Assessment of a Green Credit Policy Aimed at Energy-Intensive Industries in China Based on a Financial CGE Model

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Abstract: We establish a financial computable general equilibrium model and try to quantitatively calculate the systematic effects of a green credit policy. We apply punitive high-interest rates to the energy-intensive industries as a green credit policy. This study focuses on the following industries: paper, chemical, cement, and iron and steel. We first conduct three experiments representing green credit policy scenarios over the short-, medium-, and long-term. Then, we simulate a scenario wherein a green security and the green credit policies are both carried out simultaneously. Finally, we compare the policy effects of the green credit policy, the differentiated electricity price policy, and the raised production tax levied on the energy-intensive industries policy. The result shows that the green credit policy is effective in suppressing the investments in energy-intensive industries, and it is comparatively less effective in the adjustment of the industrial production structure. The green security policy helps the green credit policy reduce the total financing of the target

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industries. However, the green credit policy plays the leading role in achieving policy goals. The policies of differential electricity prices and raising production tax help output structural adjustments. However, their negative effects are much larger than those of the green credit policy.

Keywords: Green Credit Policy; Energy-intensive Industries; Financial CGE Model; China

1 Introduction

China has been implementing a green credit policy since 2007. It applies to commercial banks or other financial institutions that provide loans and lower interest rates to environmentally friendly and energy-saving companies. In addition, these institutions apply ease lending and exact punitive (higher) interest rates to companies or investments associated with highly polluting or energy-intensive industries. The purpose is to guide capital into environmental causes and out of enterprises or infrastructure projects that waste resources and pollute the environment. The environmental protection authorities are responsible for the data collection and are expected to provide a strong basis for the implementation of green credit policy on China's banking and financial institutions.

In recent years, banks in China have played a key role in the implementation of the green credit policy, and the rules continue to be updated. In 2009, Bank of China introduced principles on environment security and saving energy in their lending procedure. China Construction Bank provided clean energy credit, industrial environmental mitigation loans, agricultural eco industrial loans, and other green finance services for customers. By the end of 2009, its green credit balance was 181.097 billion yuan. By the end of 2013, policy banks and China Development Bank in Beijing had loan balances in renewable energy and clean energy projects totalling 37.062 billion yuan, or 43.82% of their total loan. They also had their loan balances in energy savings and environmental protection projects amounting to 154.228 billion yuan.[1]

The relation between saving energy or environmental conservation goals and commercial banks in China is closer than in other countries for a reason. China's capital market and insurance market have not yet fully developed and large nationalised commercial banks form the main body of the financial sector in China. Therefore, the country’s state-owned commercial banks should be the principal agent of sustainable finance. In this paper, we simulate green credit policy by building scenarios where commercial banks exact higher interest rates to energy-intensive industries. Then, we analyze its effects on investment reductions, energy savings, and emissions mitigation in the energy-intensive industries.

The existing literature analyzes the impact of the green credit policy on several different aspects, mostly using qualitative analysis methods. Some studies believe that the green credit policy has a positive effect on energy savings, emissions reductions, and economic development (Zheng, 2008; An, 2008; He and Liu, 2008). Many authors studied the relationship between the green credit policy and environmental risk management, and believed that the green credit policy would also be helpful in enhancing the environmental risk management of commercial banks (WANG and JIANG, 2006; Chang et al., 2008; Wei, 2010; HU and CAO, 2011). Some studies also focused on current challenges, essential developments, and execution strategies, among others. Several authors found that green credit policy

[1] See Yuan Q.D. (2012). Green credit and environmental liability insurance. China Environmental Science Press.

was not fully carried out in China or India, and either commercial banks or customers were not giving enough attention to green banking strategies or green projects (Zhang et al., 2011; Biswas, 2011; Verma, 2012). Others believed that there are challenges to face, such as collecting environmental data or information, provisioning financial incentives for commercial banks, avoiding large economic impacts on energy-intensive and high-polluting industries, and clearing policy details and standards (Aizawa and Yang, 2010; Zhang et al., 2011; Verma, 2012).

The existing literature are mostly using qualitative analysis. There have been few studies on quantitative assessment of a green credit policy in both macroeconomic and industrial level. In this paper, our aim is to quantitatively calculate the systematic effects of the policy. We impose punitive higher interest rates on the energy-intensive industries as a green credit policy. We study the effects of the differentiated interest rate policy and its related financial policies on macro economy and industrial activities. We'd also compare the green credit policy as a financial tool with other non-financial industrial policies.

We establish a financial computable general equilibrium (CGE) model for China to study the green credit policy. The model adds a financial sector to a standard CGE model and trace the interactive effects of various financial markets and real markets. The model will be able to simulate changes in the interest rates, credits, and other financial variables to the real economy, and conversely determine investment decisions, product pricings, and other real economic behaviours to the financial market. The financial CGE model makes it possible to estimate the overall impact of the green credit policy on the economic system.

Among the attempts to add the financial sector into CGE models since the 1980s, some focused on currency devaluation and international balance of funds (Easterly, 1990; Rosensweig and Taylor, 1990; Thissen and Lensink, 2001), others used financial CGE models to investigate the income distribution effects (Bourguignon et al., 1989, 1991; Mansury, 2002) or structure adjustment effects (Naastepad, 2002; Khan, 2007) of financial shocks or policies, while a few of them measured the impact of a series of financial liberalization reforms (Lewis, 1992; Yeldan, 1997). However, there are only a few Chinese financial CGE models and hardly any financial CGE model is used to assess the effects of the green credit policy.

2 Methods

2.1 Transmission channel analysis of the green credit policy

When punitive higher interest rates are imposed, target industries would readjust their financing decisions regarding the ratio between direct financing and indirect financing. Overall, the policy will increase the financing costs of the target industries. Increasing the cost will squeeze profit, thereby reducing the investment demands. Alternatively, the higher costs will also be passed to the downstream industries and the final demand by raising the prices of products. If the target industries reduce their investments, outputs might decrease because of the decline in the capital input. However, it is also possible for them to maintain a certain output if they choose to add other inputs in response to the high demand for products in the market.

The rising prices in the target industries will affect their export competitiveness, thereby putting certain pressures on employment and social stability. When the target industries reduce their investments, other industries increase theirs, altering the investment structure. Therefore, the structure of the investment goods demand is changed as well, and so is the entire commodity market structure. Changes to the commodity structure caused by changes in investments, together with production changes in the target industries, will cause forward and backward linkage effects among all industries in the economy. Furthermore, this makes the policy effect more difficult to predict. Both direct and indirect financing markets fluctuate as financing decisions made by the target industries change, including rises in the security market interest rates and so on. Thus, financing in other sectors is affected. With the changes to the investment and financing behaviours of every economic institute, monetary aggregates and interest rates deviate from the former equilibrium values, which would finally affect the prices of the commodities in the market.

During different periods, the green credit policy has different effects, with factor markets reacting differently. Regarding the labour market, for example, in the short-term, the labour force in all industries is not adjusted, and it still plays a role in the original department. In the medium-term, labour begins to flow among departments, but wages do not adjust. In the long-term, labour mobility among departments is completed. The impact on employment is completely weakened and it can be regarded as full employment. With the substitutions among capital, labour, energy, and other factors in the production process—as factor markets provide different responses with time—more uncertainty appears in the green credit policy effects.

The method used in this paper, which is the CGE method, can reflect the interdependence and interaction among multiple departments and multiple markets, as well as uncover more extensive economic ties than the partial equilibrium model. In addition, it estimates the direct and indirect impact of a policy on the overall economic system. Furthermore, this paper adds the financial department to the CGE model, which can describe the interactive effects of various financial markets and real markets. The model will be able to simulate changes in the interest rates, credits, and other financial variables to the real economy, and conversely determine investment decisions, product pricings, and other real economic behaviours to the financial market. The financial CGE model makes it possible to estimate the overall impact of the green credit policy on the economic system.

