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Supervised Credit, Government Strategies and Green Development: Evidence from China

Nadzorowany kredyt, strategie rządowe i zielony rozwój: przykład Chin

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Abstract

This study examines the relationship between supervised credit (SC), government strategies, and green development (GD) utilizing the instrumental variable two-stage least squares (IV-2SLS) and spatial econometric model and panel data from 30 provinces and cities in China from 2006 to 2020. The study reached the following main results. First, untrustworthy punishment and trustworthy incentives promote the environmental protection through optimal allocation of supervised resources, which can be positively regulated by the government transformation. Second, *beggar-thy-neighbor* and *free rider* can be found in government environmental SC. Strengthening punishment in neighboring regions will have a negative effect on the local GD, whereas increasing incentives will have the opposite effect. Third, strategic interactions among various governmental sections have varying effects on GD. The eastern regions implement *difference-based promotion* for trustworthy incentives and *ineffective imitation* for untrustworthy punishment. The central and western regions, on the other hand, use *ineffective imitation* for trustworthy incentives and *inhibiting imitation* for untrustworthy punishment, the eastern regions implement *ineffective imitation* and the central and western regions execute *inhibiting imitation*. Finally, when R&D investment exceeds a certain threshold, but the industrial structure is lower, the untrustworthy punishment can play its promoting role; otherwise, the trustworthy incentives will turn over. The study findings reveal the unique mechanism of SC and provides new impetus regional policymakers to promote sustainable GD.

Key words: supervised credit, untrustworthy punishment, trustworthy incentives, green development

Streszczenie

Niniejsze badanie analizuje związek między nadzorowanym kredytem (SC), strategiami rządowymi i zielonym rozwojem (GD) z wykorzystaniem zmiennej instrumentalnej dwustopniowej metody najmniejszych kwadratów (IV-2SLS) oraz przestrzennego modelu ekonometrycznego i danych panelowych z 30 prowincji i miast w Chinach od 2006 do 2020. W badaniu osiągnięto następujące główne wyniki. Po pierwsze, niegodne zaufania kary i wiarygodne zachęty sprzyjają ochronie środowiska poprzez optymalną alokację nadzorowanych środków, co może być pozytywnie uregulowane przez transformację rządową. Po drugie, *żebraka-sąsiada* i *swobodnego jeźdźca* można znaleźć w rządowym środowisku SC. Wzmocnienie kary w sąsiednich regionach będzie miało negatywny wpływ na lokalną GD, podczas gdy zwiększenie zachęt będzie miało odwrotny skutek. Po trzecie, strategiczne interakcje między różnymi sekcjami rządowymi mają różny wpływ na GD. Regiony wschodnie stosują *promocję opartą na różnicach* w przypadku godnych zaufania zachęt i *nieskuteczną imitację* w przypadku niegodnych zaufania kar. Z drugiej strony regiony centralne i zachodnie stosują *nieskuteczne naśladownictwo* w przypadku godnych zaufania zachęt i *wstrzymywanie naśladowania* w przypadku niegodnych zaufania kar, regiony wschodnie wdrażają *nieskuteczne naśladownictwo*, a regiony centralne i zachodnie *wstrzymywanie naśladowania.* Wreszcie, gdy inwestycje w badania i rozwój przekraczają określony próg, ale struktura przemysłowa jest niższa, niegodna zaufania kara może odgrywać rolę promocyjną; w przeciwnym razie godne zaufania zachęty się odwrócą. Wyniki badań ujawniają unikalny mechanizm SC i dostarczają nowego impulsu regionalnym decydentom do promowania zrównoważonego GD.

Słowa kluczowe: nadzorowany kredyt, kara niezaufana, godne zaufania zachęty, zielony rozwój

1. Introduction

In recent years, sustainable economic development has been the subject of extensive debate. The rapid expansion of the global economy and industrial development has been fueled by the rising demand and consumption of energy. This has climate and environmental consequences (Cao et al., 2022). For instance, rising temperatures have already resulted in significant changes to sustainable development, humanity and natural systems, such as the increased frequency of extreme weather and the loss of biodiversity (Wang et al., 2021). What is more, emerging serious ecological issues and energy crises in recent years threaten the sustainable development of human society (Khan et al., 2022). The international community has formulated objectives for sustainable development (SDGs). However, the rate and magnitude of progress are not encouraging (Zhang et al., 2020). Thus, in order to shift the global economy toward sustainable development and achieve the SDGs, an unparalleled transformation in investment away from carbon- and resource-intensive industries and toward more resource-efficient technologies and business models is required. The financial sector must play an important role in bringing about this green transformation (Aizawa et al., 2010).

Following COVID-19, the world will require $2 trillion in investments for green projects in 2021-2023 (Wang et al., 2022). It is predicted that annual investments from all spheres of society will range between $5 and $7 trillion to achieve the SDGs. The Paris Agreement requires long-term financing based on cost-benefit analysis, followed by massive global investments (Wang et al., 2022). However, due to the socioeconomic crises caused by the COVID-19 pandemic, many nations have developed recovery plans to address the effects on markets, human lives, and livelihoods. The most prevalent responses have been economic recovery plans intended to stimulate economic activity, which have been halted by global national lockdowns to prevent the pandemic's spread. In spite of this, as countries continue to address the socioeconomic effects of the pandemic, there is a risk that stimulus and recovery packages designed to revive economies will compromise environmental sustainability and sustainable development due to the health emergency (Wu et al., 2021). In light of the need to mitigate the effects of the COVID-19 pandemic on the economy, sustainable development, human welfare, and the environment, green development becomes even more vital.

Since the reform and opening, the extensive development model for industrial economy has resulted in excessive resource and environmental utilization, as well as an unreasonable industrial structure, thereby endangering the sustainable development of society and economy. China is placing a greater emphasis on the role of businesses in environmental protection in response to the growing environmental awareness of its citizens and a desire for a healthier ecological environment and sustainable development (Wen et al., 2021). Businesses have been encouraged to use a variety of environmental regulatory tools, such as market-oriented tools and command-and-control policies, to update green production technology, mitigate emissions, as well as enhance environmental performance (Wen and Lee, 2020). Financial instruments, particularly green credit, have become increasingly critical in governing enterprise environmental behavior and restricting the unchecked growth of polluting industries in recent years (Xu and Li, 2020). For example, Aizawa and Yang (2010) found that financial sectors have significantly contributed to sustainable development by reducing credit from highly polluting and high energy-consuming projects. The Chinese government has put in place a number of policies to encourage green development in the country. Examples include the 2012 Green Credit Policy, which penalizes polluters financially to reduce industrial pollution. It mandates that commercial banks limit their lending to non-green businesses and provide financial support for green businesses (Zhang et al., 2022). What is more, the report of the 19th National Congress of the Communist Party of China (NCCPC) also emphasized adherence to the fundamental national policy of resource conservation and environmental protection, as well as the establishment of a green development (GD) and lifestyle. In 2021, the Ministry of Industry and Information Technology (MIIT) issued several policies on Accelerating the High-quality Development of Ecological Industry and Digital Economy. While the 14th Five-Year Plan for Industrial Green Development, mandating that all localities expedite the development of an ecological-economic coordinated development model.

