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Analysis of Regional Social Capital, Enterprise Green Innovation and Green Total Factor Productivity—Based on Chinese A-Share Listed Companies from 2011 to 2019

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Abstract: At present, social capital is considered to be one of the important reasons for promoting economic development and causing regional economic differences, but in the existing research, there is little literature on the impact of regional social capital on enterprises' green innovation behavior and green total factor productivity (GTFP), so this paper aims to enrich the research in this area. This paper builds a regional social capital evaluation index system and uses the super-SBM model to measure the enterprise GTFP. Then, this paper brings regional social capital, enterprise green innovation and GTFP into a unified framework for the first time and further reveals the quantitative relationship between the three by using OLS and Tobit two-step methods based on the panel data of 30 provinces from 2011 to 2019. The results show that regional social capital has a positive effect on enterprise GTFP and green innovation (except for strategic green innovation output), enterprise green innovation output has a positive role in promoting GTFP, and enterprise green innovation capital investment has a masking effect between regional social capital and GTFP. Furthermore, the expansive study finds that there are differences in the impact of regional social capital on green innovation and the GTFP of heterogeneous enterprises, and financing constraints have a positive regulatory effect on the relationship between regional social capital and the GTFP of state-owned enterprises, while having an inhibitory effect on the GTFP of private enterprises. Fiscal decentralization has a partial mediating effect between regional social capital and enterprise GTFP, while urbanization and CO_2 emissions have a masking effect. Additionally, this paper aims to provide a reference for the improvement of regional social capital theory, the strategic choice of green innovation of enterprises, and the high-quality development of the economy.

Keywords: regional social capital; enterprise green innovation; green total factor productivity; high-quality development; sustainability

1. Introduction

In today's world, the contradiction between the comprehensive development requirements of countries and their environmental problems is becoming increasingly serious. Determining how to solve these problems, cope with environmental challenges and promote green and sustainable development has become a difficult problem for people all over the world. As the largest developing country in the world, since the reform and opening up, China's economy has achieved rapid development, but problems such as overcapacity, environmental pollution, the low added value of some industries and restricted core technologies are still relatively prominent, so the original model of rapid economic growth that simply relies on factor input is difficult to maintain. Therefore, China urgently needs to find a path to achieve high-quality and sustainable economic development.

Since the sociologist Pierre Bourdieu put forward the concept of social capital in the 1970s, scholars all over the world have carried out extensive research on social capital in the

dimensions of regions, enterprises and individuals. As a research branch of social capital in the region, regional social capital is considered by scholars of various countries to be another important factor driving economic growth, after material capital and human capital [1], which have a greater impact on regional economies and enterprise development [2–4]. As the main force of national economic development, the high-quality innovation capability and development level of enterprises have become an important force for maintaining their own competitiveness and promoting the sustainable development of the region and the country. Green total factor productivity (GTFP) is a comprehensive indicator that gives consideration to economic and environmental performance and comprehensively and systematically reflects the green development level of countries, regions and enterprises. [5]. Its own growth is considered to be the main driving force and source for the economy to achieve green growth in the new era. The exploration of the relationship between regional social capital, enterprise green innovation and GTFP may help to find a path to achieve high-quality and sustainable economic development.

Therefore, in the post-epidemic era, against the background of countries around the world jointly coping with environmental problems and coordinating regional progress and sustainable economic and social development, this paper studies the logical and quantitative relationship between social capital in macro-regions, enterprise green innovation and GTFP in order to contribute to the improvement of regional social capital theory, enterprise green innovation and high-quality economic development.

2. Literature Review

2.1. Social Capital

The term social capital was proposed by L. Hanifan [6] and is considered to be another important factor driving economic growth, after physical capital and human capital, and scholars mainly study social capital in three dimensions: regional, enterprise and individual.

