mechanisms are still remain to be solved. Last but not least, existing researches mainly concentrate on the direct effects of economic growth or inflation, without considering indirect effects caused by staple commodities through monetary policies, that is to say, there are lack of comprehensive studies and dynamic analyses on the effects of price shocks. In order to make up for above deficiencies, this paper takes metal resources as its research object from a new perspective of industry chains, and chooses eight industries in China to establish a SVAR model to reflect the interrelations in metal industry chains. Besides, this paper not only tries to build a research framework to analyze the effects of international metal price shocks on output and prices of each link in China's metal industry chains, but also does comparative analysis on the direct and indirect effects of international metal price shocks.

2 Transmission mechanism of international metal price shocks

Metal resources are important basic raw materials for industries, and price changes of metal resources have double effects on output, as shown in Figure 1.

On one hand, international metal price shocks will raise the production costs, which will lead to the reduction in factor inputs of short term and then trigger drops in outputs and rises in prices, which is the direct effect. Such cost pressure is transmitted along industry chains. Cost pressure faced by upstream industries will gradually be transmitted to downstream industries by increasing prices of finished products. Figure 2 shows a complete metal industry chain which begins with inputs of metal raw materials, and metal price shocks are also gradually transmitted along industry chains like this. Following SUN et al [28] and WU [29], we divide industries into three kinds according to product features and the position of different industries.

Upstream industries mainly are mining industries, which provide resource products, including ferrous metal mining industries, nonferrous metal mining industries, etc.

Midstream industries mainly are smelting and processing industries, which provide intermediate products, including ferrous metal smelting and

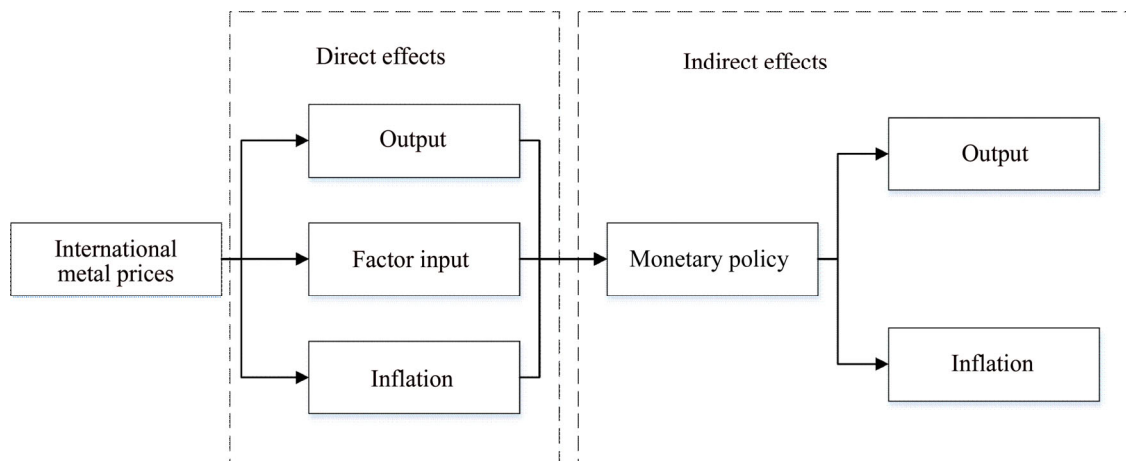


Figure 1 Double effects of international metal price shocks

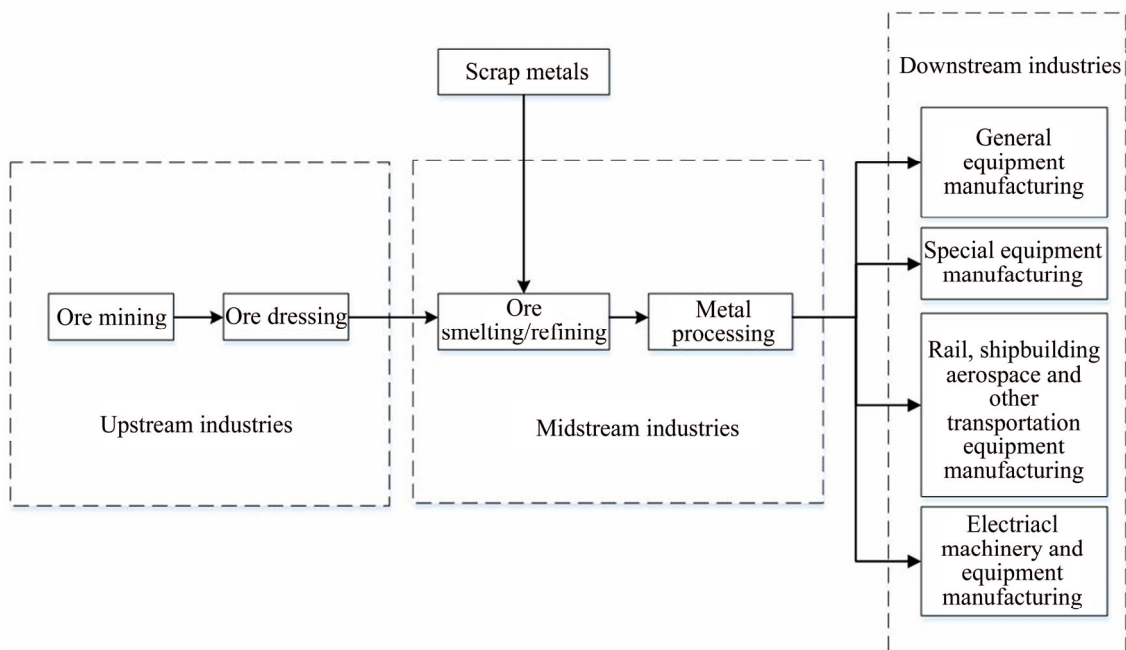


Figure 2 A sketch of metal industry chain

rolling processing industry, nonferrous metal smelting and rolling processing industry, etc.