Green finance is viewed as a crucial tool for promoting the green transformation of the economy by offering financial support to green businesses (Zhang and Wang, 2019). However, some green finance policies may conflict with their objectives of financing industrial upgrading. Therefore, how to formulate effective environmental governance policies has been extensively debated. Existing research is divided into economic, administrative, and social regulation methods (Dong et al., 2021), as well as formal and informal regulation methods (Wang et al., 2021). Empirical evidence pointed out that various regulatory means can promote upgrading of industrial structure (Zhou et al., 2020), optimize allocation of market and financial resources (Deng & Yang, 2018), enhance innovation capability of enterprises (Ding, 2019), and encourage the implementation of green technology transformation (Shen & Jinda, 2019). Green projects have a high investment, low returns, and high uncertainty. On the one hand, green technology output under the cost constraint will inevitably result in a *crowding out effect* on production

input. On the other hand, when the initial sewage cost is lower than the production income, the incentive for an enterprise to upgrade related technologies is insufficient, which is not conducive to GD. In this regard, some scholars seek enterprise GD strategies from the perspective of government supervision. Specifically, it should establish and improve stronger environmental protection law enforcement for green innovation (Wang and Wang, 2021) and adopt an administrative order-style supervision (Dong and Wang, 2021) to actively explore the government incentives for resource allocation. The concept of supervised credit (SC) system in China was first proposed in 2000. What is more, China accelerated the construction of the social credit system (SCS) in 2015, integrating the credit construction with the practice of *streamlining the government, delegating power, and enhancing government services* and optimizing the business environment.

In addition, it should *randomly select inspection objects, randomly select the law enforcement inspectors, and disclose the results of random inspections and investigations to the public in a timely manner* to give full play to trustworthy incentives and untrustworthy punishments subsequently, with the goal of compelling the subject not to lose faith. The General Office of the State Council issued the Opinions on Promoting the Construction of a Social Credit System with High-Quality Development and Promoting the Formation of a New Development Pattern in March 2022, mandating the full implementation of credit evaluation in environmental protection and strengthening the sharing and application of evaluation results.

According to the current literature, SC is an important means to improve the environmental regulation efficiency (RE). The credit endowment advantage can alter the resource allocation incentives mechanism, which is conductive to both full-cycle governance and initial governance (Xin and Ying, 2021). It has been argued that untrustworthy punishment demonstrates high level of specificity and coercion. An untrustworthy enterprise's marginal cost of production will increase while its reputation will drop significantly; on the contrary, a trustworthy enterprise can benefit from the *green channel* in many aspects of production and operation (Yin and Zhang, 2012). The current literature, however, focuses on analyzing the role of SC at the enterprise level, with few investigating the mechanism by which the GD is indirectly affected. In this light, it is policy relevant to investigate the relationship between SC, government strategies, and GD, which has important policy implications.

To this end, this study aims to conduct a three-part investigation into the relationship between SC, government strategies, and GD. First, it proposes a logical framework of *SC – resource allocation – GD* through model building, and then uses the IV-2SLS to verify the causal relationship between different variables. Second, the dynamic spatial Durbin model (DSDM) and the generalized spatial three-stage least squares model (GS3SLS) are employed to investigate the spatial interactions of governments in the central, western, and eastern regions on the strategies of untrustworthy punishment and trustworthy incentives in order to explore the strategic behaviors of the governments. Third, the 3SLS is used to test the effects of government transformation (GT) on the benchmark model, and a threshold regression model is established to emphasize the importance of regional characteristics and the effectiveness of *streamlining the government, delegating power, and improving government services* in formulating the environmental SC policies.

This paper is organized as follows. Section 2 discusses Theoretical Derivation, while Section 3 discusses research design, model development, and data. The findings are presented in Section 4, and finally Section 5 concludes.

2. Theoretical Derivation

2.1. Mechanism of SC on GD

In an oligopoly market, it is assumed that N enterprises produce identical products with similar quality, that marginal costs are ignored, and that the damage caused by unit pollution during the production and operation is d. When an enterprise adopts green technologies, the marginal cost increases by c units ($c < d$), but the pollution approaches 0. Alternatively, it can use relatively cheap technologies, in which case the cost increases by λc, pollution decreases by $1\text{-}\lambda$, and the market demand-price relationship is $P = P(Q)$. If the government decides to implement SC in this market, which requires the enterprise to reduce pollution, the enterprise must incur additional costs until c.

The supervision consumption resource is assumed to be a function $m(\alpha)$ passing through the origin, and α is the probability of implementing supervision. $m'(\alpha) > 0$, $m''(\alpha) > 0$, and $m(0) = 0$ are assumed. If there are n trustworthy enterprises, there will be $N\text{-}n$ enterprises facing untrustworthy punishment. If the economic loss is f, the expected marginal cost will be $\lambda c+f$. If a rational enterprise decides the output based on the probability of supervision and the amount of punishment, the output of a single trustworthy enterprise can be set as $q_h(\alpha, f)$, the output of a dishonest enterprise is $q_d(\alpha, f)$, and the total market output is expressed as follows:

$$Q_h(\alpha, f) = nq_h(\alpha, f) \quad (1)$$

$$Q_d(\alpha, f) = (N - n)q_d(\alpha, f) \quad (2)$$

At this time, the optimal production functions q_h and q_d of the two types of subjects are expressed as follows:

$$q_h = max[P(nq_h + Q_d(\alpha, f)) - c)]q_h \quad (3)$$

$$q_d = max[P((N - n)q_d + Q_h(\alpha, f)) - \lambda_2 c - f\ )]q_d \quad (4)$$

According to the connotation of GD, the government should minimize the total production cost and pollution damage synchronously, that is, to find the minimum value of the social loss (SL) function *SL = SL (α, f, n)*:

$$min\ SL = cQ_h(\alpha, f) + [\lambda_2 c + (1-\lambda_2)d]Q_d(\alpha, f) + m(\alpha) \quad (5)$$