2.1.1. Regional Social Capital

Research on regional social capital focuses on its measurement and economic consequences. In measurement research, Grootaert et al. [7] measure trust and solidarity, community and network. Nahapiet and Ghoshal [8] divide social capital into three dimensions: structure, relationship and cognition. In terms of specific calculations, scholars mostly choose indicators such as the number of social organizations, public welfare blood donation and business environment as substitutes. At the same time, scholars mainly study the economic consequences of regional social capital from three dimensions: the impact on the economy, enterprises and individuals. In the study of economic impacts, Akanpaaba et al. [9] found that the higher the environmental dynamics are, the more significant the relationship between regional social capital and market performance is. Seo and Mun [10] found that regional social capital has a positive moderating effect on the relationship between economic policy uncertainty and cash holdings through an empirical study of a sample of listed companies in the United States from 1990 to 2018. In the study of the impact on firms, Hendijani Zadeh [11] found that regional social capital can reduce the risk of stock price crashes through private companies' news concealment, accounting soundness and excessive management risk. Kraus et al. [12] found that regional social capital has a catalytic effect on SMEs to expand into international markets through an empirical study of semi-structured interviews with business elites. In the research on personal impact, Yue and Rivera [13] conducted a survey of Chinese entrepreneurs and found that regional social capital is more conducive to entrepreneurship. Hasan et al. [14] researched a P2P lending platform in China and found that regional social capital affects the trustworthiness of trustees and the trust propensity of principals. Biernat et al. [15] found that regional social capital has a positive impact on the quality of life and health of individuals.

2.1.2. Corporate Social Capital

Much of the research on corporate social capital is focused on promoting corporate performance and innovation. Klimek and Jędrych [16] and Jędrych et al. [17] found that when the six types of capital, including corporate social capital, are balanced, firms maximize efficiency, while energy firms have higher social capital than firms in other sectors. Fiordelisi et al. [18] studied the performance of 1789 companies in 27 countries and found that firms with high social capital outperformed their peers in times of economic hardship. Liu et al. [19] used the Poisson panel model to study the data of 277 manufacturing enterprises in China from 2013 to 2018 and found that the accumulation of corporate social capital promotes innovation performance. Fu [20] selected 500 enterprise managers from 30 textile enterprises as a sample and found that corporate social capital and enterprise dynamic ability are necessary conditions for enterprises to improve their technological innovation performance. Kim and Shim [21] surveyed SMEs in the Bomont tourism cluster in South Korea and found that social capital promotes increased knowledge sharing and innovation in the tourism cluster. Sanchez-Famoso et al. [22] found that family and non-family social capital has a combined positive impact on family business innovation. Zhou et al. [23] found that corporate social capital indirectly affects product innovation performance through the quality of the transferred knowledge. Zahra [24] concluded that organizing social capital will have a moderating effect on technological capabilities at the international scale.

2.1.3. Personal Social Capital

Scholars' research on the social capital of the individual dimension mainly focuses on its impact on enterprises and individuals themselves. Among them, in the study of the impact on enterprises, Syakir et al. [25] conducted a study of 92 zakat institutions in 42 countries and found that CEO social capital is positively correlated with institutional performance. Danso et al. [26] found that CEO social capital is positively correlated with announced returns from asset sellers. Zhang et al. [27] selected Chinese listed companies from 2008 to 2017 as a sample and found that companies with higher CEO social capital had lower litigation risk. Cao et al. [28] analyzed 122 Chinese technology companies and found that the CEO's connected social capital had an inverted U-shaped relationship with the entrepreneurial orientation of enterprises, while the bridged social capital of CEOs was positively correlated with entrepreneurial orientation. In the study of the impact on individuals themselves, Vráblíková and van Deth [29] used survey data from 28 democracies and found that citizens with higher levels of personal social capital were more politically active. Tatarko and Schmidt [30] used a sample of 2061 adult respondents in Russia and found that personal social capital contributes to entrepreneurship. Kulbo et al. [31] found that an individual's social capital plays a partial mediating role between organizational capital and graduate employability. Sun et al. [32] found a positive link between individual social capital and health-related quality of life.

2.2. Enterprise Green Innovation

At present, scholars mainly study the green innovation of enterprises from the dimensions of national policies, enterprises' own characteristics and the external environment. In the study at the national policy level, Pei and Wang [33] found that the country's low-carbon pilot city policy has a significant impact on green patent filings. Zhu et al. [34] constructed a systematic dynamic model of the green innovation capability of science and technology enterprises and found that the national green development strategy is conducive to the green transformation of regional production and life. Liu and Dong [35] used the promulgation of China's Green Credit Guidelines as a quasi-natural experiment and used a difference-in-differences (DID) model to show that green credit policies improve the overall green innovation of heavily polluting enterprises. Shen and He [36] constructed the DID model and concluded that China's deleveraging policy has a positive role in promoting corporate green innovation. Yang et al. [37] found that there is an inverted U-shaped

relationship between the uncertainty of economic policies and the green innovation ability of enterprises. Chai et al. [38] found that energy-saving and emission-reduction planning inhibits the innovation of heavily polluting enterprises.