Downstream industries mainly are final consumer industries of metal, which produce final consumer products, including general equipment manufacturing, special equipment manufacturing, rail, shipbuilding, aerospace and other transportation equipment manufacturing, electrical machinery and equipment manufacturing, etc.

On the other hand, decrease in factor inputs and increase in price level will push the monetary policy change of monetary authority, and then cause a second round change in output and price level, which is the indirect effect [30, 31]. According to the results by SEGAL [32] and TANG

et al [33], the indirect effect of metal price fluctuations via monetary policies mainly manifests in two aspects: first, rise in metal prices leads to inflation, and the reduction of real money balances, which arise the real interest rates, and then negatively impact the output. Second, the tight monetary policies carried out to curb inflation further amplify the effect of metal price shocks on output.

In a mature and free market, cost shocks can be smoothly transmitted along industry chains. And prices of raw materials, intermediate products and final consumer products will rise evenly. Because producers and consumers share the pressure caused by cost increase, the profit rate of a single industry

is not significantly affected [22, 34]. Limitations on price regulations and lack of domestic demand both lead to viscous price adjustments, and transmission delay is different in various links in an industry chain. Additionally, other factors such as inelastic monetary policy will also lead to the indirect effects of different links in the metal industry chain. Hence, analyzing the position of each industry in an industry chain, and the dependency level of each industry is important to study industrial differences of international metal price shocks, and then induct and reveal transmission mechanisms of international metal price shocks in different industries.

3 Construction and estimation of SVAR model

In the existing related researches, the vector autoregressive model (VAR) has been widely used by scholars, but it has limitations such as not considering economic theory and being unable to describe current correlations. For this reason, SIMS [35] and BERNANKE [36] advanced VAR model and put forward structural vector auto regression model (SVAR) which included current effects of variables. Based on the existing economic theory, the SVAR model can establish the current correlation between variables, which can effectively identify the intrinsic structural errors. Furthermore, it can simplify model parameter estimation and reduce the loss of degrees of freedom by imposing constraints on the contemporaneous relationship matrix. Compared with the VAR model, it can more accurately describe the dynamic impact of international metal price shocks and is more in line with economic reality. Since the SVAR model is based on the VAR model, we first construct a VAR model:

$$y_t = \phi_1 y_{t-1} + \cdots + \phi_p y_{t-p} + e_t \quad (1)$$

where y_t is the endogenous vector; p is the lag order; e_t is disturbance item and $\phi_1, \cdots, \phi_p$ are the parameter matrix to be estimated.

Next, according to TANG et al [33], LIU et al [37], we establish a SVAR model concluding four endogenous variables: international metal price, industrial output, industrial PPI and interest rate. The SVAR model including the above four variables is:

$$Ay_t = \phi_1 y_{t-1} + \cdots + \phi_p y_{t-p} + \varepsilon_t \quad (2)$$

where $y_t = (P_{\text{METAL}}, C_{\text{IAV}}, C_{\text{PPI}}, C_{\text{IR}})$; P_{METAL} is the international metal price; C_{IAV} is the year-on-year growth rate of China's industrial added value; C_{PPI} is the producer price index; C_{IR} is the interest rate; ε_t is the white noise vector; A is the contemporaneous correlation matrix of endogenous variables. The primary step of SVAR model is to identify the contemporaneous correlation matrix of endogenous variables A , and then premultiply both sides of Eq. (1) with A to obtain:

$$Ay_t = A\phi_1 y_{t-1} + \cdots + A\phi_p y_{t-p} + Ae_t \quad (3)$$

Compare Eq. (2) with Eq. (1) to obtain:

$$Ae_t = \varepsilon_t \quad (4)$$

Orthonormalizing ε_t into $\varepsilon_t = Bu_t$, the estimation model of SVAR can be written as:

$$Ae_t = Bu_t \quad (5)$$

Equation (5) is called SVAR-AB model, where $E(u_t u_t') = I$ (u_t is a structural shock vector). Constraints need to be put on matrix A to ensure the identification of the SVAR model, and for a SVAR-AB model with k variables, $k(k-1)/2$ constraints should be put on matrix A to justly identify the model. After identifying matrix A , relationships among other coefficient matrixes can be obtained.

This paper chooses short-term constraints and puts $4 \times (4-1)/2 = 6$ constraints. Thus, this paper puts forward the following hypothesis: 1) changes of current international metal prices will not be influenced by any other variables, that is to say $a_{12} = a_{13} = a_{14} = 0$; 2) current output will not be influenced by other current variables except current international metal prices, which means that effects of inflation and interest rate on output are lagging, that is to say $a_{23} = a_{24} = 0$; 3) current inflation can only be influenced by international metal prices and output in the same period, that is to say $a_{34} = 0$; 4) current interest rate is jointly influenced by international metal prices, output and producer price index. But what should be noticed is that the hypothesis can only be applied in current period, and it doesn't mean that subsequent variables will not affect variables above-mentioned in the long run. Through the hypothesis above, estimation of Eq. (5) can be written as:

