Journal of Business and Environmental Management (JBEM)

Volume 2, Number 1, 2023, Pages 67 –82

Journal Home Page

https://journals.airsd.org/index.php/jbem

Bulk Raw Material Price Impacts, Imported Inflation and Regulatory Path

Cheng Xi[1], Zhang Jiyang[2], Yin Jingdong[3]

[1] *Guangzhou CAS Cogniser Technology Co.,Ltd., Guangzhou , China 510000, Email:13901584390@139.com*
[3] *Zhang Ji-yang, School of Business, Nanjing University, Nanjing, China, 210008, Email: DG1902040@smail.nju.edu.cn*
[3] *School of Economics, Nanjing University of Finance & Economics, Nanjing, China, 210023, Email: yjdnufe@163.com*

ARTICLE INFO

Article History:

Received:	February	20, 2023
Revised:	March	25,2023
Accepted:	April	29,2023
Available Online:	May	30,2023

Keywords:

International bulk raw material price impacts; Input inflation; wage and price linkage; target inflation management

ABSTRACT

Based on the actual price impact of international bulk raw materials, this paper simulates the influence of different control schemes on price level and imported inflation of the main downstream industrial prices through adopting the wage - price linkage mechanism, and separates the net effect of wage - price linkage on price: In view of different inflation targets, the corresponding price regulation scheme of critical point is proposed. The conclusion of this paper is that imported inflation is an important factor for China's inflation; When the one-time price impacts reach 50%, the cost coverage will increase the general price level by 8.66%, When the downstream price is completely controlled, the general price level will rise by only 3.3%; The linkage between wage and price increases the general price level by one percentage point, but it does not lead to a spiral explosion path between wage and price. For the imported inflation caused by price changes of international raw materials, controlling product prices of downstream industries is an effective way to control inflation.

Corresponding Author's Email: yjdnufe@163.com

INTRODUCTION

The international transmission mechanism of inflation consists of two aspects: price convergence and cost promotion. Prices convergence have been playing an important role in input inflation in the small open economy, but for the big country economy, the change of domestic prices caused by price changes of international raw materials, including petroleum, coal and iron ore, also has a significant influence on imported inflation. In history, what reflected that the change of the bulk raw materials price has a great impact on the commodities price and economy is no better than the petroleum crisis in 1970s and 1980s of the last century, the two petroleum crises had a significant impact on the price level and inflation of the United States and the world. In the early twenty-first Century, with the rapid development of China's economy and the shale gas revolution in the US, the international petroleum price has gone through two stages: the upward and downward cycles before and

after the year 2010. The changes in the prices of energy and international bulk raw materials have a significant influence on China's economic and price levels, it is an important factor that leads to China's economic fluctuations and input inflation and deflation.

LITERATURE REVIEW

In all, to estimate the economic impact of the change in the price of bulk raw materials, the macro-econometric model, the computable general equilibrium model and network methods are mainly adopted. Relevant literatures can be found in Tunali and Aydogus (2007), Lin and Wang (2009), Xi et al. (2020), Kang and Zheng (2021), Asadi et al. (2022), Song et al. (2023), Zhu et al. (2023), Kilian and Zhou (2023), etc., this paper will not repeat it. The advantage of the macro-econometric model, the computable general equilibrium model and network methods is to assess the impact of exogenous shocks on the macro-economy. The input-output price model is more effective in simulating price impacts. This paper focuses on the input-output method.