Obviously, equation (5) indicates that to achieve this goal, both the enterprise production cost and the government supervision cost must be minimized (the loss caused by untrustworthy punishment is transferred from the enterprise to the government, so it is not included in the above equation). *SL* is closely related to technological progress (represented by the change of c or λ) and industrial structure (represented by the proportion of untrustworthy enterprises and that of trustworthy enterprises). However, the supervised resources function set in this work are closely related to the supervision probability α, the following equation for the partial derivative of the *SL* function with respect to α can be obtained. It is assumed that the social welfare loss caused by government regulation is minimal at α^*, the below expression can be got:

$$c\frac{\partial Q_h(\alpha, f)}{\partial \alpha} + [\lambda_2 c + (1-\lambda_2)d]\frac{\partial Q_d(\alpha, f)}{\partial \alpha} + m'(\alpha) = 0 \quad (6)$$

After performing partial derivative on *n*, equation (7) can be acquired:

$$\frac{\partial \alpha^*}{\partial n} = \frac{\partial^2 SL/\partial \alpha \partial n}{\partial^2 SL/\partial \alpha^2} = 0 \quad (7)$$

The relationship between SL and the number of trustworthy enterprises at α* can be expressed as follows:

$$\frac{\partial SL(\alpha^*, f, n)}{\partial n} = \frac{\partial SL(n)}{\partial n} = c\frac{\partial Q_h(\alpha, f)}{\partial n} + [\lambda_2 c + (1-\lambda_2)d]\frac{\partial Q_d(\alpha, f)}{\partial n}$$
$$= c\frac{\partial Q_h(\alpha, f)}{\partial n} + (1-\lambda_2)(d-c)\frac{\partial Q_d(\alpha, f)}{\partial n} \quad (8)$$

Q_h increases with the increase of *n*, and the overall marginal cost of production rises, but Q_d decreases. At this time, the damage of environmental pollution is higher than the production cost. Therefore, the less the damage caused by environmental pollution, and lower the total SL. The opposite happens when *n* decreases. Therefore, it can be concluded that *n* and *SL* show an inversely proportional growth relationship. It means that under the government regulation, the number of trustworthy enterprises increases, the SL decreases, and the GD is enhanced. Meanwhile, a specific amount of manpower and material resources are required during the government regulation, the RE ρ ($\rho \in [0,1]$) has to be considered. ρ = 1 means it is fully regulated, and efficiency is a decreasing function of cost. It is believed in this work that the greater the number of trustworthy enterprises, the lower the probability of the government regulation, the less the supervision costs. In this case, the limited supervised resources can be fully and efficiently utilized, which may be the essential difference between the two regulation methods. In view of this, the below research hypothesis is proposed:

H1: SC promotes the GD through RE

2.2. The mechanism of government strategies for GD

The ecological resources are purely public goods, so it is beyond reproach that local governments issue some environmental supervision policies and strengthen the resource protection. Since the reform of the tax-sharing system, nominating officials based on local gross domestic product (GDP) growth has resulted in obvious regulation inefficiency. On the one hand, government departments introduce the local high-polluting enterprises by default but enjoy the fruits of industrial GD in adjacent areas, which is the so-called *free rider* and *beggar-thy-neighbor* (Ke and Dongfang, 2016). Regions with large differences in economic levels tend to adopt the environmental control strategies that are completely opposite to those of their competitors, with the same purposes of *attracting investment* and *crowding out pollution* (Wenbin and Lipeng et al., 2010). Local governments imitate in smog management, but *ineffective imitation* is found in the central and western regions (Huihui and Luxin, 2019). On the other hand, government departments and local polluting enterprises have reached an economic development strategy (Guangyu and Li'an, 2019), and added hidden barriers to strengthen the local protection (Zhaolin and Yehui, 2018). Such activities hinder the free flow of the market, resulting in regulation inefficiency and loss of green efficiency. Essentially, SC belongs to one of the government strategies, so it suggests that strategic imitation is adopted for SC. In view of this, the below research hypothesis is put forward:

H2: Local governments have similar interactions in RE, which may weaken/enhance their original positive role;

2.3. The RE on SC and GD

Since the founding of the PRC, the political-oriented and economic-oriented government model has made great progress in mobilizing social resources, promoting the construction of heavy industry, and accelerating economic transition. However, it emphasizes more on the priority of efficiency and ignores the overall balanced development of society and economy. In addition, the government claims to promote the China's economy from high-speed growth to high-quality development. In view of this, it has to implement the innovation-driven development strategy and promote supply-side structural reforms. For this purpose, the central government has started to promote *streamlining the government, delegating power, and improving government services* to speed up the local GT, eliminate local protection, reduce unnecessary intervention, release the dividends of factor market reform, and

effectively stimulate the vitality of market players. What's more, under the background of *streamlining the government, delegating power, and improving government services*, GT aims to rationally allocate government functions, scientifically divide responsibilities and division of labor, improve the operating mechanism, and reshape the relationship among the government, the market, and society. It not only refers to the transformation of the government management model, but also includes the process of innovation and transformation in management concepts, management systems, and institutional methods (Bo and Xia, 2019).

It is believed in this work that it should enhance the role of environmental SC in at least two aspects to accelerate the GT. First, the *strengthening supervision* under *streamlining the government, delegating power, and improving government services* requires government departments to actively apply the new technologies such as big data and cloud computing to collect the credit information of polluting enterprises in government affairs and market fields comprehensively and to give the real-time evaluation on the enterprise. In this way, it solves the difficulty in finding and identifying the pollutant discharging or *inaccurate credit profile*, realizing the full chain coverage of intelligent supervision of pre-prevention, in-process capture of key objects, and post-event tracking (Qiuxia, Shuying, 2020). Second, *streamlining the government and delegating power* requires government departments to speed up the disclosure of government information, lower the institutional cost of corporate information search, accept the supervision of the central government and the masses, and consciously strengthen environmental policy and regulation strength. It is the most direct and effective administrative means to promote regional environmental protection cooperation to establish an environmental supervision system covering the government, society, and the public for accurate implementation of supervision and punishment (Zhang et al., 2019). In addition, it should strengthen the environmental protection trustworthy incentives and reduce the contract performance costs jointly, and the subjects of environmental protection untrustworthy punishment and the supervision should be jointly managed, which can bring a good environmental SC effect (Meng, 2021). In summary, another hypothesis can be expressed as follows:

H3: Government strategies positively regulate the promotion of SC to GD.