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 \\ a_{41} & a_{42} & a_{43} & 1 \end{pmatrix} \begin{pmatrix} e_{P_{\text{METAL}}} \\ e_{C_{\text{IAV}}} \\ e_{C_{\text{PPI}}} \\ e_{C_{\text{IR}}} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 \\ 0 & 0 & b_{33} & 0 \\ 0 & 0 & 0 & b_{44} \end{pmatrix} \begin{pmatrix} u_{P_{\text{METAL}}} \\ u_{C_{\text{IAV}}} \\ u_{C_{\text{PPI}}} \\ u_{C_{\text{IR}}} \end{pmatrix} \quad (6)$$

4 Empirical results and discussions

4.1 Data specifications

The CRB index is a commodity futures price index calculated by Commodity Research Bureau, which is composed of future contracts of energy, metal, agricultural products, animal by-products, soft commodities and other commodities. It is an important reference indicator of international commodity price fluctuations. This paper selects the CRB metal index to measure international metal prices and denotes it as P_{METAL} . According to the analysis above, metal industry chains include metal mining industries in the upstream industries, smelting and processing industries in the midstream industries and final consumption commodities industries like electronic, equipment manufacturing, transportation industries in the downstream industries. Hence, in order to select data about output and price of metal industry chains, this paper firstly defines the upstream, midstream and downstream industries in metal industry chains. Following SUN et al [28], upstream industries include ferrous metal mining industries (M3) and nonferrous metal industries (M4); midstream industries include ferrous metal smelting and rolling processing industries (M24) and nonferrous metal smelting and rolling processing industries (M25); downstream industries include general equipment manufacturing (M27), special equipment manufacturing (M28), rail, shipbuilding, aerospace and other transportation equipment manufacturing (M29) and electrical machinery and equipment manufacturing (M30). Then we use year-on-year growth rate of industrial added value (C_{IAV}) and producer price index (C_{PPI}) as the measure of industrial output and price of these 8 industries, respectively, while interest rate is indicated by weighted average interest rates of the 7-date

interbank rates. All data are monthly data obtained from Wind database, and the sample interval ranges from February 2006 to December 2015. The empirical analysis of SVAR model requires variables to be stationary time series. The unit root test of these variables shows that the original sequences of C_{IAV} , C_{PPI} and C_{IR} are stationary, while the first-order difference of P_{METAL} is stationary.

4.2 Impulse response analysis

Before establishing the SVAR model, the optimal lagged period should be determined. In general, differences in optimal lagged period will impact the results. We establish the SVAR model whose lag length is set to 2 based on Akaike's information criterion (AIC). Then we test its stability, and the results show that the absolute value of eigenvalues of model's characteristic equation is less than 1, which means that this model is of great stability, so the effectiveness of the empirical analysis is ensured.

4.2.1 Effect of international metal price shocks on China's overall industry

Figure 3 to Figure 5 reveal the responses of C_{IAV} , C_{PPI} and C_{IR} to one standard deviation change of structural residuals. As can be seen, C_{IAV} responds positively to the international metal price shocks in the current period, and reaches a peak of 0.0130 in the 2nd month. In general, increase in international metal price shocks will raise marginal production cost of industrial production and push producers to adjust the utilization rate of capacity, which lead to decrease in capacity. Positive responses in the current period means that China's industries have better growth inertia to resist negative shocks aroused by rises in international metal prices in the short term. It was supported by HUANG et al [38], who found that the inertia of China's economic growth can reduce the negative effects of nonferrous metal price fluctuations in the short term. But since the 3rd month, positive influences start to be weakened and turn to negative in the 14th month, which implies that the negative effects of international metal price shocks appear, and lead to a decrease in China's industrial output. International metal price shocks influence China's producer price index much quicker, and the effect is positive in the current period, which is mainly due to China's high dependence on the imports of international metal resources. Increase in

international metal prices will be transferred to each industry by the cost side, then raise marginal production costs of industrial production and push industrial enterprises to improve producers prices. This result is also consistent with the finding of SU et al [25]. Facing with inflation caused by the increase in international metal prices, China's monetary policy also starts to respond since the 3rd month, and in several months later, interest rate is raised to suppress inflation, so that international metal prices have positive effect on interest rate. As shown in Figure 6, industrial output responds negatively to a standard deviation shock of interest rate since the 2nd month, which indicates that the tight monetary policy brought by international metal prices can also cause decrease in industrial output along with increase in interest rate. Thus, international metal price shocks indirectly restrain increase in industrial output through triggering the implementation of tight monetary policy.

4.2.2 Effects of international metal price shocks on upstream industries

Then we analyze the effects of international metal price shocks on the output and price of