Using input-output method to study the price problem is mainly based on the cost structure of the input-output price model. Based on the data of China's 122 sector input-output table, Ren et al. (2007) adopting the input - output price model to measure the impact of crude petroleum price on China's general price level and the product prices of various sectors. Although input-output price models have advantages in simulating price impact compared to other methods, the traditional input-output price potential impact models cannot solve the problems of conduction blockage and conduction delay, this inability makes its calculation results can only provide the potential maximum impact for the current period, which is significantly different from the actual situation. To address this issue, Lin and Wang (2009) assume two scenarios as energy price is not controlled and is controlled, and simulate the rise of general price level caused by the rise of energy price. Ren (2008) proposes and creates a Cost Transmission Capability (CTC) model to better reflect the situation of shifting cost increases across industries. In his 2012 research, he combines CTC with input-output price models to create an input-output price actual impact model to study the potential and actual impact of energy price fluctuations on China's price level. This model reduces the potential transmission effect of price by using cost transmission capability, effectively solving the problem of transmission blockage (Ren, 2012). The effectiveness of this method was once again validated in Lv's (2023) study. "China's input-output table in 2007 analysis and application Research Group" (2010) constructed a local closed input-output model, the total income obtained by the residents from various sectors as the input to the various sectors from the residents' sectors, and the consumption of all kinds of consumer goods and services by the residents' sector is used as the input to the residents' sectors from various sectors, which constructed the price model of n+1 sector, and the influence of crude oil price fluctuation on China's PPI and CPI is calculated. Sharify and Sancho (2011) traced the influence of any initial price impacts through an iterative process. Shi et al. (2021) use an input-output price impact model to analyze the impact of energy price fluctuations on industry price levels and general price levels, as well as their changing trends. Przybyliński and Gorzałczyński (2022) try to examine the potential of input-output price model to identify mechanisms of price formation and transmission. Their study suggests although IO price model shows only the pure cost push side of inflation, other factors might be analyzed by explaining the components of the proposed decomposition.

In addition, Luo and Villar (2023) use industry level classification data to empirically evaluate the prediction of cross-sectional price changes distribution by input-output models with sticky prices. The response of prices to shocks is consistent with the price sensitivity predicted by input-output models. Jia et al. (2022) examine direct and indirect transmission of price connectedness through input–output linkage. They construct a network model to analyze the spillover effect of supply and demand side prices and find that direct input–output linkages between industries can increase price spillovers, while indirect price transmission has a greater effect on price connectedness. Ni et al. (2023) construct a global input-output price model to theoretically explore the impact of production chain length on the differentiation of PPI and CPI, and empirically test the degree of impact of production chain length on the linkage between CPI and PPI.

The above studies simulate the various changes of energy and bulk raw material prices, and calculate the influence of this impact on general price level and the price of different sectors. We find that the use of input-output price model simulates the exogenous shock of the input-output does not pay enough attention to the endogeneity of initial input. Most literature assume that the change of equilibrium product price is only related to the conduction of intermediate input cost, and has nothing to do with the initial input change, that is, the cost coverage is mainly limited to the price change of intermediate input. The advantage of this simplified assumption is that the simulation process can be simplified, but the change in the initial input is important, such as the relevance of wages, VAT and price changes. Secondly, the simulation of most literature emphasizes on the analysis of reality, and the price impact of the raw materials such as the actual energy is not simulated, the correlation of domestic energy pricing and input-output cost transmission mechanism is also lack of analysis and research. Based on this, this paper is supplemented and expanded from three aspects, first is the cost coverage method of the change in the price of bulk raw materials by micro enterprises, on the basis of the portrayal of the existing cost mechanism, the model of the input-output price formation is expanded through the introduction of the linkage mechanism of wage and price, along this train of thought, it can be extended to the linkage of tax and the linkage of profit; second, a detailed description of the response mechanism of international large raw materials in China is presented. If the response mechanism of marketization is absent, the simulation effect of input-output price model may be invalid; third, the impact on the real price of bulk raw material is considered from the year 2000 to 2010 to simulate the influence on the general price level and the price of the various sectors, as well as the impact of different price controls on the price of vertical industrial sectors on imported inflation, and the net effect of wage - price linkage on price impacts is separated and the effect of different selective price regulation policies is verified. The conclusion of this paper is that: the linkage between wage and price will not guide the spiral explosion path between wages and prices; To control the price of the product in its downstream industry is the most effective means to control the input inflation caused by the change in the price of the international bulk raw materials.

The discussion in this paper is mainly limited to the year from 2000 to 2010. There are three main considerations, first, this period is the transformation and completion period of the pricing mechanism of the bulk raw materials market in China. This makes the simulation of cost transmission mechanism realistic, and it is meaningful to discuss the response mechanism of the downstream price in this period; second, from year 2000 to 2010, the price

of the international bulk raw materials was in a continuous rising cycle, and there was a big shock in the later period, the influence on prices is more significant, and it is easier to distinguish, identify and test; third, from the year 2000 to 2010, the annual average growth rate of China's iron ore imports was over 25% in 10 years, the import dependence of China's iron ore was kept above 50%. China as the importer of the international bulk raw materials, completed a low dependence shift to highly dependence, the changes in the price of the major international raw materials had a significant influence on China's prices, although coal is dominated by self-sufficiency. Since 2009, China's coals have been imported from abroad, and China's coal imports have increased rapidly, breaking through one hundred million tons. By 2013, more than 300 million tons were imported, which further strengthened the marginal relevance of coal prices at home and abroad.