In the study focusing on the firm level, Naveed et al. [39] found that gender diversity in Chinese corporate boards has a promoting effect on corporate green innovation. Liu and Lyu [40] found that ESG ratings can promote green innovation in enterprises, and that the institutional environment and redundant organizational resources have a reinforcing effect. Roh et al. [41] used data from South Korea's manufacturing industry from 2014 to 2016 and found that corporate intellectual property significantly affects green product innovation. Feng et al. [42] found that digital transformation promotes green innovation in Chinese enterprises by constructing a double-fixed-effect model. Liu [43] constructed the short-sighted indicators of managers through text analysis and machine learning and found that the short-sighted behavior of management is negatively correlated with corporate green innovation.

In the study of the external environment, Al Swidi et al. [44] analyzed 257 manufacturing SMEs in India and found that consumer pressure for green innovation is positively correlated. Fiorillo et al. [45] analyzed more than 6000 listings in 56 countries and found that corporate green innovation was positively correlated with the number of equity analysts tracking companies. Li and Shen [46] conducted empirical tests and concluded that cities with higher levels of happiness had higher levels of green innovation among the listed companies. Wang et al. [47] found through their analysis of Chinese construction companies that the political affiliation of enterprises has a significant positive impact on green innovation. Zhang and Wang [48] found that corporate political ties have an inverted U-shaped relationship with green innovation.

2.3. Green Total Factor Productivity of Enterprises

The current research on GTFP is mainly carried out from the aspects of measurement of different industries, urban construction, environmental protection requirements and green innovation. In studies on measures in different industries: Jiang et al. [49] used the Super-SBM model to measure the GTFP of China's mineral resources industry from 2004 to 2019, and believed that improving GTFP is the key for China's mineral resources industry to get out of the dilemma of resource depletion and environmental degradation; Liu et al. [50] used the SBM model to measure the GTFP of dairy farming in 27 provinces in China from 2009 to 2020, and found that the GTFP of dairy farming showed fluctuating growth; Guo et al. [51] used the SBM-ML method to measure China's GTFP and analyzed the dynamic evolution of China's fish farming industry; Hong et al. [52] found that digital financial inclusion can significantly improve China's agricultural GTFP by measuring and testing agricultural GTFP. In the study on urban construction: Yang et al. [53] used the SBM-Undesirable model to calculate the GTFP and found that the construction of new energy demonstration cities can significantly improve the GTFP of resource-based cities; Wang et al. [54] used PSM-DID and spatial DID models to conduct quantitative research and found that low-carbon city pilot policies can promote the improvement of urban GTFP; Zhang et al. [55] found that implementing urban environmental legislation can significantly improve the GTFP of enterprises. In the study on environmental protection requirements: Yan et al. [56] used data envelopment analysis to measure industrial GTFP and found that environmental regulation can promote the growth of industrial GTFP; Tong et al. [57] concluded that strict environmental regulations significantly improved China's GTFP. Wang et al. [58] used Chinese provincial panel data and non-radial SBM models to measure GTFP, and found that public environmental protection demands are conducive to improving GTFP. In the study on green innovation: Wu et al. [59] selected the economic environment statistics at provincial and municipal levels in China from 2004 to 2019, and found that enterprise green innovation improved GTFP; Zhao et al. [60] found that green innovation has a significant positive impact on GTFP, while financial

development, population density and environmental regulation are negatively correlated with GTFP.

Although some research has been carried out on regional social capital, enterprise green innovation and GTFP, there are still some problems and content worth studying. First of all, the evaluation indicators of regional social capital are not uniform, and the alternative variables are simple and non-standardized. Secondly, although some scholars have studied the relationship between social capital and enterprise innovation at the enterprise level, and the relationship between enterprise innovation and GTFP, no scholars have studied the relationship between green innovation behavior and the GTFP of enterprises from the macro-level social capital, and its quantitative relationship and specific mechanism are not clear.