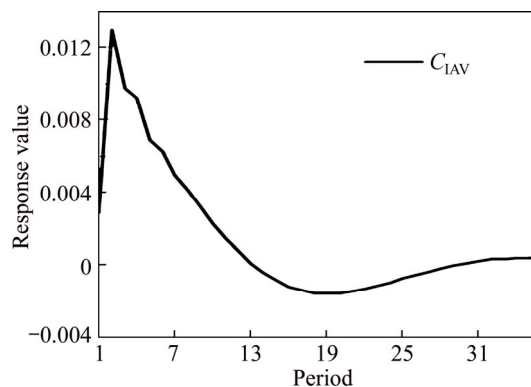


Figure 3 Effect of international metal price shocks on industrial output

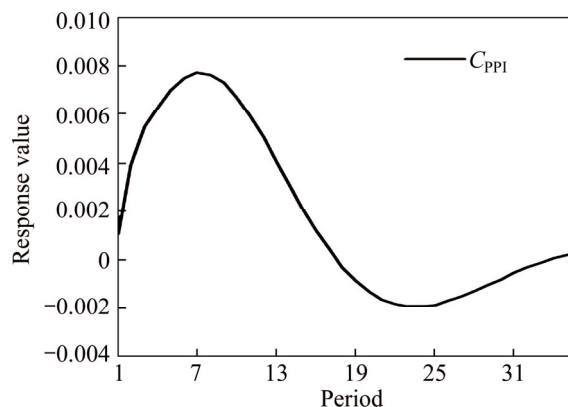


Figure 4 Effect of international metal price shocks on industrial price

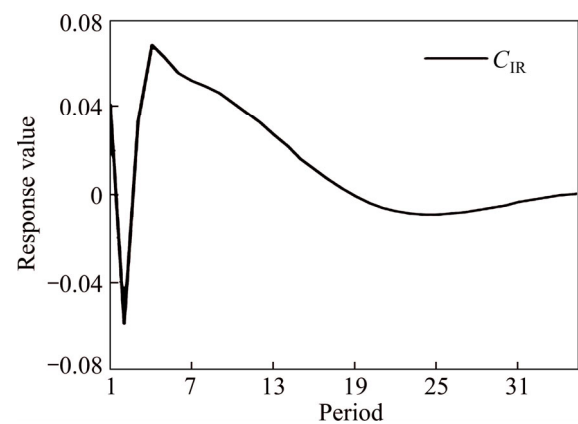


Figure 5 Effect of international metal price shocks on interest rate

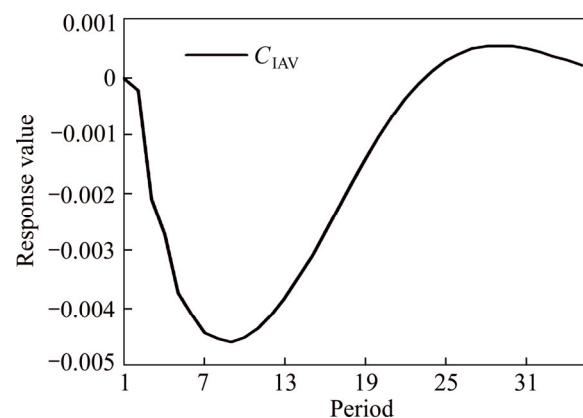


Figure 6 Effect of interest rate on China's industrial output

different links in metal industry chains. Upstream industries mainly include mining industries. Thus we choose ferrous metal mining industries (M3) and nonferrous metal industries (M4) as representative industries in upstream of metal industry chains. Firstly, we examine the impulse responses of upstream industrial output and price to international metal price shocks, and the results are shown in Figures 7 and 8. From both figures we can know that, under one standard deviation of positive international metal price shocks, C_{PPI} of ferrous metal mining industry and nonferrous metal mining industry show positive responses in the current period, and reach the peak of 0.0295 and 0.0232 in the 7th and the 5th month, respectively, which indicates that the transmission speed is relatively quick. While the output in these industries does not decrease but increases when facing with the rise of international metal prices, which violates the theoretical expectation. The possible reason is that these two industries are close to metal industry chains, and have relatively strong bargaining power,

so that they can transmit the cost of metal raw materials into downstream industries quickly, therefore international metal price shocks have less negative impacts on them and they maintain relatively strong growth inertia. The responses of interest rate in these two industries to international metal prices shocks are still positive (as shown in Figure 9), and the effects of interest rate changes on output of ferrous and nonferrous mining industries are negative since the 3rd month (as shown in Figure 10), which reach the bottom of -0.0054 and -0.0047 in the 10th and the 7th month, respectively. It is can be seen that though international metal price shocks do not have strong direct inhibitory effects on output of upstream industries, but the shocks exert strong indirectly inhibitory effects on output of upstream industries by triggering the implementation of tight monetary policy.

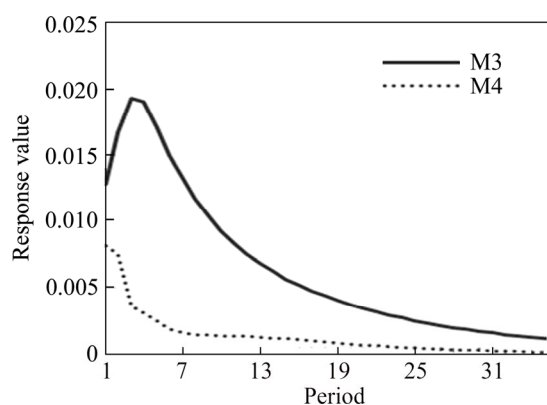


Figure 7 Effects of international metal price shocks on upstream industrial output

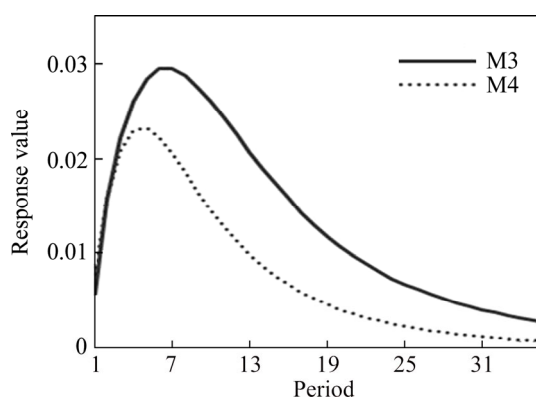


Figure 8 Effects of international metal price shocks on upstream industrial price

4.2.3 Effects of international metal price shocks on midstream industries

Midstream industries mainly include smelting and processing industries. We choose ferrous metal smelting and rolling processing industries (M24)