2.2 The data and model description

This is a static single-country CGE model with a financial department. The database of the financial CGE model is the Financial Social Accounting Matrix (FSAM) with extended financial sectors. Accounts in our FSAM are: 42 production sectors[2], the current accounts of institutions (household, energy enterprise, energy-intensive

[2] For display convenience, we demonstrate 15 aggregate industries, which are agriculture, coal, crude oil, paper, petroleum, chemical, cement, metal, electricity, construction, traffic, light industries, mining, heavy industries and service.

enterprise, other enterprise, government, rest of world), financial accounts of the same institutions, bank systems (commercial bank and central bank), and financial asset accounts (deposit, loan, enterprise bond, government bond, foreign asset, FDI, foreign lending and so on). The benchmark data of the financial CGE model are obtained from a Chinese social accounting matrix from 2007 for the real side, and the flow of fund table and balance sheet from 2007 from the Central Bank of China for the financial side, as well as a balance of payment table. The data of the enterprises are calculated based on the annual reports of the listed companies.

The schematic FSAM is shown in Table 1. The accounts from 11 to 17 are filled with data split from the 'savings' data in the Chinese SAM of 2007. They represent new debts or new assets of institutions where the consistency between real and financial accounts is maintained. The specification of the real side of the model follows that of the standard CGE model developed by IFPRI in 2002. Readers can refer to Löfgren et al. (2002) for a detailed description of the model specifications. However, our model differs from the standard CGE model in two important aspects. One is in the modelling of energy use. As Figure 1 shows, we consider four kinds of energy (crude oil, petroleum, coal, and electricity) as input factors, together with labour and capital. Thus, we can pinpoint the role of energy in economic activities and take into account the finite substitutions among different kinds of energy, as well as among energy and other input factors. The second aspect where our model differs is in the financial module. We extend the savings-investment closure in the standard CGE models by making use of financial intermediation to achieve the transformation of savings to investments.

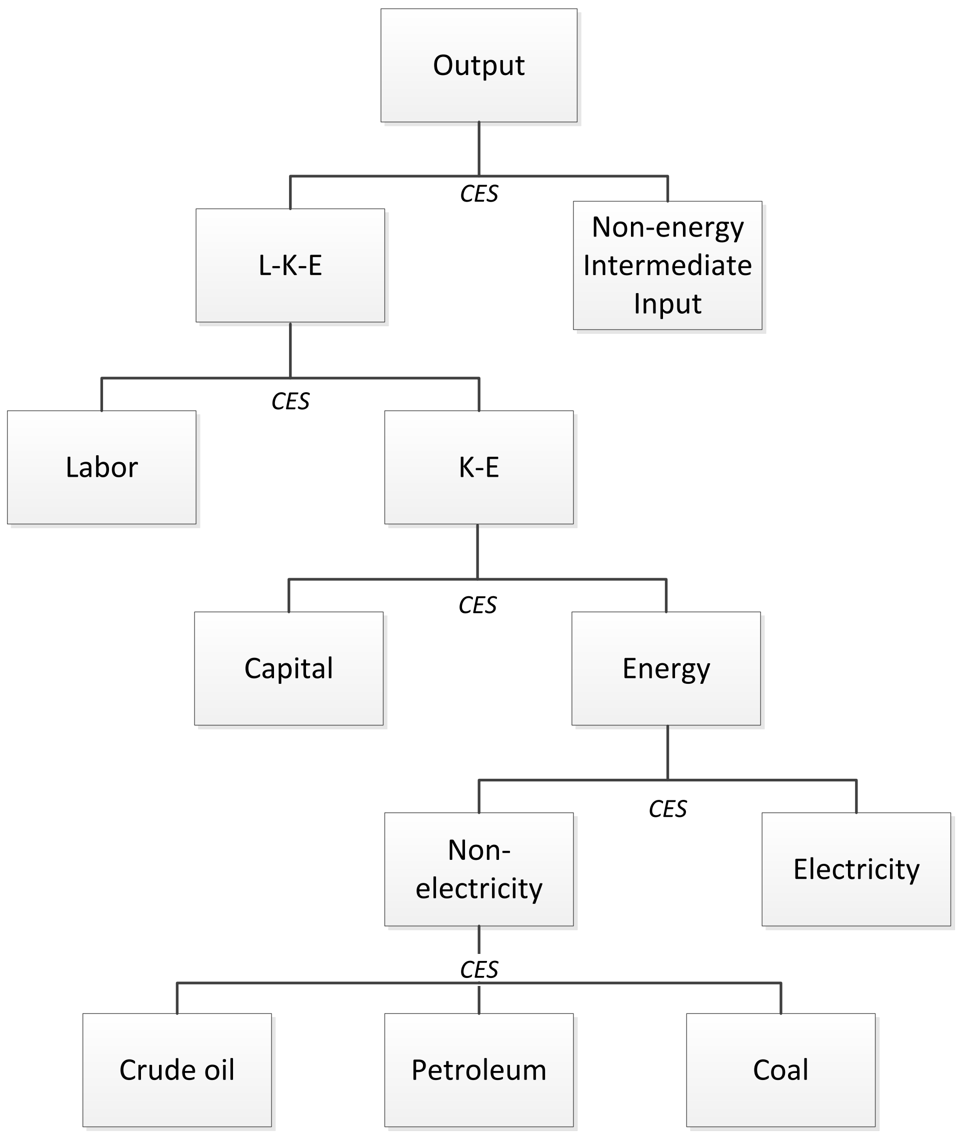

Figure 1 Structure of Production Function of the FCGE Model

Figure 2 demonstrates the financial intermediate channels with dotted lines, and real economic activity channels with solid lines. The financial decisions of institutions

Table 1 A Schematic FSAM

		Production		Factors		Current Account of Institutions				Fixed Investment	Inventory	Capital Account of Institutions						Financial Flows	Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Production	1		IMI			HHE		GOE	EXP	FCF	III								Total Demand
	2	DOS																	
Labor	3		LAI																Factor Income
Capital	4		CAI																
Households	5			LI	CI		TR	TR	TR										Income of Institutions
Enterprises	6				CI														
Government	7	TRF	PRT			IT	IT												
Rest of World	8	IMP						TR											
Fixed Investment	9											INV	INV	INV					Investment
Inventory	10									III									
Households	11					SAV												FL	Changes in Liabilities of Institutions
Enterprises	12						SAV											FL	
Government	13							SAV										FL	
Commercial Bank	14								SAV									FL	
Central Bank	15																	FL	
Rest of World	16																	FL	
Financial Flows	17											FA	FA	FA	FA	FA	FA		Financial Flows
Total	18	Total Supply		Factor Income		Expenditure of Institutions				Investment		Changes in Assets of Institutions						Financial Flows	

Notes: The description of the notations in the table is as follows. IMI: intermediate inputs. HHE: household expenditures. GOE: government expenditures. EXP: exports. FCF: fixed capital formulation. III: increase in inventory. LAI: total labor income. CAI: capital income. LI: labor income to institutions. CI: capital income to institutions. TR: Transfer payments. TRF: tariff. PRT: production tax. IT: income tax. Imp: imports. Inv: investment. SAV: savings of institutions. FL: changes in financial liabilities. FA: changes in financial asset (i.e., household, enterprises, government, rest of world) include real investment, financial investment, financing decisions, and so on. The financial decisions of the household sector are demanding currency and investing in loanable fund market. The latter means keeping money in commercial banks, while the former depends on price levels, real output, and interest rate levels. The financial decisions of enterprises include financing from the loanable fund market, enterprise bond (security) market, and the rest of the world. Enterprises make the financial decisions according to the relative interest rates of the different financing sources. There is one aggregate commercial bank account that represents all the commercial banks in China. It collects deposit from institutions, lends money to enterprises, holds government bonds, and hands deposit reserves over to the central bank. And the central bank issues currency, collects deposit reserves, and holds government bonds and foreign exchange reserves. The commercial bank and the central bank accounts do not have the optimizing behaviours like private institutions do. Instead and they are responsible for collecting accounts data and balancing the financial SAM.