3. Research Design

3.1. Model setting

To alleviate the potential endogeneity, this work adopts the test hypothesis based on IV-2SLS. In the first stage regression, the direct impacts of SCS construction in the environmental protection on environmental SC is stripped out. In the second-stage regression, the GD is regressed by taking the environmental SC effect obtained in the first stage regression as an explanatory variable. The specific model settings are shown in equations (9) and (10).

$$SC_{it} = \alpha_1 + \alpha_2 ESCS_{it} + \alpha_3 \sum X_{it} + \varepsilon_{it} \quad (9)$$

$$GD_{it} = \beta_1 + \beta_2 SC_{it} + \beta_3 \sum X_{it} + \varepsilon_{it} \quad (10)$$

Next, the equations (11) and (12) are constructed, which together with equation (9) form a 3SLS to verify the mediating effect of RE. In these equations, X_{it} is the control variable, and ε_{it} refers to the random disturbance term.

$$RE_{it} = \theta_1 + \theta_2 SC_{it} + \theta_3 \sum X_{it} + \varepsilon_{it} \quad (11)$$

$$GD_{it} = \sigma_1 + \sigma_2 RE_{it} + \sigma_3 \sum X_{it} + \varepsilon_{it} \quad (12)$$

Finally, the interaction terms of government strategies and SC are incorporated into equation (10) to test the H3. The specific expression is as follows, which can form a new 2SLS model together with the previous equations. The interpretations of the remaining variables are the same as before.

$$GD_{it} = \beta_1 + \beta_2 SC_{it} + \beta_3 SC_{it} \times GT_{it} + \beta_4 GT_{it} + \beta_5 \sum X_{it} + \varepsilon_{it} \quad (13)$$

3.2. Spatial model checking

Previous studies have confirmed that pollutants such as haze and dust spread to adjacent areas with natural media such as wind and water flow, and local governments will take responsive actions to environmental control strategies in adjacent areas. It is necessary to consider the use of spatial econometric models to test H2 and to reverify the previous hypothesis at the spatial level to improve its robustness.

In this work, the following DSDM is constructed, which is more general in setting and is a standard framework for capturing various spatial spillover effects. In the expression (14), *w* is the spatial weight matrix. An economic-geographic nested matrix is established, which integrates the close economic relationship and the actual geographic distance of different regions. $GD_{i,t-1}$ is the lag term of local GD, and wGD_{it} represents the level of GD in neighboring areas. Meanwhile, ρ_3 and ρ_4 measure the impacts of SC strategies in local and neighboring regions on GD, respectively. The interpretations of remaining variable are consistent with the previous model.

$$GHQD_{it} = \rho_0 + \rho_1 GHQD_{i,t-1} + \rho_2 wGHQD_{it} + \rho_3 CS_{it} + \rho_4 wCS_{it} + \sum X_{it} + \varepsilon_{it} \quad (14)$$

3.3. Descriptions of variables

3.3.1. Establishment of environmental SCS (ESCS)

The currently empirical research on the construction of SCS is relatively limited. Some scholars take the credit environment index (CEI) as a surrogate variable, but it is difficult to control the potential endogeneity; while some use the number of local Buddhist monasteries as an instrumental variable, but this variable more reflects the trustworthy atmosphere in the social and humanistic sense and is hard to show the credit construction effectiveness of government departments in specific fields.

Referring to the ideas of Dong Zhiqiang et al. (2012), Chen Shiyi and Chen Dengke (2018), this work undertakes the time of the document on official environmental protection credit evaluation system issued by the provincial and municipal environmental protection departments as an instrumental variable for analysis. On the one hand, it is reasonable to seek appropriate instrumental variables from a historical perspective, because they are objective and hardly affected by reverse causality. On the other hand, ESCS is to establish an evaluation system around the goal of accurately depicting the *credit profile* of the subject, which can be extended to improving the standards and norms, completing the information system, implementing differentiated supervision, and designing reward and punishment measures, etc. In this sense, the earlier the credit evaluation standards are established, the more opportunities the government will have to try and find new ones, the more likely supporting mechanisms (such as the regulatory mechanism mentioned in this work) will be established, and the more likely the entire SCS will be perfect. Guangdong (2006) is the first province to issue the enterprise environmental credit evaluations, followed by Zhejiang (2007), Hebei (2008), Chongqing (2009), and Jiangsu (2012). These provinces are ordered according to the time sequence of issuing the above credit evaluation policies and the CEI which can comprehensively reflect the overall SCS efficiency separately, and the results are similar.

3.3.2. SC

By referring the simulation experiment of Cui Meng (2021), this work divides environmental SC into two parts: trustworthy incentives (SC_1) AND untrustworthy punishment (SC_2). For SC_1, green credit is selected as a substitute variable, because only those with good environmental credit status are more likely to obtain loose financing constraints. Green credit is calculated by the ratio of the interest expenditure of the six energy-intensive industrial industries to the total industrial interest expenditure. For SC_2, the number of enterprises that are subject to the untrustworthy punishment each year is selected as a substitute variable. After being punished, the enterprises face with the *cage* of joint punishment and stricter constraints on financing loans and administrative approvals, reflecting that the local government wants to warn other untrustworthy enterprises by severe punishment.

3.3.3. GD

To comprehensively measure the mutual coordination among economy, society, and ecology under the constraints of resources and environment, this work designs the evaluation system from innovation, coordination, openness, and sharing by referring to the practice of Ma Zongguo et al. (2022) based on the *five concepts (innovation, coordination, green, openness, and sharing* for national economic and social development during the *14th Five-Year Plan*. Among them, green innovation includes innovation input and innovation capability; green coordination includes energy consumption and the contribution ratio of high-tech industries to the economy; green opening includes high-tech products and patent exports; and green sharing includes forest coverage rate and waste harmless treatment. In this work, the final evaluation results are obtained by using the technique for order preference by similarity to ideal solution (TOPSIS) entropy weight method.

3.3.4. RE

It is difficult to calculate the efficiency of allocation of supervised resources for environmental protection departments. Most of the previous studies on measuring the government efficiency took employment and capital stock as inputs and social and economic results as outputs to calculate the total factor productivity. However, it can't reflect the particularity of the environmental protection, and some indicators are overlapped with the GD focused in this work. Similar with the thought of Yang Haisheng et al. (2015), this work takes the decline rate of environmental protection petitions (including the total number of letters, telephone, and Internet complaints) in each region in that year as the expected output, and the total investment in industrial pollution control and the personnel in the environmental protection system are the capital and labor input, respectively. In addition, the stochastic frontier analysis (SFA) is adopted to estimate the efficiency of allocation of supervised environmental resources.