Therefore, by building a regional social capital evaluation index system, this paper quantifies the social capital situation in various regions of China and, for the first time, incorporates regional social capital, enterprise green innovation and GTFP into a unified framework, takes the panel data of 30 provinces in China from 2011 to 2019 as a sample, and analyzes the logical and quantitative relationship between the three by using OLS and Tobit two-step methods. This paper looks forward to providing some references for policy formulation, the green innovation of enterprises and the high-quality and sustainable development of economies around the world through research and analysis.

3. Theoretical Analysis

1. The influence of regional social capital on GTFP and enterprise green innovation

Based on the theory of resource dependence, the development of enterprises depends on the supply of various resources in the region. Regional social capital, as a combination of intangible resources such as the structure, relationship and cognition in the region, has a great impact on the development of enterprises [61]. With the improvement of social capital, the business environment in the region may become more harmonious, and the level of trust can be steadily improved [62]. Additionally, with the improvement of the regional business environment, the pressure of the financing environment and constraints of enterprises will be eased, thereby reducing the financial pressure on enterprises [63] and promoting enterprises to invest in green innovation and various elements. With the improvement of the regional social trust level, the enterprise owner can reduce their energy investment into dealing with the risk of the transfer of controlling rights and pay more attention to the scientific basis and accuracy of the enterprise's decision-making [64], which will promote the further optimization of the enterprise's organizational structure and personnel. The possibility of moral hazard and adverse selection for managers is greatly reduced, the conflict of interest between the owners and operators of enterprises is alleviated [65], and the managers of enterprises can pay more attention to long-term development and green innovation [66], reduce the operating cost and unexpected output of the enterprise [67], and ultimately promote the growth of its GTFP [68,69].

2. The influence of enterprise green innovation on GTFP

As a comprehensive indicator that considers both production efficiency and unexpected outputs such as carbon dioxide in the production process of enterprises, enterprise GTFP is affected by various factors. As the key to technological transformation and upgrading, enterprise green innovation has a great impact on GTFP [70]. The innovation input of enterprises comes from the decision-making of executives. With the development of regional economies, the competition among enterprises will be further intensified [71], which will stimulate managers to increase green innovation input and accelerate green innovation output in order to seek high-quality development [72]; with the change in enterprise strategy, improved enterprise green innovation input and output levels will promote enterprise transformation and upgrading [73], eliminate outdated production capacity, and then improve the production and operation efficiency of the enterprise and reduce unexpected output, so as to achieve GTFP growth [74]. Based on the above analysis, we

find that regional social capital will not only have an impact on enterprise green innovation, but also further promote the improvement of GTFP, so enterprise green innovation may be an important path for regional social capital to influence GTFP.

4. Empirical Design

4.1. Variable Definition and Data Source

4.1.1. Explained Variable

Green total factor productivity (GTFP) of enterprises. This paper selects the super -SBM model to measure the GTFP of all industry enterprises from 2011 to 2019. The specific input-output indicators are calculated as follows: (1) The input indicators take into account the three elements of labor, capital and energy. The labor input is expressed by the number of employees of the enterprise, the capital input is expressed by the net fixed assets of the enterprise, and the energy input is calculated by multiplying the regional energy consumption by the ratio of the enterprise's operating income and the regional financial income. (2) The expected output is measured by the sales revenue of the enterprise. (3) The unexpected output index is measured by the carbon dioxide emissions of enterprises. See Table 1 for details.

Table 1. GTFP calculation comparison table.

Category	Indicators	Indicator Description
	Labor input (T)	Number of employees (T)
Input	Capital input (T)	Net fixed assets (T)
	Energy input (T)	(Enterprise operating revenue (T)/total regional financial revenue (T))· Total regional energy consumption (T)
Expected output	Sales revenue (T)	Total operating revenue (T)
Unexpected output	CO_2 emissions (T)	Total CO_2 emissions (T)

4.1.2. Explanatory Variables

Regional Social Capital (RSC). In view of the shortcomings of the regional social capital indicators in the existing research and their interdependence with the macroeconomic system, based on the research of Nahapiet et al. [8], as shown in Table 2, this paper divides regional social capital into four dimensions—structure, relationship, cognition and politics— and selects 11 macro indicators to construct a regional social capital index. In the calculation, the logarithm of the third-level indicators is averaged to obtain four second-level indicators, which are then averaged to finally form the regional social capital index. The larger the index, the higher the regional social capital level.