It is necessary to point out that the international bulk raw materials referred to in this paper is the three main fuels and raw materials of petroleum, iron ore and coal, not including agricultural and sideline products. The remainder of this paper is arranged as follows. The second part combines the price changes of international bulk raw materials from the year 2000 to 2010, to analyze the market response mechanism of domestic related product prices, the third part constructs the theoretical model of the wage-price linkage input-output price; the fourth part simulates the impact of raw material price impacts on price level and imported inflation under different scenarios, the fifth part is the discussion of target inflation and critical price regulation, and the final is the conclusion.

METHODOLOGY

Assume that $p = (p_1, p_2, \dots, p_n)^T$ is the product price or price index vector of n industry sectors, a_{ij} represents the physical form or the input-output consumption coefficient measured at the non-variable price, $a_y = (a_{y1}, a_{y2}, \dots, a_{yn})^T$ is the additional value coefficient of each sector unit product. It is made up of the cost of the product, the price of the product in section j is made up of the unit's intermediate consumption and unit initial input or unit additional value, the formula can be expressed as follows:

$$\boldsymbol{p_j = \sum_{i=1}^{n} a_{ij} p_i + a_{yj}\ (j = 1, 2, \dots, n)} \qquad \textbf{(1)}$$

Δp represents the adjustment of the prices of various sectors or corresponding changes of adjustment, Δa_y represents the adjustment of the added value of each sector unit or the corresponding change of adjustment, based on the equilibrium assumption of input and output price model, the adjusted price equilibrium model satisfies:

$$\boldsymbol{\Delta p_j = \sum_{i=1}^{n} a_{ij} \Delta p_i + \Delta a_{yj}\ (j = 1, 2, \dots, n)}$$

$$\boldsymbol{\Delta p = A^T \Delta p + \Delta a_y} \qquad \textbf{(2)}$$

In previous studies, it was assumed that the initial input was not affected by product price impacts, that is, to follow the assumption that Δa_y is equal to zero, which was unable to study the change characteristics of change correlation between initial input and intermediate input price, these features include fixed compensation mechanism of nominal wage and price change, fixed relation between value added tax and price change. Since there is no need to

assume that Δa_y is equal to zero, formula (2) provides a simulation probability for the initial input diversification behavior pattern. For this paper, the study has been expanded by establishing a model of wage-price linkage mechanism to simulate the potential influence of price level and inflation.

At the technical level, the model (2) includes n equations, the variables include the price series of n sectors and the additional value series of n sectors. In order to solve the equation, n constraints usually need to be added. In order for the model (2) to be used to analyze wage-price linkage, the initial input needs to be further subdivided.

Suppose that $D_j$represents the depreciation of fixed assets, $v_j$represents the labor remuneration, and m_j represents the social net income created by the laborer, such as profit and taxes, the initial input changes are the sum of the changes of constituent components, $\Delta a_{yj} = \Delta D_j + \Delta v_j + \Delta m_j$, assuming that depreciation and social net income are not affected by price changes, $\Delta D_j = \Delta m_j = 0$, substituted into formula (2), get

$$\Delta \boldsymbol{p_j} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} \boldsymbol{a_{ij}} \Delta \boldsymbol{p_i} + \Delta \boldsymbol{v_j} \ (\boldsymbol{j = 1, 2, \dots, n-1}) \qquad \textbf{(3)}$$