2.3 Green credit policy module

Below are the model specifications that are closely related to the operation of the green credit policy.

Equation 1 is the investment demand function. The investment demand of each industry is decided by the capital cost, the price of the investment goods, and the profit rate of the investment. WF_{cap} is the profit rate of the investment, which has

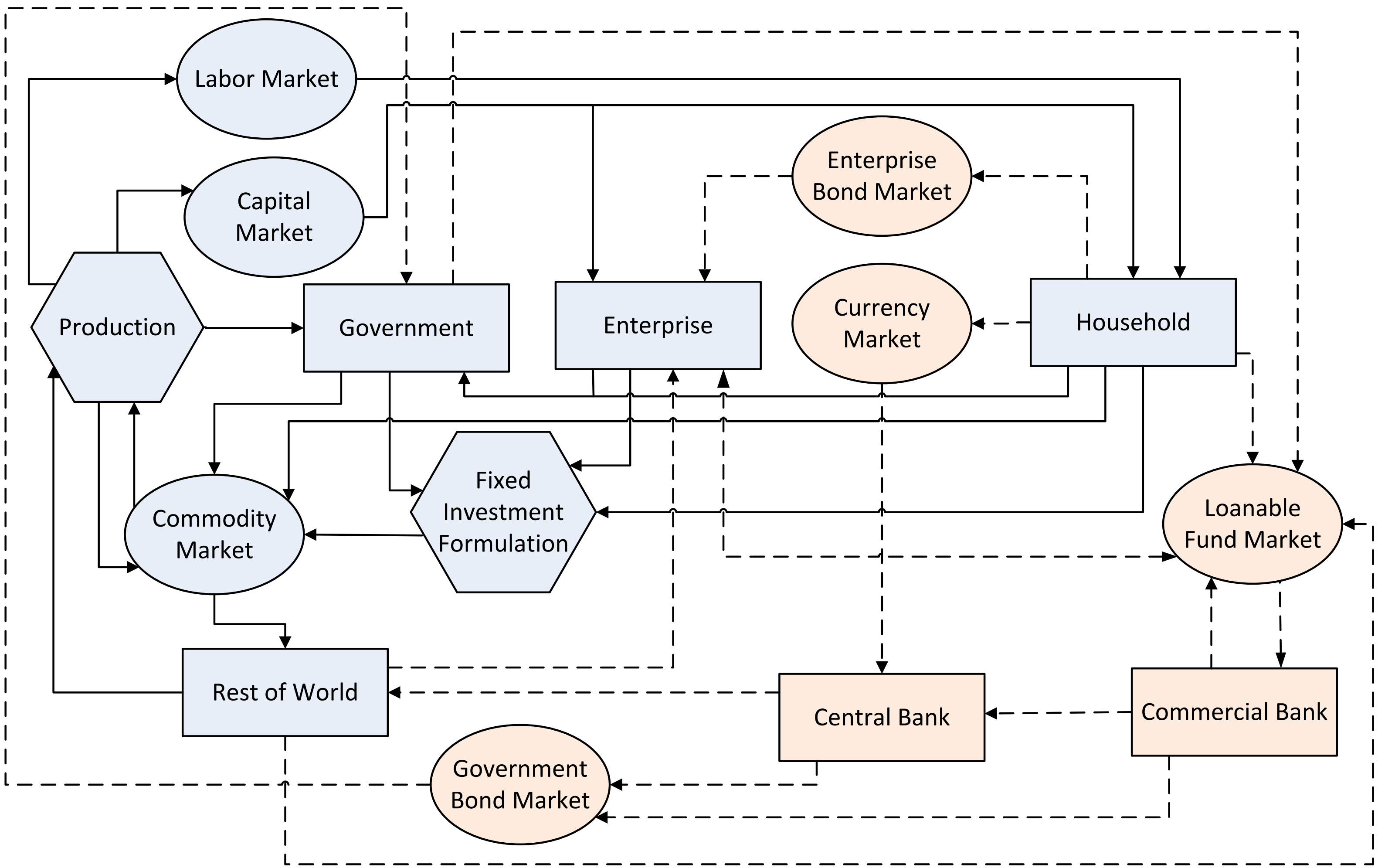

Figure 2 Schematic Diagram of the FCGE Model

taken the capital cost into account. The capital cost in the model is made up of interest cost of the loan, the security cost, and other financing costs. ZD_a represents real investment demand by sector of origin; λ_a is a scale parameter of investment; PINF is the inflation rate; PK_a is the price of the investment goods for industry a; εzd_a is the exponent parameter of the investment demand equation; $QF_{cap,a}$ is the capital input of industry a.

$$ZD_a = \lambda_a \cdot (WF_{cap} \cdot WFDIST_{cap,a} / (1+PINF) \cdot PK_a)^{\varepsilon zd_a} \cdot QF_{cap,a} \tag{1}$$

Equation 2 means that the profit rate of a commercial bank is constant. Instead of a zero profit assumption of commercial bank sector, we assume that the aggregate commercial bank keeps a constant profit margin. State-owned commercial banks provide the most loan fund in the loanable fund market in China, and interest rates are not fully floating. So the assumption in Equation 2 would be consistent with China's situation. INTRSTD represents the interest rate of the deposit; $FSTOCKD_{ins}$ is the financial stock of the deposit for institution ins.; shprofitb is the profit share parameter of commercial bank. $INTRSTC_{insp}$ is the interest rate of a commercial bank loan for a private institution insp.; $FSTOCKE_{insp}$ is the financial stock of a loan for a private institution insp.

$$\sum (INTRSTD \cdot FSTOCKD_{ins}) * shprofitb = \sum (INTRSTC_{insp} \cdot FSTOCKE_{insp}) \tag{2}$$

Equation 3 means that capital gains in the model include interest costs and the profit of capital. YF_{cap} is the total capital gains. Since capital cost has been counted in WF_{cap}, the capital gains in the whole economy should add the capital cost back.