4.1.3. Mediating Variables

Enterprise Green Innovation (EGI). This paper divides enterprise green innovation into green innovation input and output. Green innovation input includes two indicators: R&D capital ratio (RDCR) and R&D personnel ratio (RDPR); and Green Innovation output includes three indicators: total output of enterprise green patent (TOEGP) [75], substantive green innovation output ($SGIO_1$) and strategic green innovation output ($SGIO_2$) [76].

Fiscal decentralization (FD). This paper uses the ratio of provincial financial budget revenue to national budget revenue to measure this.

Urbanization level (UL). This paper uses the ratio of urban population to total population in each province to measure this.

Carbon dioxide emissions (CO_2). This paper uses the natural logarithm of the total carbon dioxide emissions of each province to measure these.

Table 2. Regional social capital evaluation index system.

Dimension	Indicator	Specific Content
Structural dimension	Urbanization level	Proportion of urban population in each province to the total population
	Industrial level	Proportion of secondary industry in GDP of each province
	Consumption level	Consumption level of residents in each province
Relationship dimension	Economic network	1—(investment in state-owned fixed assets of each province/investment in fixed assets of the whole society)
	Information network	Total amount of postal and telecommunications services in each province/total number of people in each region
	Interpersonal network	Proportion of tertiary industry in GDP of each province
Cognitive dimension	Trust level	Trust index of each province
	Guarantee level	Ratio of education, social security, employment, medical and health expenditure to total expenditure of each province
	Environmental protection level	Proportion of provincial environmental protection investment to local financial expenditure
Political dimension	Institutional factors	Average of the total number of members of the 18th and 19th Central Committees in each province in the longest serving place
	Native place factor	Average of the total number of people in the places of origin of the 18th and 19th central committee members of each province

4.1.4. Life Cycle Variables

On the basis of Dickinson [77], this paper divides the life cycle into the startup period, growth period, maturity period and recession period, according to the characteristics of enterprise cash flow. See Table 3 for details.

Table 3. Characteristics of enterprise cash flow.

Cash Flow	Startup Period	Growth Period	Maturity Period	Recession Period				
Net operating cash flow	−	+	+	−	+	+	−	−
Net investment cash flow	−	−	−	−	+	+	+	+
Net cash flow from financing	+	+	−	−	+	−	+	−

Note: + indicates positive cash flow, − indicates negative cash flow.

4.1.5. Financing Constraint Variables

Drawing on the relevant studies of Hadlock and Pierce [78], this paper uses the *SA* index to measure the financing constraints of enterprises. This index is composed of two variables: enterprise size and age, which reduce the endogeneity to a certain extent. The larger the *SA* index, the stronger the financing constraint of the enterprise. As shown in Formula 1, where $Size_{i,t}$ is the natural logarithm of the total assets of the enterprise, and $Age_{i,t}$ is the establishment age of the enterprise, i and t represent enterprise and year.

$$SA_{i,t} = -0.737 \times Size_{i,t} + 0.043 \times Size^2_{i,t} - 0.04 \times Age \tag{1}$$

4.1.6. Control Variables

Considering that GTFP is not only affected by regional social capital and enterprise innovation but also affected by various factors, such as the enterprise's own conditions, this paper takes the enterprise scale (ES) and other variables as control variables and controls them in the empirical process. See Table 4 for details.

Table 4. Definition of main variables.