For wage-price linkage model, wage-price linkage requirements:

$$\Delta \boldsymbol{v_j} = \boldsymbol{\pi} \qquad \textbf{(4)}$$

Substitute$\pi = \sum_{i=1}^{n} \frac{w_i}{\sum w_i} \Delta p_i$ and formula（4）into formula (3):

$$\Delta p_j = \sum_{i=1}^{n} a_{ij} \Delta p_i + \sum_{i=1}^{n} \frac{w_i}{\sum w_i} \Delta p_i \, v_j \ \ (j = 1,2, \dots, n-1)$$

$$= \sum_{i=1}^{n} a_{ij} \Delta p_i + \sum_{i=1}^{n} (\frac{w_i}{\sum w_i} v_j) \Delta p_i$$

$$= \sum_{i=1}^{n-1} a_{ij} \Delta p_i + a_{nj} \Delta p_n + \sum_{i=1}^{n-1} (\frac{w_i}{\sum w_i} v_j) \Delta p_i + \frac{w_i}{\sum w_i} v_j \, \Delta p_n$$

set $d_{ij} = \frac{w_i}{\sum w_i} v_j$, matrix $D = (d_{ij})$, $v^{n-1} = (v_1, v_2, \dots, v_{n-1})$, the matrix can be expressed as:

$$\Delta \boldsymbol{p^{n-1}} = \boldsymbol{A^T} \Delta \boldsymbol{p} + \boldsymbol{D^T} \Delta \boldsymbol{p} + \boldsymbol{a_n^{n-1}} \Delta \boldsymbol{p_n} + \boldsymbol{v^{n-1}} \frac{\boldsymbol{w_n}}{\sum \boldsymbol{w_i}} \Delta \boldsymbol{p_n} \qquad \textbf{(5)}$$

Matrix $(I - A^T - D^T)_{(n-1)\times(n-1)}$ is reversible, in this way, the price model of wage- price linkage can be obtained (6):

$$\Delta \boldsymbol{p^{n-1}} = (\boldsymbol{I - A^T - D^T})^{-1} (\boldsymbol{a_n^{n-1}} \Delta \boldsymbol{p_n} + \boldsymbol{v^{n-1}} \frac{\boldsymbol{w_n}}{\sum \boldsymbol{w_i}} \Delta \boldsymbol{p_n}) \qquad \textbf{(6)}$$

If further consideration is given to the price regulation after the impact of raw material prices, assuming that the downstream industry with bulk raw materials as intermediate inputs is the $n-1$ sector, and assuming that the price of its products is controlled by government departments, such as fuel, coal chemical, power and steel, the wage-price linkage price model with selective price control is as follows:

$$\Delta p^{n-2} = (I - A^T - D^T)^{-1} (a_n^{n-2} \Delta p_{n-1} + a_n^{n-2} \Delta p_n + v^{n-2} \frac{w_{n-1}}{\sum w_i} \Delta p_{n-1}$$

$$+v^{n-2}\frac{w_n}{\sum w_i}\Delta p_n) \qquad (7)$$

Weight selection in formula $\frac{w_{=i}}{\sum w_i}$ has many ways, the data can be determined by the external data of the table or by the flow data of the input-output table. Due to the lack of correspondence between off-balance sheet data and input-output sector, it is more common to determine the weight by flow data from the input-output table. Table 1 provides five common options.

Table 1 :*Weight selection and Price index*

Price index	The weight
consumer price index.	Residents' consumption weight
Rural consumer price index.	The consumption weight of rural residents.
Urban consumer price index.	The consumption weight of urban residents.
Fixed asset investment price index.	Fixed capital formation weight.
GDP deflator	Total output weight

By using formula (7), the response effect of the price of each sector product to relevant impact can be obtained, then to use the inflation formula $\pi = \sum_{i=1}^{n}(\frac{w_i}{\sum w_i})\Delta p_i$, the general price increase can be further obtained.

The Measure of the Influence of The Bulk Raw Material Price Impact on the Price Level and Input Inflation

Determination and scheme design of the price impact of bulk raw materials

In order to correspond to the division of the 17 sectors input-output table, bulk raw materials are incorporated into the name of the mining industry in the input-output table. In the mining industry, the products of the non-ferrous metal mining and non-metal mining industry have not been further divided and considered. Considering the period of year 2001 to 2010, this paper uses the input-output table issued by the National Bureau of Statistics in 2005 of 17 x 17 sectors as the center milestone for simulation, of course, if we use input-output table between the year 2002 and 2007 for segmentation simulation, there may be some differences. Generally speaking, there is little difference, the literature (Wang Jiyuan et. al 2015) provides the estimated results from 1998 to 2011 for reference.