3.3.5. GT

Most of current research has replaced GT with specific government behaviors (local protection and official replacement) or outcome variables (market integration and factor market development. However, any single indicator can't comprehensively reflect the comprehensive changes from the government in multiple aspects under the background of *streamlining the government, delegating power, and improving government services.* According to

the *three-dimensional theory of credit* proposed by Wu Jingmei et al. (2016), the core of GT is to speed up the construction of government affairs integrity. It is embodied in improving the efficiency of government affairs services, elevating the level of scientific decision-making, promoting transparency and openness in government affairs, and building an efficient and honest system mechanism, offering high-quality public services, creating a good development environment, and maintaining social fairness and justice. This work evaluates the degree of GT by referring to the view of Feng Xingyu et al. (2022) to measure the GT from four aspects (government affairs openness, keeping promises, market relations, and public services), and obtains the final GT indicators based on the TOPSIS entropy weight method.

3.3.6. Control variable (X_{it})

The control variable X_{it} in the above equations includes government scale (*GOV*), factor endowment (*FE*), research and development investment (*RDI*), and industrial structure (*IS*). They are measured with the ratio of the government general public budget expenditure to the regional GDP, the ratio of energy supply to demand, the ratio of R&D expenditure of scaled enterprises to the regional GDP, and the ratio of the total output value of the tertiary industry to the total output value of the secondary industry, respectively.

3.4. Data sources

Due to availability of data, the research sample is composed of data from 30 provinces and cities in mainland China in 2006-2020 (Tibet is excluded due to too many missing values). The data comes from *China Environmental Yearbook*, *China Environmental Statistical Yearbook*, *China's Blue Book of Rule of Law*, *China Industrial Statistical Yearbook*, *China Provincial Economic Comprehensive Competitiveness Report*, *China Insurance Yearbook*, and various work plans, official news reports, statistical annual inspection, and other public data of provincial and municipal governments. Some missing values are estimated based on the linear trends, and all indicators have been written off.

4. Empirical Analysis

4.1. Benchmark model checking

In this work a fixed effect model is employed to estimate the direct impacts of SC on GD, and the results are shown in Table 1. The models (1) and (2) present that the estimated coefficients of environmental SCS and two SC strategies (SC_1 and SC_2) are significantly positive, indicating that environmental SC will boost GD and helps to achieve sustainable development. The corresponding Cragg-Donald Wald F statistics are 14.74 and 16.88, respectively, rejecting the hypothesis of weak instrumental variables. The instrumental variables are undertaken as the control variables to the model for ordinary least squares (OLS) regression, and the results reveal that the estimated coefficient of ESCS in model (3) is not significant. It indicates that there is no reverse causality in the conduction path of SC in the benchmark model, which confirms the direct promotion effect of SC on GD.

Table 1. Benchmark model estimation results, source: own calculation

Variable	Model (1)		Model (2)		Model (3)	
	GD	SC_1	*GD*	SC_2	SC_1-*GD*	SC_2-*GD*
SC_1	0.45** (0.12)				0.44** (0.06)	
SC_2			0.07** (0.03)			1.69** (7.98)
ESCS		0.39** (0.11)		2.56** (0.93)	0.06 (0.04)	0.07 (0.08)
Control variable	Control	Control	Control	Control	Control	Control
Fixed effects	YES	YES	YES	YES	YES	YES
N	420	420	420	420	420	420
R^2	0.62	0.65	0.52	0.58	0.71	0.67

Note: ***, **, and * represent the significance levels of 1%, 5%, and 10%, respectively, and the standard error is given in brackets, the same below

The 3SLS model is adopted to estimate the mediating effect of allocation of supervised resources, and the results are shown in Table 2. It shows that the estimated coefficients of ESCS, SC (SC_1 and SC_2), and RE are all significantly positive, indicating that both the environmental untrustworthy punishment and trustworthy incentives can significantly improve RE, thereby promoting GD and sustainable development. Such result proves its mediating effect and verifies H1. Finally, Table 3 exhibits that the interaction terms of GT and environmental untrustworthy punishment and trustworthy incentives are significantly positive for the estimated coefficients of RE and GD. Such

result reflects the importance of *streamlining the government, delegating power, and improving government services* and accelerating the GT. Therefore, the H3 is true.

Table 2. 3SLS estimation results, source: own calculation

Variable	Model (1)			Model (2)		
	GD	*RE*	*SC₁*	*GD*	*RE*	*SC₂*
SC₁		0.73** (0.24)				
SC₂					0.05** (0.01)	
RE	0.70** (0.29)			0.52** (0.11)		
ESCS			0.36** (0.03)			2.87** (0.55)
Control variable	Control	Control	Control	Control	Control	Control
Fixed effects	YES	YES	YES	YES	YES	YES
N	420	420	420	420	420	420
R^2	0.54	0.59	0.63	0.65	0.64	0.62

Table 3. The mechanism of GT, source: own calculation

Variable	Model (1)			Model (2)		
	GD	*RE*	*SC₁*	*GD*	*RE*	*SC₂*
RE	0.45** (0.13)			0.69** (0.24)		
SC₁		0.24** (0.07)				
SC₂					0.04** (0.02)	
SC₁×GT		0.54** (0.16)				
SC₂×GT					0.05** (0.02)	
ESCS			0.23** (0.07)			4.56** (1.87)
Control variable	Control	Control	Control	Control	Control	Control
Fixed effects	YES	YES	YES	YES	YES	YES
N	420	420	420	420	420	420
R^2	0.65	0.58	0.70	0.72	0.52	0.69

4.2. Robustness checking

This work adopts a series of measures to confirm that the findings are scientifically robust. First, by referring to the practice of Qiu and Wang (2018), this work estimates the industrial eco-efficiency as a substitute indicator of high-quality GD based on the Super-SBM model. It obtains similar results by taking the industrial added value, industrial sulfur dioxide, net fixed assets, and the number of employees at the end of the year as the expected output, undesired output, the capital input, and labor input, respectively. Second, this work separates the samples into two time periods for re-regression by taking the key event in the Enterprise Environmental Credit Evaluation Measures jointly issued by the Ministry of Environmental Protection, the National Development and Reform Commission, and the People's Bank of China in 2013 (results are reported in Table 4). After the issue of related policy, the two types of SC have significantly improved the RE and GD, which indirectly confirms the reliability of the research conclusions in the time dimension.

4.3. The spatial effect of ESCS

The DSDM contains the space lag terms and time lag terms of the explained variables, which fails to satisfy the classical assumption of the OLS method. The maximum likelihood method is difficult to effectively control the endogeneity. Referring to the practice of Zhou and Han (2020), this work selects the Han-Phillips-GMM method (the generalized method of moment (GMM) proposed by Han and Phillips) to estimate the model and provides the results of the systematic GMM and OLS together, as shown in Table 5. In the OLS model excluding the endogeneity, the estimated coefficient of ESCS is not significant. Compared with the systematic GMM model excluding

the spatial correlation, the estimated coefficient of Han-Phillips-GMM is significantly improved, which is in line with expectations, showing excellent statistical robustness.