Variable Type	Variable Name	Variable Code	Definitions
Explained variable	Enterprise green total factor productivity	$GTFP_{i,t}$	Calculated by the super-SBM model
Explanatory variable	Regional social capital	$RSC_{i,t}$	Regional social capital index in year t
Mediating variable	Green innovation input	$RDCR_{i,t}$	R & D investment/total operating income of Listed Companies in year t
		$RDPR_{i,t}$	Number of R & D personnel/total number of employees of Listed Company in year t
	Green innovation output	$TOEGP_{i,t}$	Add 1 to the sum of green patents applied by Listed Companies in year t, and take the natural logarithm
		$SGIO1_{i,t}$	Add 1 to the sum of green invention patents applied by Listed Companies in year t, and take the natural logarithm
	Fiscal decentralization Urbanization level Carbon dioxide emissions	$SGIO2_{i,t}$	Add 1 to the sum of Green utility model patents applied by Listed Companies in year t, and take the natural logarithm
		$FD_{i,t}$	Provincial budget revenue/national budget revenue in year t
		$UL_{i,t}$	Urban population/total population of each province in year t
		$CO_2{}_{i,t}$	Natural logarithm of total carbon dioxide emissions of each province in year t
Lifecycle variable	Life cycle	$LC_{i,t}$	Classification according to the characteristics of the cash flow of Listed Companies in year t
Moderating variable	Financing constraints	$SA_{i,t}$	SA index of Listed Companies in year t
Control variable	Enterprise scale	$ES_{i,t}$	Natural logarithm of the total assets of the listed company at the beginning of the year in year t
	Asset liability ratio	$ALR_{i,t}$	Debt/total assets of Listed Companies in year t
	Return on assets	$ROA_{i,t}$	Net profit/total assets of Listed Companies in year t
	Management Expense Rate	$MER_{i,t}$	Management expenses/main business income of Listed Companies in the year t
	Cash holdings	$CH_{i,t}$	Monetary funds/total assets of Listed Companies in year t
	Enterprise growth	$EG_{i,t}$	Growth rate of operating income of Listed Companies in year t
	Executive compensation	$EC_{i,t}$	Natural logarithm of the compensation of the top three executives of Listed Companies in year t
	Equity incentive	$EI_{i,t}$	Number of shares held by executives of Listed Companies/total number of shares in year t
	Company age	$CA_{i,t}$	Add 1 to the Listed Company's age, and take the natural logarithm
	Year	YEAR	Dummy variable
	Industry	IND	Dummy variable

4.2. Data Source

Based on the panel data of 30 provinces from 2011 to 2019, this paper takes the A-share listed companies in Shanghai and Shenzhen stock exchanges as specific samples. Among them, the original data related to regional social capital are from the China Statistical

Yearbook, and the financial data such as enterprise green innovation are from the guotai'an (CSMAR) database and China Research Data Service Platform (CNRDS). All data were cross-checked. Additionally, the initial samples were screened: financial and insurance companies, listed companies with special treatment and samples with serious missing data were excluded, and continuous variables were winsorized by 1%. Finally, the balanced panel data composed of 8244 sample observations were obtained. State15 statistical software was used in the multiple regression analysis. The meanings of specific variables are shown in Table 4:

4.3. Model Construction

In order to deeply study the quantitative relationship between regional social capital, enterprise green innovation and GTFP and eliminate the influence of heteroscedasticity, this study adopts the least square method to conduct empirical research. Additionally, the empirical model of the impact of regional social capital on GTFP is as follows:

$GTFP_{it} = \alpha 0 + \alpha 1 Rsc_{it} + \alpha 2 Control_{it} + \varepsilon_{it}$ (model 1)

The empirical model of the impact of regional social capital on enterprise green innovation is as follows:

$EGI_{it} = \beta 0 + \beta 1 Rsc_{it} + \beta 2 Control_{it} + \varepsilon_{it}$ (model 2)

The empirical model of the impact of enterprise green innovation on GTFP is as follows:

$GTFP_{it} = \gamma 0 + \gamma 1 EGI_{it} + \gamma 2 Control_{it} + \varepsilon_{it}$ (model 3)

Based on models 1 and 2, the mediating effect of enterprise green innovation is further explored, and the model is as follows:

$GTFP_{it} = \omega 0 + \omega 1 Rsc_{it} \gamma 1 + \omega 2 EGI_{it} + \omega 3 Control_{it} + \varepsilon_{it}$ (model 4)

The adjustment effect models of financing constraints are as follows:

$GTFP_{it} = \eta 0 + \eta 1 Rsc_{it} + \eta 2 Sa_{it} + \eta 3 Rsc_{it} \times sa_{it} + \eta 4 Control_{it} + \varepsilon_{it}$ (model 5)

Among them, i and t represent the enterprise and year, respectively; GTFP stands for Green Total Factor Productivity of Enterprises; RSC is regional social capital; EGI stands for enterprise green innovation; Control stands for control variable; ε_{it} is a random perturbation term.