According to the price data of petroleum, iron ore and raw coal in the international raw material market and in the domestic market from 2000 to 2010, it is found that oil price rose 178%, Long covariance ore prices of iron ore rose 608%, coal prices rose about 284%. Considering that the three kinds of products belong to the mining industry, based on the weighted total industrial output value of the three kinds of products in the 2005 Chinese Statistical Yearbook, we have approximately 267% of the initial actual impact of the mining industry in the same period.

Downstream product price adjustment scheme and simulation is mainly designed for the two core sectors of power and thermal, and water production and supply industry and coking, gas and petroleum processing, both of which are most closely associated to the mining industry and are subject to different degree of the government price control. The scheme takes the form of five schemes respectively including the cost coverage pricing (no control), complete

control (no adjustment), up-regulation of 10%, up-regulation of 20% and the actual change. The actual impact is simulated on the basis of the actual price rise by 29.99% and 143.99% respectively of the two sectors of power, thermal and water production and supply, and the coking, gas and petroleum processing industry.

The price index of various kinds is calculated by the weight of the corresponding indexes of each department in the input-output table.

Influence simulation

Table 2 is the results of the simulation of five schemes. As a comparison, the actual change in the price of the last column in the table refers to the actual change in the corresponding price index of 2000-2010.

Table 2 : *The change of the Price index under the price impact of the bulk raw materials and the wage-price linkage*

	CPI	Rural CPI	Urban CPI	Fixed asset investment price index	GDP deflator
Cost coverage	46.75	45.04	46.29	56.63	52.07
Complete control	17.62	17.83	17.54	28.61	23.72
Up-regulation 10%	19.78	19.86	19.75	30.68	25.83
Up-regulation 20%	21.94	21.90	21.95	32.76	27.94
Actual change	33.92	33.41	34.11	45.00	41.02
Actual price change	23.55 %	28.57 %	20.93 %	28.09%	26.94%

From the simulation results in Table 2, the actual price impact of bulk raw materials in 2000-2010 had significant effect on the CPI (consumer price index), consumer price index of rural residents, the urban consumer price index, the price index of investment in fixed assets and GDP deflator. Cost coverage scheme had the greatest impact, which had no price control on the downstream products price of the two sectors. Under this scheme, the CPI rose by 46.75%; the complete control scheme of the downstream two sector prices had the minimum effect, and CPI rose only by 17.62%. This indicates that the price policy of complete control to the two sectors downstream power and petroleum processing can significantly inhibit the price impact of bulk raw materials.

According to the simulation results in Table 3 of CPI, consumer price index of rural residents, urban consumer price index and the price index of investment in fixed assets under the actual change, rise respectively by 33.92%, 33.41%, 34.11% and 46%, compared to the five price index actual rises in the same period of 2000-2010, which were respectively

23.55%, 28.57%, 22.93% and 28.09%, the simulation results show that the actual changes were different from the actual situation: the simulation results were obviously exceeded the actual price rises, which overestimated the actual price impact of three sectors of mining, power and petroleum processing industries.

Why is the calculated result from input-output price model of wage-price linkage to the consumer price index 33.92% corresponding to the actual change larger than the actual CPI rise 23.55% over the 2000-2010? The main reasons are:

(1) The wage- price linkage mechanism only plays part of the function. As far as wage decision is concerned, unless there is a hyperinflation, only performance wages show the nature of linkage. The establishment of the minimum wage and price linkage, and subsistence allowance and price linkage mechanism have not been prevailed in our country. Generally, the coverage of the wage-price linkage accounts for only a small part of the economy, so the increase in the general price level by bulk raw materials price impact and wage-price linkage in the not so great.

(2) Price control. In 2000-2010, bulk raw materials prices in the first half period are generally low, especially the price of coal and electricity prices that were running in the low level, and cost coverage intensity is not big. In the latter half period, especially the 2007-2008, the price rose more quickly, in order to stabilize the prices, the National Development and Reform Commission carried out different levels of price controls on the downstream products sectors. This control was not limited to electricity and fuel and other sectors, even including life services. Regulation of a wide range weakened the price rise strength. The price index of raw materials, fuel and power that best reflects the impact of raw material prices increased by only 52.17% in the ten years during 2000-2010.

(3) Excessive competition and incomplete cost coverage in the downstream industry. Coal chemical industry and steel and other downstream industries are basically competitive industries. There are serious excessive competitions, which makes the price change of upstream raw materials difficult to pass on to downstream products or consumers.