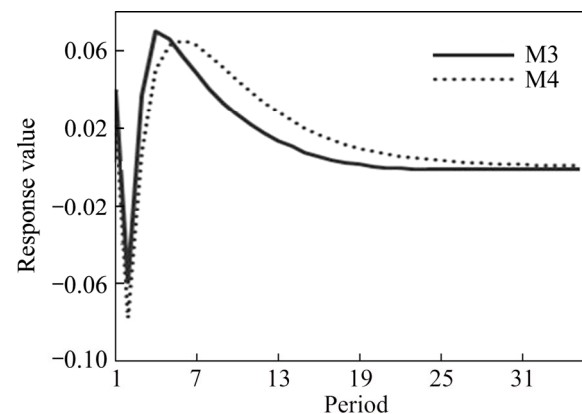


Figure 9 Effects of international metal price shocks on interest rate for upstream industries

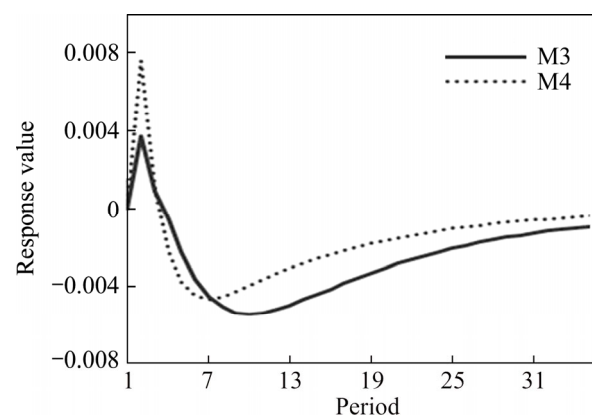


Figure 10 Effects of interest rate shocks on upstream industrial output

and nonferrous metal smelting and rolling processing industries (M25) as representative industries in midstream of metal industry chains. Firstly, we examine the impulse response of midstream industrial output and price to international metal price shocks, and the results are shown in Figures 11 and 12. From both figures we can see that, under one standard deviation of positive international metal price shocks, C_{PPI} of ferrous metal smelting and rolling processing industry and nonferrous metal smelting and rolling processing industry also shows the positive responses in the current period, and the response values reach the peak of 0.0237 and 0.0265 in the 6th and the 5th month, respectively, which indicates that the transmission speed is relatively quick. However, unlike upstream industries, the output of ferrous metal smelting and rolling processing industry and nonferrous metal smelting and rolling processing industry show positive responses at first when facing with international metal price shocks, while it turns to negative since the 11th and the 14th

month, respectively, which means that the negative effects of international metal price shocks on midstream industries are much more severe than those on upstream industries. This is because smelting and processing industries have significant overcapacity, and production supply exceeds demand. Under the circumstance of drastic market competition, enterprises can not transmit the pressure of production costs by rising products price, so they can only cope with external shocks by reducing output. The responses of interest rate in these two industries to international metal price shocks are still positive (as shown in Figure 13), and interest rate has negative effects on ferrous metal smelting and rolling processing industry and nonferrous metal smelting and rolling processing industry, which reaches the bottom of -0.0033 and -0.0037 in the 9th month, respectively. It can be seen that international metal price shocks also exert indirectly inhibitory effects on output of midstream industries by triggering the implementation of tight monetary policy, but the effects are relatively small (as shown in Figure 14).

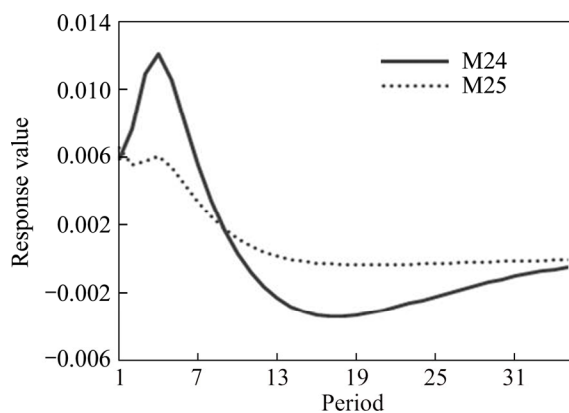


Figure 11 Effects of international metal price shocks on midstream industrial output

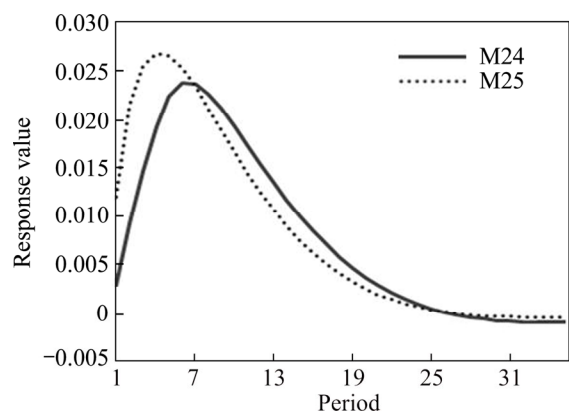


Figure 12 Effects of international metal price shocks on midstream industrial price

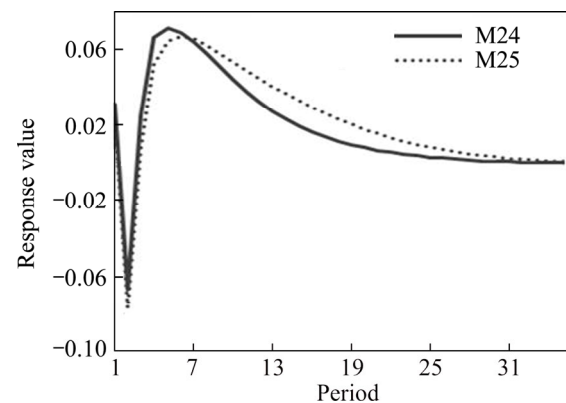


Figure 13 Effects of international metal price shocks on interest rate for midstream industries