Table 4. Periodic 3SLS inspection, source: own calculation

		Model (1)			Model (2)		
		GD	*RE*	*SC₁*	*GD*	*RE*	*SC₂*
2007-2012	*SC₁*		0.29** (0.07)				
	SC₂					0.07** (0.02)	
	RE	0.14** (0.04)			0.17** (0.06)		
	ESCS			0.23** (0.11)			1.38** (0.51)
2013-2020	*SC₁*		0.43** (0.19)			0.10** (0.03)	
	SC2₂				0.26** (0.12)		
	RE	0.19** (0.07)					2.29** (0.75)
	ESCS			0.43** (0.22)			
Control variable		Control	Control	Control	Control	Control	Control
Fixed effects		YES	YES	YES	YES	YES	YES

Table 5. DSDM estimation results, source: own calculation

	Dependent variable: GD		
	(1) *OLS*	(2) System *GMM*	(3) *Han-Phillips-GMM*
GD		0.14** (0.06)	0.10** (0.03)
*GD*W*			0.15** (0.04)
SC₁	0.14** (0.06)	0.15** (0.04)	0.29** (0.08)
*SC₁*W*			-0.18** (0.06)
SC₂	0.07* (0.04)	0.14** (0.07)	0.20** (0.11)
*SC₂*W*			0.12** (0.04)
Control variable	Control	Control	Control
Fixed effects	YES	YES	YES
N	420	420	420
R^2	0.65	0.67	0.73

First, according to the estimation results of models (1) and (2) based on Han-Phillips-GMM, the estimated coefficients of both types of SC strategies and GD are significantly positive, further confirming the H1 and H2. The estimated coefficient of the first order lag term of GD is significantly positive, indicating that the country is in a steady upward stage. The better work performance in the previous stage can predict the effectiveness of the current stage more accurately. In addition, the coefficient of the spatial lag term of GD is significantly positive, indicating that competition or imitation among different regions promotes the positive demonstration effect of the development model of adjacent regions on the local area.

However, strengthening untrustworthy punishments in adjacent areas will harm the local GD, while strengthening trustworthy incentives will exert the opposite effect. To control pollution replying on punishment solely will lead high-polluting enterprises to transfer to other regions with weaker punishment, which is a *beggar-thy-neighbor* phenomenon. Trustworthy incentives can be regarded as the financial assistance and incentives for entities that meet specified conditions and the measures to seize liquidity resources. If the intensity of punishment in the two regions is similar and one region releases the trustworthy dividend signal, the green transition cost (weak incentives) that the polluting enterprises have to pay to in the other region is obviously higher, so the enterprises are possible to transfer to that region, which is called *free rider* in environmental governance. Industrial transfer lowers the local industrial output and reduces pollution emissions more, thereby increases the level of GD, which has been confirmed in previous model.

Table 6. GS3SLS estimation results (trustworthy incentives), source: own calculation

	Trustworthy incentives	Eastern regions		Middle regions		Western regions	
		GD	SC_1	*GD*	SC_1	*GD*	SC_1
Overall	SC_1	0.36**		0.06		0.09	
	ESCS		0.27**		0.19**		0.32**
	Strategic interactions	-63.92** (different)		31.94** (imitated)		46.64** (imitated)	
2006-2009	SC_1	0.13**		0.28**		0.38**	
	ESCS		0.11**		0.22**		0.18**
	Strategic interactions	35.57** (imitated)		9.15 (independent)		17.78 (independent)	
2010-2013	SC_1	0.24**		0.08			
	ESCS		0.10**		0.17**		0.21**
	Strategic interactions	27.21** (imitated)		43.38** (imitated)		5.99 (independent)	
2014-2017	SC_1	0.31**		0.03		0.04	
	ESCS		0.27**		0.11**		0.16**
	Strategic interactions	-66.58** (different)		27.11** (imitated)		29.87** (imitated)	
2018-2020	SC_1	0..38**		0.07		0.05	
	ESCS		0.35**		0.21**		0.17**
	Strategic interactions	-45.72** (different)		79.35** (imitated)		32.48** (imitated)	

Table 7. GS3SLS estimation results (untrustworthy punishment), source: own calculation

	Untru-stworthy pu-nishment	Eastern regions		Middle regions		Western regions	
		GD	SC_1	*GD*	SC_1	*GD*	SC_1
Overall	SC_2	0.03		-0.06**		-0.08**	
	ESCS		2.27**		1.14**		1.29**
	Strategic interac-tions	47.82** (imitated)		36.54** (imitated)		54.98** (imitated)	
2006-2009	SC_2	0.04**		0.02		0.06**	
	ESCS		1.22**		1.23**		1.17**
	Strategic interac-tions	-49.32** (imitated)		6.10 (independent)		10.54 (independent)	
2010-2013	SC_2	0.05**		-0.08*		0.07**	
	ESCS		1.16**		1.18**		1.32**
	Strategic interac-tions	-40.45** (imitated)		53.67** (imitated)		1.12 (independent)	
2014-2017	SC_2	0.03		-0.05**		-0.08**	
	ESCS		2.13**		2.30**		2.22**
	Strategic interac-tions	62.68** (imitated)		80.19** (imitated)		69.37**(imitated)	
2018-2020	SC_2	0.03		-0.06**		-0.10**	
	ESCS		2.19**		2.36**		2.14**
	Strategic interac-tions	78.56** (imitated)		65.83** (imitated)		54.29** (imitated)	

4.4. The impacts of government strategic interaction

In this work, the samples are divided into eastern, central, and western regions according to the National Bureau of Statistics. A spatial lag term is introduced into the 3SLS model to form new equations (15) and (16) according

to the ideas of Deng Huihui and Yang Luxin (2019). Firstly, the GS2SLS method, which is equally effective under heteroscedasticity, is employed to estimate the spatial autoregressive model. Based on the estimated coefficient $\tilde{v}$, it can be judged whether different regions are imitated, independent, or different in terms of regulatory policies. Then, the GS3SLS proposed by Yang and Lee et al. (2017) is used for estimation to judge the result of spatial strategy interaction as promotion or invalidation or inhibition, with a total of nine combinations. The estimated results are shown in Tables 6 and 7.

$$GD_{it} = \pi_1 \sum w_{ij}\, GD_{it} + \pi_2 SC_{it} + \pi_3 SC_{it} + \pi_4 \sum X_{it} + \varepsilon_{it} \quad (15)$$

$$SC_{it} = \sigma_1 \sum w_{ij}\, SC_{it} + \sigma_2 \sum w_{ij}\, ESCS_{it} + \sigma_3 ESCS_{it} + \sigma_4 \sum X_{it} + \varepsilon_{it} \quad (16)$$

The above tables exhibit that the eastern regions have imitated at the beginning but realized different designs for mechanism of the trustworthy incentives, which promotes the GD; While the central and western regions have always imitated mutually with not as good results as expected. In the design of the untrustworthy punishment mechanism, the eastern, central, and western regions all have imitated mutually, but the results are quite different: it fails to play the positive role in eastern regions and inhibits the GD in central and western regions. This finding is consistent with that of Zhang Zhenbo et al. (2020), Deng Huihui, and Yang Luxin (2019). It means that as the environmental binding indicators are officially included in the government promotion assessment, the competitive situation of environmental governance is changing from bottom-to-bottom competition to strategic imitation, but the result weakens or even reverses the original effect of ESCS.