Table 2 simulation results have an important corollary: spiral between wages and prices will not lead the general price level tend to the explosion path, but tend to a steady convergence, which indicates the cost-push inflation is not enough to bring the irremediable hyperinflation. If a country has hyperinflation, it may be resulted from overly loose monetary policy.

In order to further describe the impacts of the actual change scheme and other different control schemes on the price of each sector, Table 3 gives the relevant simulation results. The mining industry in the table is the initial impact sector. The impact of the actual price increases by 267.14%. The two downstream industries of the power, thermal and water production and supply industry and coking, gas and petroleum processing industry reflect the corresponding scheme adjustment.

From the sub-sector, simulated raw material price changes of cost coverage scheme have very significant direct influence on downstream sector price: coking, gas and petroleum processing industry and power, thermal and water production and supply industry and metal products manufacturing industry rose by 182.82%, 96.65% and 88.72 respectively.

If coking, gas and petroleum processing industry and power, thermal and water production and supply industry follow the second scheme, various sectors' affected degrees are significantly reduced, in which the most affected energy-intensive industries such as metal manufacturing industry, the impact is 58.20%, is 30% down from the first scheme.

Compared with the traditional wage-price non-linkage pricing model, the difference simulated by wage-price linkage model reflects the net effect of wage-price linkage mechanism on price. In order to get the comparative effects of wage-price linkage and wage-price non-linkage of different price adjustment schemes or actual price changes, we will simplify the impact to rise by 100% of the initial impact from petroleum, coal and iron ore prices.

Table 3 : *The changes in the price of various products under 267% price impacts of the mining industry and the linkage of wages and price (%)*

Mining industry (exogenous shock)	267.14				
	cost coverage	Complete control	Up-regulation by 10%	Up-regulation by 20%	Actual change
Agriculture	47.80	18.44	20.625	22.81	34.39
Food manufacturing industry	37.45	15.03	16.714	18.40	28.33
Textile, sewing and leather products manufacturing industry	43.32	17.58	19.543	21.51	34.34
other Manufacturing industry	44.83	19.43	21.350	23.27	36.03
Electricity, heat and water production and supply industry	96.65	non-adjustment	Up 10%	Up 20%	30.00
Coking, gas and petroleum processing industry	182.82	non-adjustment	Up 10%	Up 20%	144.00
Chemical industry	69.83	34.58	37.221	39.86	58.11

Building materials and other nonmetallic mineral products industry	76.47	43.67	46.196	48.72	67.59
Metallic mineral products manufacturing industry	88.72	58.19	60.498	62.81	79.39
Machinery manufacturing industry	55.13	28.24	30.268	32.30	46.18
construction industry	61.00	31.35	33.523	35.70	49.25
Transportation and post and telecommunications industry	50.88	11.74	14.232	16.73	26.36
Wholesale and retail trade, accommodation and catering industry	32.39	11.18	12.768	14.35	24.34
Real estate, leasing and business services industry	27.85	11.82	13.006	14.20	21.57
Financial and insurance industry	28.955	10.236	11.617	12.997	20.780
Other service industry	46.01	18.83	20.859	22.89	35.22

From the simulation results in Table 4, the mining industry is given a 100% price impact. After wage and price are linked, various price indexes are obviously improved, in which the price index of investment in fixed assets increases the most, reaching 12.52% in the downstream products 20% price adjustment scheme, and reaching 9.52% under non-adjustment scheme of complete price control. The consumer price index also increased significantly, reaches 8.16% under the 20% adjustment scheme, and the complete control scheme is 5.13%.

Table 4 : *100% price impact and various price index changes under wage-price linkage and non-linkage*

Linkage method	Wage-price linkage	Wage-price non-linkage

Control method	Complete control	10% up-regulation	20% up-regulation	Complete control	10% up-regulation	20% up-regulation
CPI	5.13	6.64	8.16	4.16	5.58	6.995
rural CPI	4.99	6.21	7.44	3.85	4.96	6.070
Urban CPI	5.09	6.53	7.96	4.08	5.41	6.746
Fixed asset investment price index	9.52	11.02	12.52	8.71	10.14	11.556
GDP deflator	7.55	9.01	10.47	6.65	8.02	9.394

Considering with the wage-price non-linkage, the simulation results show that the price index simulation results are all decreased, generally by one percentage point, accounting for 20% of the whole price rise. This shows that the wage-price linkage has obvious influence on prices, compared with the non-linkage. In terms of influence intensity, if price control is carried out to the downstream sectors, with the increase of control efforts, the price index differences of the two kinds of mechanisms will decrease to varying extents.