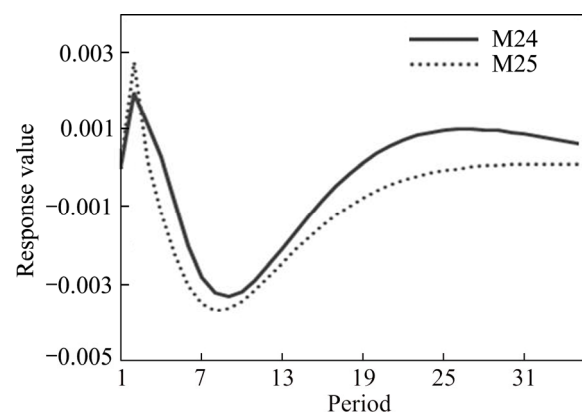


Figure 14 Effects of interest rate shocks on midstream industrial output

4.2.4 Effects of international metal price shocks on downstream industries

Downstream industries mainly include metal final consumer industries, and equipment manufacturing industries are the main departments. Thus we choose general equipment manufacturing (M27), special equipment manufacturing (M28), rail, shipbuilding, aerospace and other transportation equipment manufacturing (M29) and electrical machinery and equipment manufacturing (M30) as representative industries in downstream of metal industry chains. Firstly, we examine the impulse responses of downstream industrial output and price to international metal price shocks, and the results are shown in Figures 15 and 16. As shown in both figures, the effects of international metal price shocks on downstream industries PPI are focused on electrical machinery and equipment manufacturing industry, and the effects on other industries are comparatively small. C_{PPI} of electrical machinery and equipment manufacturing industry displays a positive response in the current period,

and reaches the peak of 0.0065 in the 5th month, while the maximum responses of other industries to international metal price shocks all do not exceed 0.0014, which almost can be ignored. The general equipment manufacturing industry, special equipment manufacturing industry, rail, shipbuilding, aerospace and other transportation equipment manufacturing industry and electrical machinery and equipment manufacturing industry all show positive responses at first when facing with the international metal price shocks. The output of general equipment manufacturing industry, special equipment manufacturing industry, electrical machinery and equipment manufacturing industry reach the peak of 0.0074, 0.0112 and 0.0072 in the 1st month, respectively. However, the output of rail, shipbuilding, aerospace and other transportation equipment manufacturing industry reaches the peak of 0.0125 in the 2nd month. According to the expectation, equipment manufacturing is the direct downstream industry of metal raw materials and it will be negatively affected. But the results are contrast to the expectation. The possible reason is the insufficiency of market demands and price regulations disrupting markets in China, which makes price shocks stop at midstream industries and can not be transmitted to downstream industries. So price shocks have little effects on C_{PPI} of downstream industries, and output is not adversely affected. Responses of interest rate in these four industries to international metal prices shocks are still positive (as shown in Figure 17), and interest rate has negative effects on general equipment manufacturing industry, special equipment manufacturing industry, rail, shipbuilding, aerospace and other transportation

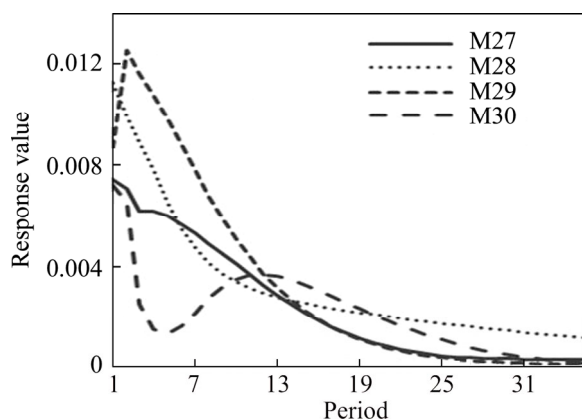


Figure 15 Effects of international metal price shocks on downstream industrial output

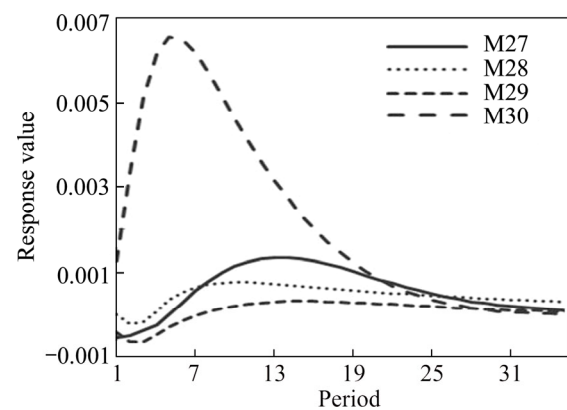


Figure 16 Effects of international metal price shocks on downstream industrial price

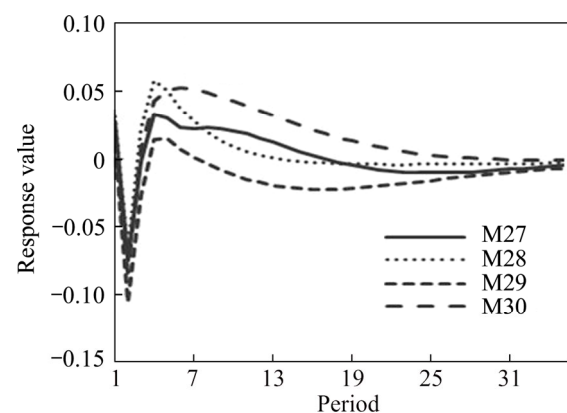


Figure 17 Effects of international metal price shocks on interest rate for downstream industries