4.5. Threshold effect test

The previous section confirms that related policies and methods for formulating the ESCS may be unreasonable. In this view, this section aims to establish and test the following threshold model to reveal the circumstances under which the untrustworthy punishment and trustworthy incentives can play their roles. In the below model, *I(·)* is an indicative function, which is 1 when the condition is satisfied or 0 when the condition is not satisfied; *X* is the threshold variable, that is, the control variable and GT; and $[\eta_1,\eta_2\cdots\eta_{n+1}]$ measures the effects of SC strategy on GD under different threshold conditions. SC_{it}_0 is lower than the threshold variable, while SC_{it}_1 is greater than that.

$$GD_{it} = \delta_1 CSSC_{it} \cdot I(X \le \lambda) + \delta_2 SC_{it} \cdot I(X > \lambda) + \theta \sum X_{it} + \varepsilon_{it} \quad (17)$$

The threshold regression exhibits that for environmental protection untrustworthy punishment, there is a single threshold for *RDI* and *IS*, which is 0.01 and 1.64, respectively, and there is no significant threshold effect for other variables. Specifically, when *RDI* exceeds the threshold, the effect of untrustworthy punishment on GD changes from insignificant ($\gamma = 0.01$, $p > 0.05$) to positively significant ($\gamma = 0.24$, $p < 0.05$). When the *IS* is lower than the threshold, untrustworthy punishment can positively promote the GD ($\gamma = 0.16$, $p < 0.05$), while the case will be opposite when it exceeds the threshold ($\gamma = -0.22$, $p < 0.05$). For environmental trustworthy incentives, there is a significant single threshold for GT and IS (0.72 and 1.02, respectively) only. When the GT is higher than the threshold, the influence of trustworthy incentives on GD turns from insignificant ($\gamma = -0.09$, $p > 0.05$) to positively significant ($\gamma = 0.37$, $p < 0.05$). When the IS is higher than the threshold, the effect of trustworthy incentives on GD changes from insignificant ($\gamma = -0.12$, $p < 0.05$) to positively significant ($\gamma = 0.31$, $p < 0.05$). Thus, if the governments of different regions directly imitate the strategies of neighboring regions without consideration of these differences in characteristics, the positive effect of ESCS on GD may be completely invalidated.

5. Conclusion

There has been much discussion about sustainable economic development, but as nations deal with the socioeconomic effects of the pandemic, there is a chance that stimulus and recovery plans intended to boost economies will undermine environmental sustainability and sustainable development because of the medical emergency. Green development is increasingly important in light of the need to reduce the COVID-19 pandemic's negative effects on the economy, sustainable development, human welfare, and the environment. This study explored the relationship between supervised credit (SC), government strategies, and green development (GD). In doing so, it established a logical framework of *SC-supervision efficiency-GD* through model derivation and theoretical analysis, and analyzed the potential impacts of GT and strategic interactions on the above process. This study used the instrumental variable two-stage least squares (IV-2SLS) and spatial econometric model and panel data from 30 provinces and cities in China from 2006 to 2020.

The comprehensive analysis of this study yielded the following main results. First, we found that untrustworthy punishment and trustworthy incentives both promote GD by improving the RE. This intermediary process distinguishes SC from traditional environmental control methods and can be accelerated by GT. Second, we pointed out that local governments adopted *beggar-thy-neighbor* and *free rider* problems in ESCS. Strengthening the untrustworthy punishment in neighboring regions will hinder local high-quality development, whereas emphasizing trustworthy incentives will benefit local GD. Third, our analysis revealed that local governments have spatial strategic

interactions. In the eastern regions, differential designs of trustworthy incentives promote local high-quality development, while their mutual imitation in untrustworthy punishment fails. In the central and western regions, imitation causes the original positive effect of SC to fail or even have a negative effect. Finally, we found that when the regional *IS* level is low and *RDI* is high, untrustworthy punishment can be effective. Trustworthy incentives are only effective when both the GT and RDI are high.

The findings of this study have policy implications for local governments seeking to accelerate GD and achieve sustainable regional development. First, it can speed up the development of ESCS, improve the mechanism for evaluating environmental enterprises' environmental credit, and strengthen differentiated SCs. Meanwhile, technologies such as big data and artificial intelligence should be actively applied for intelligent supervision of credit to enhance the timeliness, accuracy, and effectiveness of supervision, thereby comprehensively improving the efficiency of allocation of supervised resources. Second, emphasis should be placed on improving and optimizing the credit incentives and punishment system, as well as strengthening new entrant screening to avoid becoming a *transit station* for high-polluting enterprises. It should optimize and improve the trustworthy incentives system by identifying and removing the financing constraints of these enterprises timely and enhancing their willing to maintain trustworthiness. In addition, it can explore an inclusive and prudent regulatory system. In any case, environmental untrustworthy punishment and trustworthy incentives should be designed based on the actually local conditions.

Third, it is suggested that regional integration be promoted, and regional development alliances formed. The transformation leading regions can be designated as *benchmarks* to radiate and drive the transformation of neighboring regions. Meanwhile, it can establish a joint pollution prevention and control mechanism, as well as perfect a sound regional supervision and law enforcement system, to prevent opportunistic high-pollution and high-emission enterprises from transferring to nearby regions, thereby reducing local *beggar-thy-neighbor* and promoting the integrated industrial GD in the entire region.

Fourth, it is recommended that the reform of *streamlining the government, delegating power, and improving government services* be deepened and the local GT be accelerated. Under the *Guiding Opinions of the State Council on Strengthening the Construction of Government Integrity*, it should strengthen the construction of government integrity, improve the efficiency of government services, elevate the level of scientific decision-making, promote the transparency and openness of government affairs, and build an efficient and honest system and mechanism. In addition, it can continue to reform the factor market, eliminate the administrative barriers, promote factor free flow, and accelerate the elimination of old and duplicate production capacity, thereby providing an effective and long-term guarantee mechanism for green, sustainable and high-quality development.