Design of Price Impact and Selective Price Control Scheme

In view of the significant impact of changes in the price of international bulk raw materials on domestic prices, how to choose reasonable price control objects and control efforts to achieve twice the result with half the effort is the key to control policy design. From the practice of price controls in China, significant imported inflation occurred in 2007 and 2008, the macro adopted a moderately tight fiscal policy and prudent monetary policy. In the level of structure, the National Development and Reform Commission has taken a lot of temporary price control measures, the scope is broad and strict. In the review perspective, it is worthy of further study on whether drastic temporary control measures at that time is necessary, and the simulation results of input-output price model of this paper provides beneficial enlightenment.

As for the various simulation results In Table 3, in accordance with market pricing method of cost coverage, imported inflation resulted from price changes in the international market bulk raw materials is the most significant. In 2000-2010, CPI rose by 46.75%. On the contrary, in case of taking complete control way to control the downstream products of electricity, thermal and water production and supply industry and coking, gas and petroleum processing industry, CPI rose by only 17.62% over the same period, even lower compared with the same period of actual inflation 23.55%, indicating that the downstream direct processing sector's price control regulation on inflation is very crucial and effective. How to choose the right control depends on the extent of the price impact and the control goal of inflation. According to the experience of China and the mature market economy countries, the target inflation of 3%-5% is the critical region to start the reverse macroeconomic policy.

Table 5 is a simulation of the various levels of price impacts and control policy inflation effects. The data in brackets are the simulation results of the wage- price linkage mechanism.

Table 5 : *Price impact and control policy simulations under the conditions of wage price linkage mechanism and non- linkage (%)*

	Cost coverage	Complete control	Up-regulation 5%	Up-regulation 7.5%	Up-regulation 10%	Up-regulation 15%	Up-regulation 20%
Mining industry price rise 50	5.19 (8.66)	2.04 (3.30)	2.71 (4.38)	3.04 （4.92）	3.37 （5.46）	4.04	4.71
Mining industry price rise 100	10.83 (17.33)	4.08 (5.13)	4.74	5.08			
Mining industry price rise 150	15.57 (25.82)	6.11 (9.56)					
Mining industry price rise 200	20.77	8.15					

Note: the number in bracket is the price impact under the wage-price linkage conditions and the influence of the regulation policy on the price.

The various simulation results in Table 5 show that, if the wage-price is not linked, under the circumstances that other conditions are not changed, when the bulk raw material combined price reaches 50% in one-time impact, for the target of 3% inflation, the downstream price up-regulation should not exceed 7.5%; when the price impact reaches over 100%, the price of control can weaken the influence on the general price level, but the downstream price control is unable to achieve the inflation control target. If the price of mining industry is no more than 30%, even without price control measures, the price will rise by about 3%. Therefore, 30% is a critical point for launching price control.

If the wage-price is linked, when one-time price impact reaches 50%, in case of no price controls to downstream products, the cost coverage will make the general price level rise by 8.66%, far exceeding the 3% inflation target. Such impact is large enough to trigger more stringent control measures. If the downstream prices are fully controlled, the general price level will also rise by 3.3%. Therefore, under the wage-price linkage mechanism, the structural price freezing will become an inevitable choice to control inflation. According to the cost coverage plan, if inflation control goal is not more than 3%, the corresponding

increase rate of mining industry price should not exceed 17.5%, which is a very tight redundancy.

If the inflation target is set to 5%, the redundancy of price regulation should be larger. For inflation control target at 5%, downstream price up-regulation space is about 8%; if the price impact reaches 100%, only to completely control the downstream product prices can reach 5% inflation control target. According to the calculation results of Table 6, the general price level rises about 5.13%. If the price impact is 150%, even with complete control to the downstream price, it will be difficult to achieve the 5% inflation target. At this time, the general price level will rise by 9.56%.