$WFDIST_{cap,a}$ indicates capital cost difference across industries. $OMEGA1_{e,a}$ is sector a's share parameter of the real investment for enterprise e. $FSTOCKC_e$ is the financial stock of credit for enterprise e; $FSTOCKB_e$ is the financial stock of enterprise security for enterprise e.

$$YF_{cap} = \sum (WF_{cap} \cdot WFDIST_{cap,a} \cdot QF_{cap}) + \sum\sum (INTRSTC_e \cdot OMEGA1_{e,a} \cdot FSTOCKC_e + INTRSTB_e \cdot OMEGA1_{e,a} \cdot FSTOCKB_e) \quad (3)$$

Equation 4 shows that the capital input of each activity includes the initial capital stock and investment, so that the change of investment would affect the production activities in each sector. $QF0_{cap,a}$ means the initial capital stock of industry a.

$$QF_{cap,a} = QF0_{cap,a} + ZD_a \quad (4)$$

Equation 5 and 6 show that the ratio of a commercial bank loan to direct financing depends on the relative interest rates of the loan and security. The interest rates of the loan towards each type of enterprise are exogenous and are policy variables. Meanwhile, the interest rates of the security are endogenous, which reflects the change of supply and demand in the security financing market. $FFLOWC_e$ is the financial flow of credit for enterprise e; $FFLOWB_e$ is the financial flow of enterprise security for enterprise e; $g2_e$ is the share of the commercial loan to the total borrowing of enterprise e; INTRSTA is the interest rate of the borrowing for industry a.

$$FFLOWC_e = g2_e \cdot (FFLOWC_e + FFLOWB_e) \quad (5)$$

$$g2_e / (1 - g2_e) = \psi_e \cdot ((1 + INTRSTC_e) / (1 + INTRSTA))^{\varepsilon 2_e} \qquad (6)$$

2.4 Features of the financial CGE model

Endogenous price level: standard CGE models need a numeraire to decide other relative prices, usually some weighted price index like labour wage. But it has limitations when explaining macro issues like inflation. This model takes the price of currency as a numeraire, so other prices of commodities or wages can be seen as absolute prices. Thus the price level is endogenous.

Non-neutrality of money: the structure features of the model, such as the fixed labour wage or price control in certain industries, together with the assumption that savings and investment are decided by real interest rate, support the assumption of money's non-neutrality this model. That is, the change of price level would affect real variables (real output of each industry, real import, real export and so on).

Since money is non-neutral, the price level is endogenous, and there are structure adjustments in real economy and financial economy, it is possible to model the process of interaction and mutual influence of real side and financial side of the economy.

3 Results and Discussion

3.1 Scenario settings

The target industries are the paper, chemical, cement, and iron and steel industries.[3]

Table 2 shows us the scenario settings. We first conduct three experiments, representing the green credit policy scenarios over the short-, medium-, and long-term, respectively. The loan interest rate for energy-intensive industries would be two percentage points higher than that for other industries. According to the presumption that the profit rates of commercial banks are constant, the loan interest rates for other industries would be lower than the initial ones. In the S0a scenario, we conduct a short-term green credit policy experiment. We maintain fixed labour employment in each industry. In the S0b scenario, we conduct a medium-term green credit policy experiment. Compared to the S0a scenario, we allowed labour to flow among the industries, and the average labour wage is exogenous, while unemployment is permitted. In the S0c scenario, we conduct a long-term green credit policy experiment. Compared to the S0a scenario, we also allowed labour to flow among industries, and the average labour wage is endogenous with full employment.

Second, according to the transmission channel analysis of the green credit policy in section 2.2, enterprises in the energy-intensive industries may turn to alternative financing choices in the direct financing market under green credit policy. It is reasonable that the government would limit their financing in the direct

[3] Energy industries are among the high-emission industries. However, as we calculated from the model, restricting the credit of energy industries has a larger negative effect on other industries, since energy is the foundation of our economy. To avoid a major shock to our economy, we should appropriately protect the energy industries. This paper does not involve the energy industries as target sectors.

Table 2 Scenario Settings

Scenarios	Scenario Explanation	Sub-scenarios	Scenario Explanation
S0	Loan interest rate for energy-intensive industries would be 2 percentage higher	S0a	Short term: labor employment fixed in each industry
		S0b	Medium term: labor flow among industries, average labor wage exogenous, unemployment
		S0c	Long term: labor flow among industries, average labor wage endogenous with full employment.
S1	Green security and green credit policies both carried out.	S1	Green security and green credit policies are both carried out.
S2	Comparison to 2 other policies -- differentiated electricity price policy and production tax policy	S2a	Levy production tax in target industries 1 percentage points higher than in others
		S2b	Electricity price in target industries is 20% higher than that in other industries

financing market. Thus we simulate the S1 scenario, wherein the green security and green credit policies are both carried out. The green security policy refers to the listed companies that must pass the environmental audit by the environmental authority during the listing, financing, and refinancing processes. This policy makes it harder for target industries to obtain financing from the direct financing markets. Thus, we can see the effects with both policies constraining financing for target industries in both direct and indirect financing markets. We decrease the elasticity of the substitution between loans from commercial banks and security financing. At the same time, we implement a green credit policy as in S0b.

Lastly, due to high demand of products of the energy-intensive industries, green credit policy might have limited effects on the outputs of the target industries. We would like to compare the policy effect of the green credit policy with that of the differentiated electricity price policy and the raising production tax of target industries policy, two policies working through the demand side. In the S2a scenario, we levy a production tax in the target industries at one percentage point higher than other industry taxes. According to the zero profit rate assumption of the electricity industry, the electricity prices of other industries decrease slightly. In the S2b scenario, the electricity prices in the target industries are 20% higher than in other industries. According to the tax neutrality principle, the production taxes of other industries decrease slightly.

3.2 Policy effects analysis of green credit in the short-, medium-, and long-term

3.2.1 Impacts on financing flows and financing cost of S0 scenarios

Table 3 Changes in Financing Flows and Financing Cost

Unit: Billion Yuan

	Enterprise types	Bank Loan	Security Finance	Loan Interest (%)	Security Interest (%)	Average Interest (%)
S0a	Energy Intensive	-6.675	6.155	1.762	0.313	1.100
S0b	Energy Intensive	-6.922	5.967	1.762	0.296	1.092
S0c	Energy Intensive	-6.624	6.195	1.762	0.315	1.101
S0a	Others	4.502	0.129	-0.238	0.313	-0.182
S0b	Others	3.971	0.078	-0.238	0.296	-0.183
S0c	Others	5.337	0.223	-0.238	0.315	-0.182

From Table 3, we can see that in general, the green credit policy increases the loan interest rates of the target industries and the average finance cost, as a result. Thus, the loans of those industries decrease and security financing increases. However, the total amount of financing decreases. For other industries, the loan interest rates decrease and so does the average finance cost. Thus, the amount of both commercial bank loans and security financing increases.

In the short-term, when the green credit policy is implemented, the loan interest rates of the target industries increase by 1.762%. The security interest rate decreases by 0.313%, while the average finance cost increases by 1.1%. These industries would cut their bank loans by 6.675 billion yuan and increase their security financing by 6.155 billion yuan. Meanwhile the loan interest rate of the other industries decreases by 0.238%, while their average finance cost decreases by 0.182%. The other industries would increase their bank loans by 4.502 billion yuan and cut their security financing by 0.129 billion yuan.

In the medium-term, compared to the short-term, the target industries decrease their financing amounts in the direct and indirect finance markets, respectively. The target industries further reduce their loans from commercial banks by 0.247 billion yuan, and security financing decreases by 0.088 billion yuan. The security interest rate decreases again by 0.017%, and the average financing cost decreases by 0.008%. The other industries reduce the bank loans compared to S0a scenario by 0.531 billion yuan, and security financing by 0.129 billion yuan. Their average financing cost decreases by 0.001%.

In the long-term, compared to the medium-term, the target industries raise the total financing. Bank loans increase by 0.298 billion yuan and security financing increases by 0.028 billion yuan. The security interest rate increases by 0.019% more than in the medium-term, and the average finance cost increases by 0.003%. The other industries also raise the total financing. Their bank loans increase by 0.366 billion yuan and security financing further increases by 0.145 billion yuan. Their average finance cost decreases by 0.001%.

Among the three different periods, it is in the medium-term scenario that the target industries have the least amount of total financing and the strongest policy effect. The short-term effect takes second place, and the long-term has the weakest policy effect.