References

1. AIZAWA M., YANG C., 2010, Green Credit, Green Stimulus, Green Revolution? China's Mobilization of Banks for Environmental Cleanup, *J. Environ. Dev.* 19: 119-144.
2. CAO X., KANNAIAH D., YE L., KHAN J., SHABBIR M. S., BILAL K., TABASH M. I., 2022, Does sustainable environmental agenda matter in the era of globalization? The relationship among financial development, energy consumption, and sustainable environmental-economic growth, *Environmental Science and Pollution Research*: 1-11.
3. CAO G. et al., 2019, The influence of official replacement on economic growth and its mechanism--empirical evidence from prefecture-level administrative regions, *China Journal of Economics* 6(04): 102-126.
4. CHEN S.Y., CHEN D.K., 2018, Smog pollution, government governance, and high-quality economic development, *Economic Research Journal* 53(02): 20-34.
5. CUI M., 2021, Tripartite evolutionary game of environmental credit supervision under the background of collaborative governance, *System Engineering Theory and Practice* 41(03): 713-726.
6. DENG H. H., YANG L. X., 2019, Haze governance, local competition and industrial green transformation, *China Ind. Econ* 10 118-136.
7. DING J., 2019, Green credit policy, credit resource allocation, and corporate strategic response, *Economic Review* (04): 62-75.
8. DONG Z.Q., 2012, Institutional soft environment and economic development – empirical research on the business environment of 30 major cities, *Management World* 2012(04): 9-20.
9. DONG Z. Q., WANG H., 2021, Effectiveness Test of Market-based Environmental Regulation Policy – Empirical Evidence from the Perspective of Carbon Emissions Trading Policy, *Statistical Research* 38(10): 48-61.
10. FENG X.Y. et al., 2020, Government transformation, credit governance and industrial green development, *Technology Economics* 05: 73-84.
11. KHAN J., LI Y., GIRARDIN E., 2022, Is a clash coming when trade and climate meet at the border? The impact of the EU's carbon border adjustment on China's belt and road initiative, *Structural Change and Economic Dynamics* 63: 112-124.
12. MA Z.G. et al., 2022, Evaluation of green and high-quality development of national independent innovation demonstration zones, *China Population, Resources and Environment* 32(02): 118-127.
13. SHEN H.L., JIN D., 2019, Heterogeneous environmental regulation, industrial enterprise R&D and employment skills structure – an empirical study based on spatial panel Durbin model, *Soft Science* 33(08): 39-43+53.

14. QIU Z.L., WANG Y.H., 2018, The influence of environmental regulation on industrial eco-efficiency under the constraints of administrative monopoly – test based on dynamic space Doberman model and threshold effect, *Industrial Economics Research*, 2018(05): 114-126.

15. WANG X., WANG Y., 2021, Green credit policy enhances green innovation research, *Management World* 37(06): 173-188+11.

16. WANG P., SHUFENG G., 2021, Formal environmental regulation, human capital and green total factor productivity, *Macroeconomics* (05): 155-169.

17. WANG K. H., ZHAO Y. X., JIANG C. F., LI Z. Z., 2022, Does green finance inspire sustainable development? Evidence rom a global perspective, *Economic Analysis and Policy* 75: 412-426.

18. WEN H., LEE C. C., ZHOU F., 2021, Green credit policy, credit allocation efficiency and upgrade of energy-intensive enterprises, *Energy Economics* 94: 105099.

19. WEN Q.X. et al., 2020, Research on the implementation of enterprise environmental protection credit evaluation policy, *Chinese Journal of Environmental Management* 12(04): 96-103.

20. WU J.M. et al., 2018, Research on government credit evaluation in the new era: a review and prospect from a new perspective – based on Wu's three-dimensional credit theory, *Modern Management Science*, 2018(04): 3-5.

21. WU S., ALHARTHI M., YIN W., ABBAS Q., SHAH A. N., UR RAHMAN S., KHAN J., 2021, The carbon-neutral energy consumption and emission volatility: The causality analysis of Asean region, *Energies*, 14(10): 2943.

22. XU X., LI J., 2020, Asymmetric impacts of the policy and development of green credit on the debt financing cost and maturity of different types of enterprises in China, *Journal of Cleaner Production* 264: 121574.

23. YANG H.S. et al., 2014, Policy instability and economic growth – empirical evidence from changes of local officials in China, *Management World* 2014(09): 13-28+187-188.

24. YANG K., LEE L. F., 2017, Identification and QML estimation of multivariate and simultaneous equations spatial autoregressive models, *Journal of Econometrics* 196(1): 196-214.

25. YIN J.H. et al., 2020, Policy Uncertainty and innovation of heavy polluting enterprises – evidence from key monitoring enterprises of wastewater state control, *Journal of Beijing Institute of Technology (Social Sciences Edition)*, 22(05): 23-31.

26. ZHANG J., ALHARTHI M., ABBAS Q., LI W., MOHSIN M., JAMAL K., TAGHIZADEH-HESARY F., 2020, Reassessing the Environmental Kuznets Curve in relation to energy efficiency and economic growth, *Sustainability* 12(20): 8346.

27. ZHANG K. et al., 2016, Interaction between inter-regional environmental protection investment and endogenous strategy of pollution emissions, *China Industrial Economics* 2016(02): 68-82.

28. ZHANG M. et al., 2019, Using three-sided dynamic game model to study regional cooperative governance of haze pollution in China from a government heterogeneity perspective, *Science of the Total Environment* 694(C): 133559.

29. ZHANG M., ZHANG X., SONG Y., ZHU J., 2022, Exploring the impact of green credit policies on corporate financing costs based on the data of Chinese A-share listed companies from 2008 to 2019, *Journal of Cleaner Production:* 134012.

30. ZHANG W.B. et al., 2010, The pattern and evolution of inter-provincial competition in China's environmental regulation intensity – analysis based on two-zone space Durbin fixed effects model, *Management World* 2010(12): 34-44.

31. ZHANG Z., JIN T., MENG X., 2020, From race-to-the-bottom to strategic imitation: how does political competition impact the environmental enforcement of local governments in China?, *Environmental Science and Pollution Research* 27(20): 25675-25688.

32. ZHAO B. et al., 2019, Government transformation, public service, and manufacturing transformation and upgrading, *Forward Position or Economics* 10(06): 123-133.

33. ZHOU J. Q., HAN, Z. Z., 2020, Environmental Regulation, Factor Market Reform Dividends and Green Competitiveness: Theory and Chinese Experience. *Contemporary Finance & Economics* (9)3.