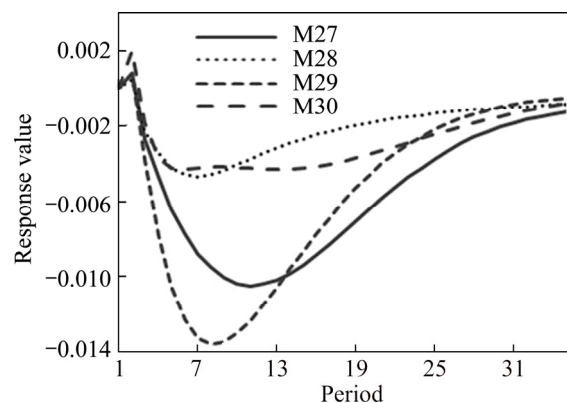


Figure 18 Effects of interest rate shocks on downstream industrial output

equipment manufacturing industry and electrical machinery and equipment manufacturing industry (as shown in Figure 18). General equipment manufacturing industry reaches its bottom of -0.01047 in the 11th month; special equipment manufacturing industry and rail, shipbuilding, aerospace and other transportation equipment manufacturing industry reach the bottom of -0.0047 and -0.0133 in the 7th month, respectively; while

electrical machinery and equipment manufacturing industry reaches its bottom of -0.0043 in the 13rd month. It can be seen that international metal price shocks exert indirectly inhibitory effects on output of downstream industries by triggering the implementation of tight monetary policy, and the effects are relatively strong.

4.3 Variance decomposition analysis

Table 1 displays each variable's variance decomposition result in the 36th month which is at a steady level.

As shown in Table 1, international metal price shocks have great impacts on the industrial overall output, and in the 36th month, the contribution of international metal price shocks to overall industry output variability increases to 21.3011%, only

second to the contribution of industrial output itself, but the effect of interest rate shock on overall industry output is small, with the contribution of 8.8365%. This means that though international price shocks will indirectly affect output by tight monetary policies, the effect is not strong. We further analyze the effect degree of international metal price and interest rate shocks on different links output in metal industry chains, and find that the contributions to output of various links in an industry chain are not the same. The contributions of international metal price shocks and interest rate shocks to output of upstream industries (the sum of M3 and M4) are 28.811% and 3.1039%, respectively, and the contributions to output of midstream industries (the sum of M24 and M25) are 23.3884% and 6.5467%, respectively.

Table 1 Variance decomposition results of each variable

Variable	Industry code	$P_{\text{METAL}}/\%$	$C_{\text{IAV}}/\%$	$C_{\text{PPI}}/\%$	$C_{\text{IR}}/\%$
Output	Overall industry	21.3011	63.8563	6.0061	8.8365
	M3	19.0430	69.3903	8.8413	2.7254
	M4	9.7680	89.6627	0.1908	0.3785
	M24	14.0042	60.3670	23.9408	1.6880
	M25	9.3842	83.9299	1.8272	4.8587
	M27	7.8192	55.4431	7.8050	28.9327
	M28	11.1227	72.9081	11.7480	4.2212
	M29	12.4783	52.4191	9.0729	26.0297
	M30	10.3511	62.5776	12.3841	14.6872
Price	Overall industry	21.2476	38.4875	34.5623	5.7026
	M3	21.3921	30.7564	46.0148	1.8367
	M4	47.6162	15.1182	30.4358	6.8298
	M24	23.6321	48.9186	24.4642	2.9851
	M25	30.7510	19.7577	34.7848	14.7065
	M27	4.1316	51.1113	28.9014	15.8557
	M28	4.3014	55.4941	38.3532	1.8513
	M29	4.5428	51.4841	35.1008	8.8723
	M30	26.5532	0.4832	55.7930	17.1706
Interest rate	Overall industry	2.3900	1.9908	3.0412	92.5780
	M3	1.9573	1.9731	7.5695	88.5001
	M4	2.4448	5.6640	2.3851	89.5061
	M24	2.7700	0.7336	5.0365	91.4599
	M25	3.2878	0.3904	2.4576	93.8642
	M27	0.9780	2.9276	4.9512	91.1432
	M28	1.1585	0.9811	1.9944	95.8660
	M29	1.4774	10.3209	2.5568	85.6449
	M30	2.2931	1.5330	2.9084	93.2655

International metal price shocks have greater effects on upstream and midstream industries than interest rate shocks, while the contributions of international metal price shocks and interest rate shocks to output of downstream industries (the sum of M27, M28, M29 and M30) are 41.7713% and 73.8708%, respectively; International metal price shocks have less effects than interest rate shocks, which proves that the direct effects of international metal price shocks on output of China's metal industry chains mainly concentrate on upstream and midstream industries, and downstream industries are mainly affected by indirect effect.

The contribution of international metal price shocks to C_{PPI} reaches to 21.2476% in the 36th month, third to changes of industrial output and itself. This shows that the international metal price shock is an important factor to push industrial C_{PPI} to increase. The contributions of international metal price shocks to C_{PPI} of upstream industries (the sum of M3 and M4), midstream industries (the sum of M24 and M25) and downstream industries (the sum of M27, M28, M29 and M30) are 69.0083%, 54.3831% and 39.529%, respectively, which means that the effect of international metal price shocks on the industrial price transmits along the metal industry chains from upstream to downstream: firstly influencing the metal mining industries, then the metal smelting and rolling processing industries, and finally transmitting to industries such as electrical machinery and equipment manufacturing in the downstream industries, and the effect of price shocks gradually weakens.