3.2.2 Impacts on production prices of S0 scenarios

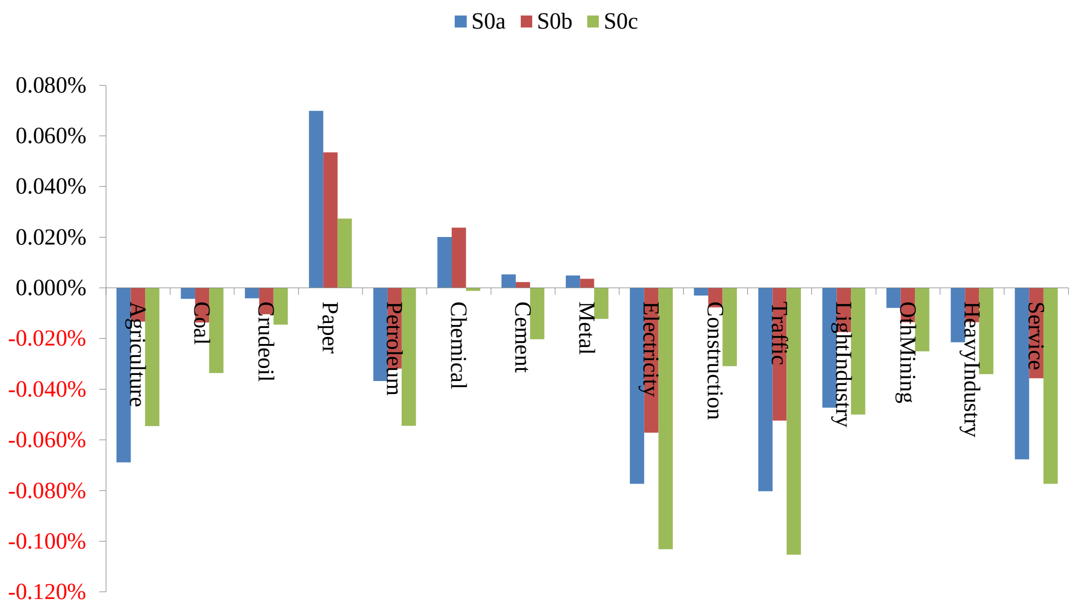

Figure 3 Percentage changes of industrial production prices of S0 scenarios

From Figure 3, we find that the paper, chemical, cement, and iron and steel industries all experience slight increases in their production prices by less than 0.08%, then they pass some of their increased costs to the downstream enterprises and the final demand. Prices do not increase much because some increased finance costs squeeze profit margins, and interest costs account for a small proportion of the total cost. The finance cost increases and the profit rate shrinks, which will harm the investment activities in the target industries.

3.2.3 Impacts on investment of S0 scenarios

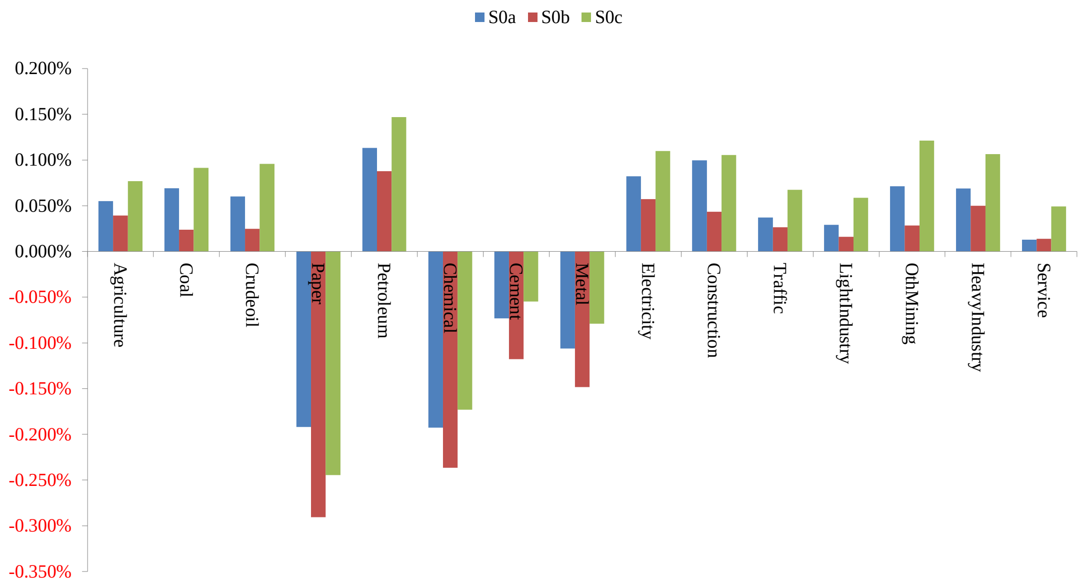

Figure 4 Percentage change of industrial investment of S0 scenarios

As Figure 4 shows, the investments in all the target industries decrease by 0.05% to 0.3% in a different period, while those in all other industries have risen. This indicates that the green credit policy can effectively restrain the excessive growth of the investments in the target industries, and it can allocate the saved capital to other industries. In these three scenarios, the depressing effect of the green credit policy towards paper and chemical industry investments is better than that towards the cement and metal smelting industries.

In the short-term, investments were reduced by about 0.2% in the paper and chemical industries, by about 0.073% in the cement industry, and by about 0.106% in the metal smelting industry. In the medium-term, compared with the short-term, their investments are all further reduced. Investments in the other industries are reduced as well. This is because when the labour begins to adjust, the process possibly accompanies unemployment. The economy slows down, and likewise the investments slow down along with it. In the long-term, investments in target industries will bounce back compared to the short-term effects, except for the paper industry. From the perspective of the investment reduction goal, the medium-term effect of green credit policy is the strongest.

During all the time periods, investment in the other industries are all increasing, indicating that the green credit policy is guiding capital into environmental causes and out of enterprises or infrastructure projects that waste resources and pollute the environment, and that the investment levels in the economy will not be affected as a whole.

3.2.4 Impacts on real output of S0 scenarios

From the medium-term industry output results in Figure 5, the green credit policy successfully curbs production in the paper and chemical industries. However, in the long-term, the suppression of the target industries' output is ineffective.

In the short-term, the green credit policy curbs the output of the paper and chemical industries more effectively than the cement and metal smelting industries.

This is mainly because the commodities in the cement and metal smelting industries are main investment goods. Since the rise in capital cost has little effect on the production prices of the target industries, the prices of investment goods would not decrease much. When the target industries reduce their investments, other industries increase theirs, and the overall economic investment is undiminished. Therefore, demand for cement and metal remains high, which will maintain high levels of output in these two industries.