The above analysis shows that no matter the 3% or the 5% inflation control target, the bulk raw material price impact and the imported international inflation therefrom during the 2000-2010, is very significant to the cumulative price effect of China, and purely downstream price control is difficult to achieve the desired inflation control target. Specifically for the inflation in 2007-2008, the retail price index rose by 5.4% and 6.6% respectively, price index of resident's living cost rose by 4.8% and 5.9%, and the macroeconomic policy also acted in cooperation with this. At the end of 2007, in the central economic work conference, according to over fast momentum of price rise, it confirmed the implementation of "two-anti" (anti-inflation and anti-overheating) macro-control policies, the implementation of prudent fiscal policy and tight monetary policy. Judged from the source of inflation and driving force, the inflation in 2007-2008 was the typical cost push inflation, and belonged to the imported cost push inflation. The actual situation was the total demand had no significant expansion, and government investment of four trillion yuan after 2008 started to launch due to the impact of the international economic situation. According to Table 2, the international crude petroleum, iron ore and coal prices in 2007-2008 appear to rise sharply, rising by 11.17%, 33.82%, 65%, 79.9%, 38.5%, and 66.31% (northwest European market) respectively, except that in 2009 the U.S. subprime mortgage crisis caused the bulk raw materials prices to fall significantly, so the price in 2009 had negative growth. In 2007-2011, the producer price index (PPI) continued to rise, accumulatively rising by 16.6% over 2006, and the cost push inflation was very significant. After 2012, with the continued decline of the bulk raw materials in the world and the worsening of China's economic overcapacity, PPI in 2012-2016 continued to have negative growth for more than consecutive 5 years.

It should be pointed out that, from the bulk raw material price impact to eventually turning into a real inflation takes time, regardless of the wage-price linkage, simply the cost coverage, not more than one year in principle according to the experience and empirical study. Basically, the final price changes can be fully reflected in the same year or beyond-the-year price data. If considering wage-price linkage, as the salary pricing mechanism is based on the cycle contract, the reaction cycle will be stretched, and there may be a relatively long carry-over effect, which will reduce the need for price control.

If the downstream industry has excessive competition and overcapacity, it will not be able to complete the cost covers, even price is possible to drop sustainability. The consistent drop of China's producer price index (PPI) proved the difficulty of cost coverage.

6. Conclusion and Policy Recommendations

(1) No matter crude petroleum, iron ore or raw coal, the price fluctuation of all these bulk raw materials is an important factor that affects the price level in China, and is the main force to drive the change of China's price level.

(2) For inflation caused by the change in the price of the bulk raw materials, the control of the products price of the downstream industry is the most effective way to control inflation. Adopting the measures of freezing the prices of electricity, thermal and water production and supply, coking, gas and petroleum processing industry, various price indexes decreased by more than 50%, and the CPI decreased from 10.83% to 4.16%. In 2007-2008, our government's strict control measures on electricity and fuel prices were very significant in restraining the inflation at that time. For 50% of the price impact of the mining industry, the rise of CPI was reduced by 2 percentage.

(3) Unlike the conclusion of simple monetary quantity theory, wage indexation does not cause wage-price to spiral according to the path of explosion, but converges to a stable point. However, if wage-price indexation exceeds the cost compensation category of input-output cost pricing, the monetary quantity theory is still effective. In this case, wage indexation policy may lead to the explosive wage-price path. This conclusion can be extended to an indexed VAT, and the indexed VAT has pushed up the price level, but it does not lead to a tax-price spiral.

(4) For specific inflation control objectives, there are different price critical control. For the 3% inflation target, if wage-price is not linked, the impact of 30% of the bulk raw material price is the critical point of price control. If the price impact is greater than 30%, a certain amount of price control is required. If the price has more than 100% impact, even with the complete control of the price of the downstream product, it cannot achieve the expected inflation target. When the wage-price is linked, 17.5% of the bulk raw materials price impact is the critical point of price control, the impact can guarantee CPI under cost coverage not more than the 3% inflation target; If full control of the downstream products with the same prices, as long as the price impact is not more than 50%, the 3% inflation target can be achieved, 50% of the price impact is the critical point of complete price control. When the inflation target is 5%, the price control space is relatively large.

(5) The input-output price formation model formed by introducing wage-price linkage mechanism can be further extended to tax linkage and profit linkage situations. In addition, through the combination of the competition and monopoly pricing characteristics of different sectors, more realistic estimates can be obtained.

ACKNOWLEDGEMENT

None

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest to this work.

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