The prediction variance of interest rate is mainly affected by the change of interest rate itself, but the impact of international metal price shocks occupies the second and has greater effects than output and producer price index, which reflects that China's monetary policy has reacted to international metal price shocks to some extent, but the degree of reaction is different in various links in metal industry chains.

4.4 Robust analysis

The sequence of variables arranged by Cholesky decomposition will have great impacts on the results of impulse response function and variance decomposition, so if variables' sequence is

differently presupposed, results may have significant differences. Thus, in order to examine the robustness of the empirical analysis results, this paper selects other reasonable sequences of variables to construct the SVAR model. Other possible sequences mainly focus on the orderings among variables such as C_{IR} , C_{PPI} and C_{IAV} . This paper constructs the SVAR model by $(P_{METAL}, C_{PPI}, C_{IR}, C_{IAV})$ sequence and $(P_{METAL}, C_{PPI}, C_{IAV}, C_{IR})$ sequence. It shows that the impulse response function and variance decomposition results of these two sequences are basically the same as the above, which means that the results of SVAR model are robust. The difference is that the effect of tight monetary policy on the prediction variance of output is significantly enlarged, and this is related to the pre-assumptions implied in these two variables' sequences.

5 Conclusions and policy implications

Based on the perspective of subdivided industry chain, this paper chooses eight industries in China to establish a SVAR model reflecting the interrelations among metal industry chains, and explores the dynamic transmission effects of international metal price shocks on the industrial output and price by applying impulse response function and variance decomposition. We can draw the following conclusions.

1) International metal price shocks not only have direct negative effects on China's industrial output, but also indirectly curb the growth of output by increasing domestic inflation pressure and pushing the implement of tight monetary policy; however, the indirect effects are relatively small.

2) The direct effects of international metal price shocks on China's metal industry chains mainly concentrate on upstream and midstream industries. Due to the insufficient domestic demand and price regulations disrupting markets, the price transmission is viscous and the direct effects of international metal price shocks on downstream industries are less, while the indirect effects of international metal price shocks through tight monetary policy have greater influences.

3) International metal price shocks can promote producer price index of various links in

China's metal industry chains. The effects transmit along the industry chain from upstream to downstream, namely influencing mining industries at first, then the smelting and processing industries, at last transferring to electrical machinery and equipment manufacturing industry and so on, and the strength weakens in sequence.

Based on the conclusions above, in order to effectively cope with the negative shocks of international metal price shocks bringing to China's industries, governments should adopt different strategies according to the differences of various links in metal industry chains.

For the upstream industries, though they have relatively strong bargaining power to transmit costs of metal raw materials into downstream industries quickly, we can still find that there maintain inner driving forces to push their prices to significantly go up with international metal price shocks, and upstream industries are relatively more affected by imported inflation. Therefore, upstream industries should pay more attention to the issue of high dependence on metal imports. In order to effectively resist the adverse impact of international metal prices, Chinese government should promote the diversification of sources of metal resources imports, reduce resource intensity and improve resource efficiency.

For the midstream industries, because of the viscosity of price transmission mechanism, cost shocks brought by increase in international metal prices can not be transferred smoothly to downstream industries; meanwhile, midstream industries are facing with greater pressure of cutting back production because of severe overcapacity and drastic market competitions. So, midstream industries should accelerate the marketization of metal resource pricing mechanism and reduce price distortion caused artificially. In addition, it needs to actively promote the supply-side structural reform, optimize industrial structure, and promote mergers and acquisitions.

For the downstream industries, due to the viscosity of price transmission, cost shocks can hardly affect downstream industries in the end of industry chains. While market demands have the most direct shocks on these industries. Thus, downstream industries should focus on changing the mode of economic growth and stimulating

domestic demands. Specifically, downstream industries should actively advance intelligent manufacturing, encourage format innovation and mode innovation, facilitate mix between "internet +" and the whole process of enterprises' production and operation.

Certainly, mastering the pricing power of metal resources in international markets is the fundamental approach to deal with international metal price shocks. China should accelerate the construction of metal futures markets based on a global vision and take certain measures, such as improving laws and regulations, expanding product category, vigorously developing hedging tools as well as improving information disclosure systems, to boost market activities and thereby achieve price discovery function based on supply and demand fundamentals and enhance the pricing power of China's metal markets.

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中文导读

产业链视角下国际金属价格冲击的行业传导效应

摘要：基于产业链的新视角，采用 2006 年 2 月至 2015 年 12 月的月度数据，选择中国 8 个工业行业以构建反映金属产业链内在联系的 SVAR 模型，分析国际金属价格冲击对我国金属产业链各个环节产出的直接效应与间接效应，在此基础上通过分解上中下游行业的通货膨胀来源，考察国际金属价格冲击的传导路径。结果显示：国际金属价格冲击对我国工业行业产出不仅具有直接的消极影响，而且还通过推升产品价格指数（PPI）、促使紧缩性货币政策的实施间接影响工业行业产出；受我国市场需求不足、价格传导机制阻滞等因素的影响，国际金属价格冲击的直接效应主要集中在上中游行业，下游行业则主要受间接效应的影响；此外，国际金属价格冲击对我国工业行业通胀具有溢出效应，这种价格冲击效应沿着产业链的上游往下游进行单向传导，并且强度依次减弱。

关键词：国际金属价格；产业链；SVAR 模型；传导效应