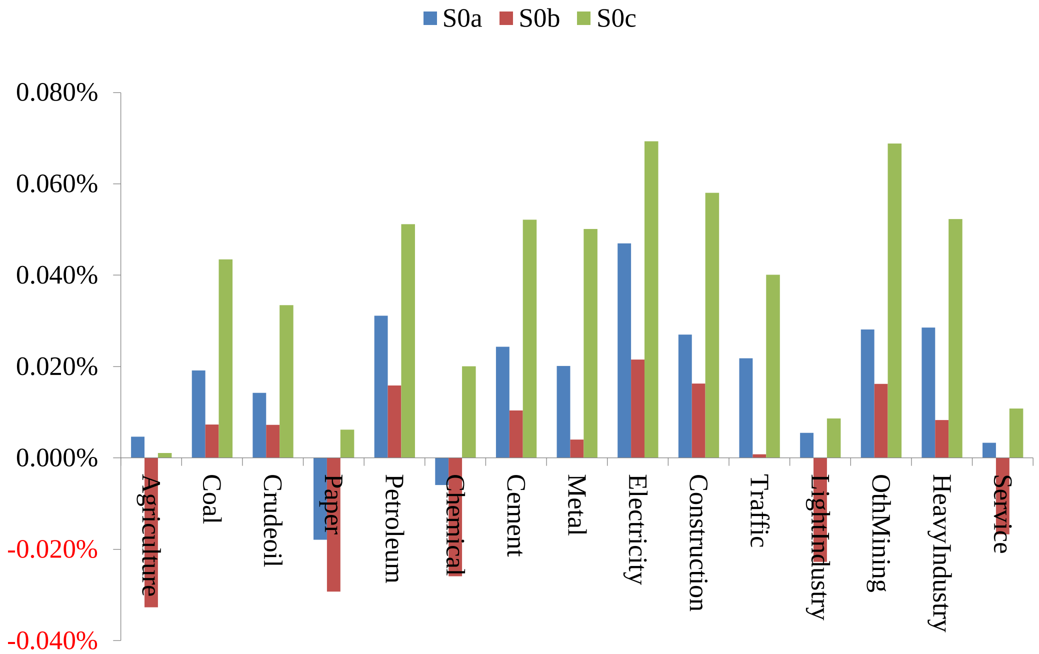

Figure 5 Percentage change of industrial real output of S0 scenarios

In the medium-term, as the labour force flows freely among the various departments, the relative labour wages of the various departments are fixed. Industries will not depress wages to offset the rising costs. The outputs of the target industries will decline compared to the short-term, and this will adversely effect agriculture, light industries, the service industry, and other labour-intensive industries.

In the long term, the output of target industries will bounce back. When the real wages decline from the medium-term to the long-term, the target industries will hire more labour or increase hours of labour to compensate for the capital shortage and to increase output, which will offset the green credit policy effect on the target industries' outputs.

The impacts on industrial output are smaller than those on investment. Green credit policy has direct effects on capital cost and relative direct effects on investments. It has small and positive effects on production prices as we have discussed in section 3.2.2. Thus it has limited effects on industrial output from the demand side.

About 90% of the target industries' outputs are used as intermediate inputs, and 10% are used as exports. Of the 90%, 30% are used as intermediate inputs of the paper, chemical, cement and metal smelting industries themselves, and 40% are used as intermediate inputs of the heavy manufacturing and construction industries, which see exports and investment goods as final demands. As the capital costs have little effect on the price of the product, the target industries may not reduce output because of price promotions. In fact, when other industry investment demands rise slightly, the market demand for investment goods is also guaranteed. High export and investment demands counteract the green credit policy effect.

3.2.5 Impacts on exports of S0 scenarios

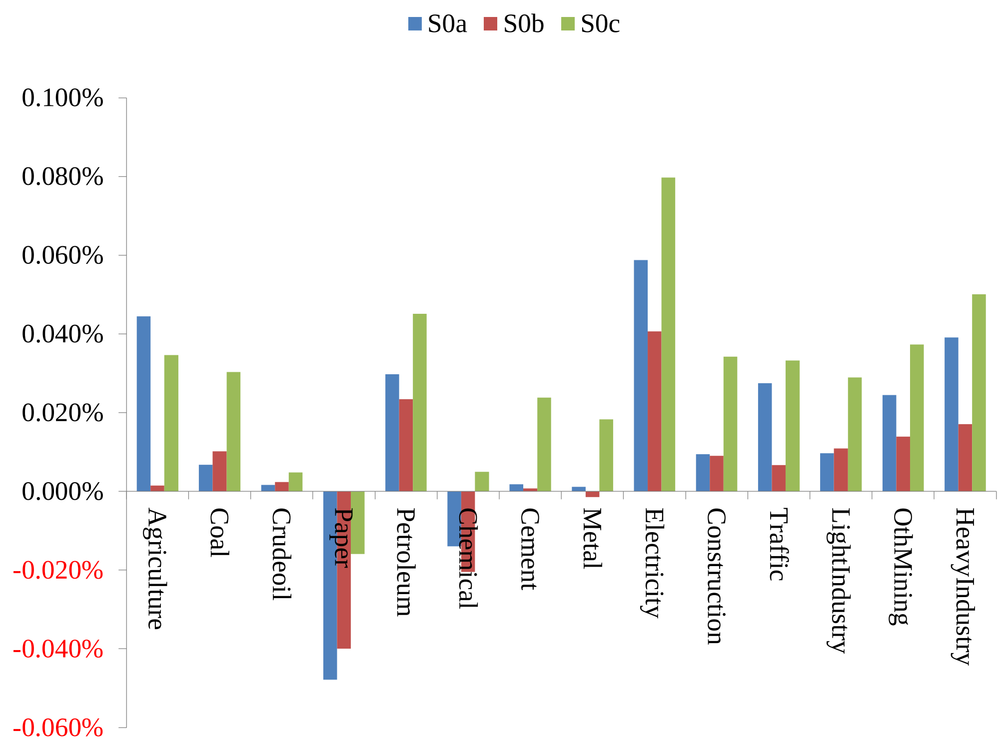

Figure 6 Percentage changes of industrial exports of S0 scenarios

As we can see from Figure 6, the paper and chemical industries are more adversely affected than the cement and metal smelting industries. The export of the paper industry decreases by 0.48% in the short-term, and by 0.40% in the medium-term. The export of the chemical industry decreases by 0.014% in the short-term and by 0.020% in the medium term. In the short- and medium-term, the exports of paper and chemical reduce, while those of the cement and metal smelting industries are hardly affected. And In the long-term, the negative impact on the exports will be greatly eased.

3.2.6 Macro impacts of S0 scenarios

Table 4 shows that, from the perspective of the real GDP, the long-term effect is the most positive. The short-term effect takes second place, and the medium-term effect is third. Among the three scenarios, the largest to smallest drops in the price level are, as follows, long-term, short-term, and medium-term.

In the short-term, the price level drops. The gross domestic product (GDP) deflator falls by 0.047%, the consumer price index (CPI) decreases by 0.057%, and the producer price index (PPI) decreases by 0.032%. The nominal GDP falls by 0.035% and the real GDP rises by 0.011%. In the medium-term, the labour flow among departments and unemployment is allowed. Thus, the real GDP decreases by 0.011%. The employment rate drops by 0.034%, and the price level rises slightly more than that in the short-term, yet it is still falling. In the long-term, labour mobility between departments continues, but with full employment. The real GDP rises higher than in the medium-term and the average price level declines further. The negative effects on the macro-economy are within an acceptable range, indicating that the policy might be favorable.

Table 4 Macro Impacts of S0 Scenarios

Unit: %

	S0a	S0b	S0c
Nominal GDP	-0.035%	-0.033%	-0.035%
Real GDP	0.011%	-0.011%	0.027%
GDP Deflator	-0.047%	-0.022%	-0.064%
CPI	-0.057%	-0.027%	-0.064%
PPI	-0.032%	-0.016%	-0.045%
Employment	0.000%	-0.034%	0.000%

3.3 Green credit policy and green security policy

3.3.1 Impacts on financing flows and financing cost of the S0b and S1 scenarios

Table 5 Changes in Financing Flows and Financing Cost of S0b and S1 scenarios

Unit: Billion Yuan

Scenarios	Enterprise types	Bank Loan	Security Finance	Loan Interest (%)	Security Interest (%)	Average Interest (%)
S0b	Energy Intensive	-6.922	5.967	1.762%	0.296%	1.092%
S1	Energy Intensive	-6.918	5.940	1.762%	0.347%	1.115%
S0b	Others	3.971	0.078	-0.238%	0.296%	-0.183%
S1	Others	3.943	0.049	-0.238%	0.347%	-0.178%

The green credit policy restricts the indirect financing of energy-intensive industries. Meanwhile, the green security policy makes it harder for these industries to finance the indirect financing market. We expect that if we implement both policies, it would be easier to achieve our goals of limiting the investments in the target industries, energy savings, and emissions reductions. In this model, we assume that the substitution elasticity is reduced between the bank loan and security financing in the S1 scenario with the additional green security policy.

As we can see from Table 5, the target industries reduce their security financing by 27 million yuan in the S1 scenario compared with the S0b scenario. They reduce their bank loan as well by 4 million yuan. Overall, the ratio between the indirect and direct financing amounts declines to lower than that in the S0b scenario, wherein only the green credit policy applies. The security interest rate relatively rises by 0.051%, and the average interest rate rises by 0.023% for the target industries, and by 0.005% for the other industries. The result indicates that the green security policy helps the green credit policy to reduce the total financing of the target industries. However, the green credit policy plays the leading role.

3.3.2 Impacts on investment of the S0b and S1 scenarios

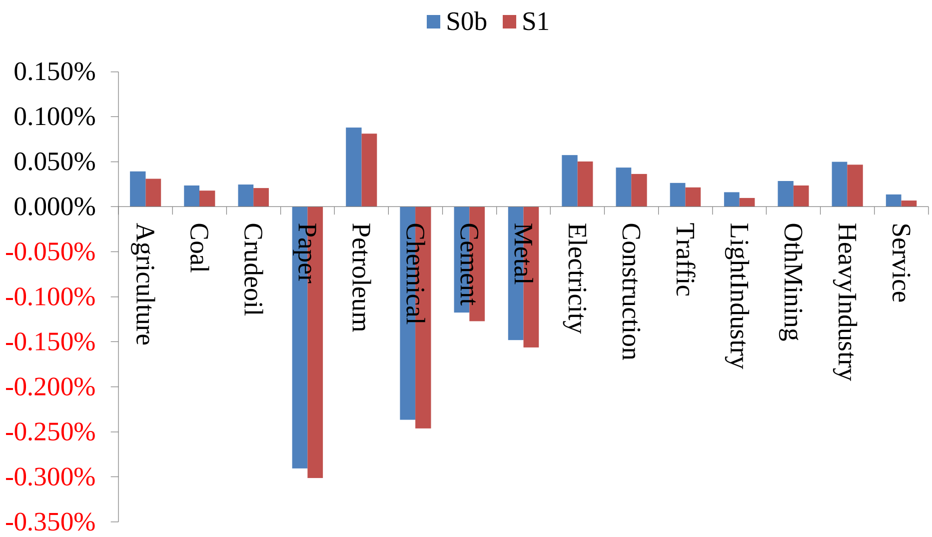

Figure 7 Percentage change of industrial investment of S0b and S1 scenarios

From Figure 7, each industry reduces its investment slightly, and the target industries have tightened their financing channels. For other industries, their increasing average financing costs cause them to reduce their investments as well. Thus the green security policy not only lowers the investment in the target industries, but also lowers the investment in the other industries.

3.3.3 Impacts on real output of S0b and S1 scenarios

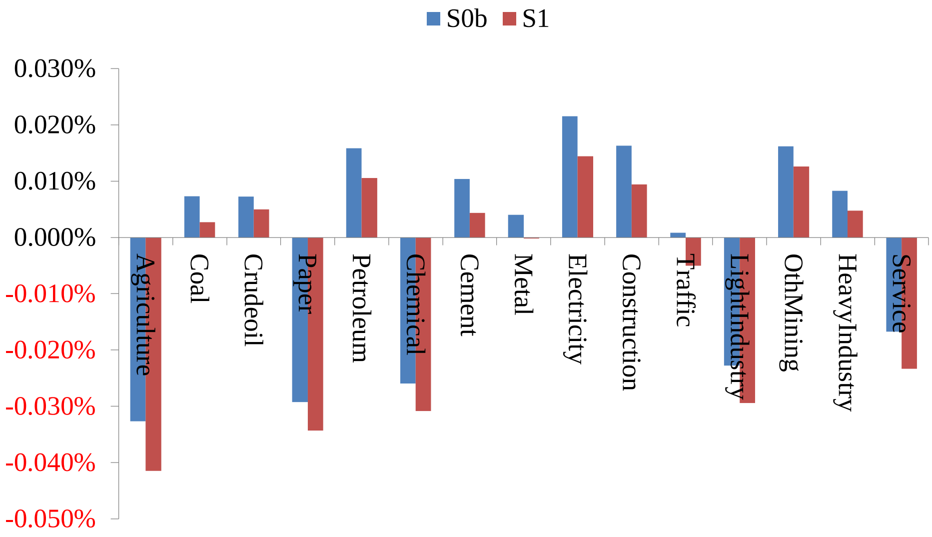

Figure 8 Percentage change of industrial real output of S0b and S1 scenarios

Figure 8 shows that when the green security policy is implemented together with the green credit policy, the real outputs in both the target industries and the other industries decrease. This means that the use of the green security policy would have a more negative effect on the economy; in the meantime, it strengthens the policy effects of green credit.

3.4 Green credit policy and other industrial policies

3.4.1 Impacts on production prices of the S0b and S1 scenarios

We can see from Figure 9 that the differential electricity prices policy and the tax policy influence the total demand, mainly through the impact on prices to reduce output. Their impacts on product prices are far greater than the green credit policy's. In the S2a and S2b scenarios, the product prices of the target industries rise by more than 0.5%. In S2a scenario, electricity price in the target industries is 20% higher than that in the other industries. According to the zero profit rate assumption of the electricity industry, the electricity prices of other industries would decrease.

Figure 9 Percentage changes of industrial production prices of S0b and S2 scenarios

3.4.2 Impacts on investment of S0b and S1 scenarios

We can see from Figure 10 that the green credit policy curbs investments and focuses on target industries more than differential power prices and tax policies do. It also has a less negative effect.

In S2a scenario, differentiated electricity price policy is ineffective in supressing investments in the cement and metal industries. The investment in the cement industry increases by 0.433% when the differentiated electricity price policy is implemented. The investment in the metal industry also increases by 0.382%. When the policy increases the energy input cost of energy-intensive industries, more capital or other inputs might be needed to achieve the optimal production conditions. Thus the investment increase in cement and metal industries is reasonable. Meanwhile in S2b scenario, the production tax policy helps to reduce investments in the target industries. Although, it also reduces investments in the other industries and as a result harm the investment level of the whole economy.

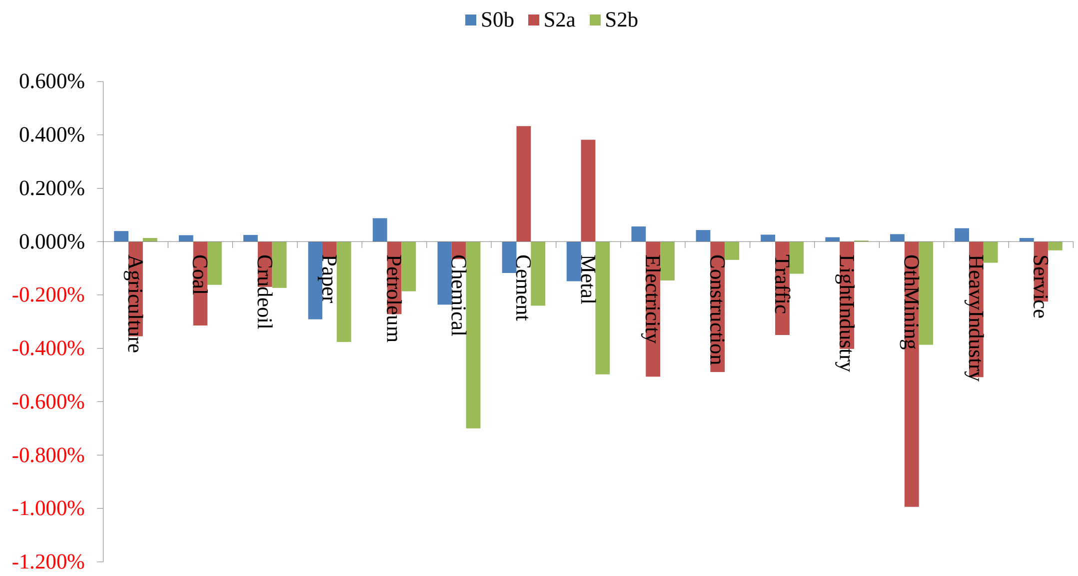

Figure 10 Percentage change of industrial investment of S0b and S2 scenarios

3.4.3 Impacts on real outputs of the S0b and S1 scenarios

From Figure 11, the differential electricity prices policy and the tax policy suppress the target industries' outputs more effectively than the green credit policy. However, their negative effects on other industries are greater. In the S2a scenario, the outputs of the four industries fall in the range of 0.35–0.9%. While in the S2b scenario, the outputs of the target industries decrease in the range of 0.25-0.7%. The outputs of some other industries decrease as well in both scenarios, such as those of construction, transportation, heavy manufacturing, service, and mining industries in the S2a scenario, and the heavy manufacturing and energy industries in the S2b scenario. Meanwhile in the S2a scenario, the consumption of electricity increases, as well as coal and oil. When the other industries have lower electricity price, they would consume more power, and thus more coal is burned. Then when the target industries turn to use coal and oil to substitute electricity, they would consume more coal and oil as well. Thus the electricity price policy fails to meet the emission reduction goal. It is also possible that the other industries do not have lower electricity price. However the alternative policy might do more harm to the macro economy.

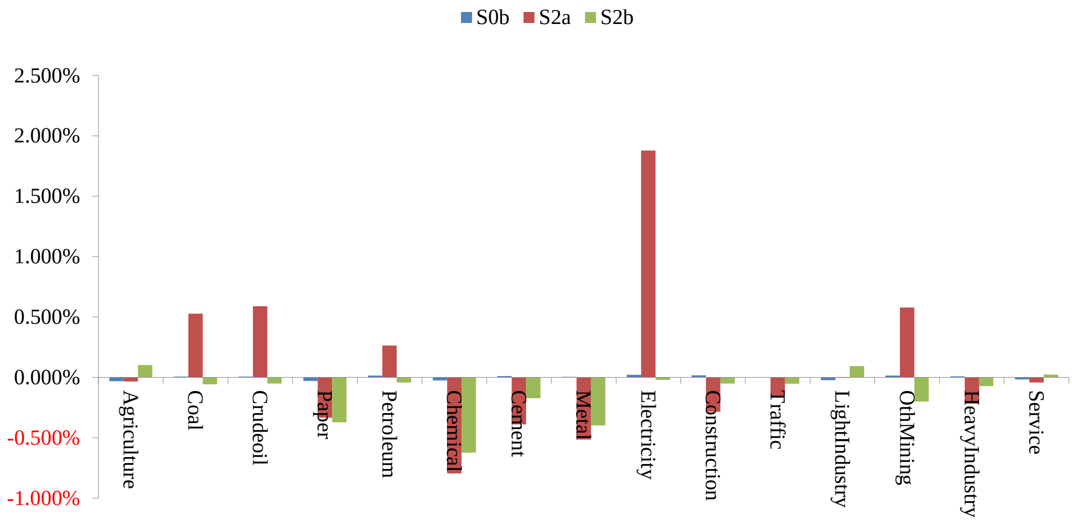

Figure 11 Percentage change of industrial real output of S0b and S2 scenarios

3.4.4 Macro impacts of S0b and S1 scenarios

Table 6 shows that the decreases in the GDP in the S2a and S2b scenarios are larger than that in the green credit policy simulation. In the S2a scenario, the nominal GDP decreases by 0.01% and the real GDP decreases by 0.201%. In the S2b scenario, the nominal GDP decreases by 0.001% and the real GDP decreases by 0.056%. The employ rate decreases by 0.034% in the S0b scenario, by 0.108% in the S2a scenario. In the S2b scenario, additional tax revenue has been returned in lump-sum to the household. The employment rate increases and so does the household welfare. The green credit policy has a negative impact on the price level, while the differential power prices policy has a positive effect on the price level. In the differentiated electricity price policy simulation in the S2a scenario, CPI increased by 0.023%, PPI increased by 0.108%, and GDP deflator increased by 0.198%. In the tax policy simulation in the S2b scenario, the GDP deflator index increased by 0.056%, the PPI increased by 0.116%, but the CPI decreased by 0.044%.

Table 6 Macro Impacts of S0b and S2 scenarios

Unit: %

	S0b	S2a	S2b
Nominal GDP	-0.033	-0.010	-0.001
Real GDP	-0.011	-0.201	-0.056
GDP Deflator	-0.022	0.198	0.056
CPI	-0.027	0.023	-0.044
PPI	-0.016	0.108	0.116
Employment	-0.034	-0.108	0.004

4 Conclusions

China has been implementing a green credit policy since 2007. There have been few studies on quantitative assessment of a green credit policy in both macroeconomic and industrial level. We establish a financial computable general equilibrium (CGE) model for China and try to quantitatively calculate the systematic effects in China of the green credit policy. We first conduct three experiments representing green credit policy scenarios over the short-, medium-, and long-term. Then, we simulate a scenario wherein a green security and the green credit policies are both carried out simultaneously. Finally, we compare the policy effects of the green credit policy, the differentiated electricity price policy, and the raised production tax levied on the energy-intensive industries policy.

The results show that the green credit policy can effectively restrain the investment activities in energy-intensive industries during all periods. It can reduce the outputs of the paper and chemical industries in the short- and medium-term, but it lacks the effect on the outputs of the cement and metal smelting industries. In the long-term, however, the output and investment in the target industry will bounce back. The negative effects on the macro-economy are within an acceptable range, indicating that the policy might be beneficial on the country as a whole.

The green security policy helps the green credit policy reduce the total financing of energy-intensive industries. The use of the green security policy would have a more negative effect on the economy. In addition, the green credit policy plays the leading role.

The green credit policy is effective in suppressing the investments in the target industries and comparatively less effective on the adjustment of the production structure, especially on the cement and metal smelting industries. Alternatively, the policies imposing differential electricity prices and raised production tax can help the output's structural adjustment, but it harms investment levels on other industries. Furthermore, both policies' negative effects on the macro economy are much larger than the green credit policy.

While the export- and investment-driven economic growth pattern does not change much, and industrialisation and urbanisation are ongoing in China, these target energy-intensive industries are still going to play an irreplaceable role in the economy. The rigid demand for export and investment activities affects the policy effect. When the green credit policy tries to help readjust the industrial structure to achieve emissions reduction goals, it is subjected to the existing industrial output structure in turn.

If we choose to use the policies of the differential electricity prices and raising production tax to achieve production structure adjustment, it will bring certain costs and risks to the economy. In the current economic environment, we recommend cautious treatment with the production structure adjustment approaches like differential electricity prices and raising production tax policy. We should ensure that economic risks are within a controllable range. Meanwhile, we could adopt the green credit policy to adjust the investment structure and achieve energy saving goals, emission reduction goals. Furthermore, we could apply green security policy to supplement and strengthen the policy effect of green credit policy in the direct financing market.

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