In the process of regression, when $\alpha 1$ and $\beta 1$ are significantly positive, it indicates that regional social capital has a positive impact on enterprise GTFP and enterprise green innovation, respectively. When $\gamma 1$ is significantly positive, it means that enterprise green innovation has a promoting effect on enterprise GTFP. If $\eta 3$ is significantly positive, it means that the financing constraint has a positive adjustment to the relationship between regional social capital and enterprise GTFP.

In the mediation effect test, if $\alpha 1$ is not significant, there is no mediation effect; if $\beta 1$ and $\omega 2$ are not significant in at least one of them, the bootstrap test is performed, assuming H0: $\beta 1 \omega 2 = 0$, and if the null hypothesis is not accepted, there is no mediating effect; if none of them are significant, there is no mediating effect; if $\beta 1$ and $\omega 2$ are significant, $\omega 1$ is not, and the Sobel test is statistically significant, it means that EGI plays a complete mediating role; if both $\beta 1$, $\omega 2$ and $\omega 1$ are significant, and $\omega 1 < \alpha 1$, the Sobel test is statistically significant, and there is a partial mediating effect; if $\beta 1 \omega 2$ and $\omega 1$ are the same number, it is a partial mediating effect, and the proportion of mediating effect to the total utility is $\beta 1 \omega 2 / \alpha 1$, and if it is different, it is a masking effect, and the effect value is $|\beta 1 \omega 2 / \omega 1|$.

4.4. Descriptive Statistic

As shown in Table 5, the average and standard deviation of GTFP of A-share listed companies in China are 0.2559 and 0.0978 respectively, indicating that there is a large space for development of GTFP of Chinese enterprises. There is a large difference among enterprises' green innovation. The maximum value and standard deviation of R & D input reach 25.03 and 7.1967, respectively, and the standard deviation of green innovation output is above 0.5; the standard deviation of enterprise financing constraint is 2.4549, which proves that the financial pressures of different companies are quite different. The difference between the return on assets and management expense rate among enterprises is the small-

est, with standard deviations of 0.0515 and 0.0681, respectively, which proves that China's economic development is relatively stable and is consistent with the actual situation.

Table 5. Descriptive statistics.

	N	Minimum	Maximum	Mean	Standard Deviation
gtfp	8244	0.09	1.33	0.2559	0.0978
rsc	8244	3.38	4.42	4.0556	0.2087
rdcr	8244	0	25.03	14.5888	7.1967
rdpr	8244	0	4.01	1.1788	1.3763
toegp	8244	0	6.87	0.3555	0.8246
sgio1	8244	0	6.72	0.2581	0.6889
sgio2	8244	0	4.94	0.2012	0.5796
es	8244	18.68	28.52	22.2751	1.3475
alr	8244	0.04	0.92	0.4258	0.2021
roa	8244	−0.24	0.2	0.0395	0.0515
mer	8244	0.01	0.46	0.0913	0.0681
ch	8244	0.01	0.71	0.1804	0.1324
eg	8244	−0.84	2.97	0.1711	0.3761
ec	8244	0	17.87	14.3994	0.8011
ei	8244	0	0.58	0.057	0.1219
lc	8244	1	4	2.6	0.903
sa	8244	−8.65	10.57	0.8535	2.4549
age	8244	0	3.37	2.2728	0.6631
ul	8244	3.55	4.5	4.1413	0.1982
co2	8244	8.49	11.93	10.7117	0.6548
fd	8244	0	0	0.06	0.033

5. Empirical Results

5.1. Influence of Regional Social Capital on GTFP and Enterprise Green Innovation

As presented in Table 6, regional social capital has a positive role in promoting enterprise GTFP, green innovation input, total green patent output and substantial green innovation output. The coefficient of influence on GTFP was 0.0481, and it passed the 1% significance test. However, the impact on the strategic green innovation output of enterprises is not significant. With the improvement of regional social capital, the business environment and trust level in the region are further improved. The management will pay more attention to the main business and the sustainable development of the company, reduce unnecessary inputs and unexpected outputs, and then improve GTFP. The improvement of the regional environment will promote the entry of external resources and bring more funds and personnel to the enterprise. This will help ease the financial constraints of enterprises, stimulate enterprise managers to increase investment in green innovation, promote the transformation and upgrading of regional enterprises, and eliminate outdated production capacity, so as to drive the green innovation output and substantive green innovation of enterprises.

5.2. Impact of Enterprise Green Innovation on GTFP

According to Table 7, the green innovation output of enterprises has a positive role in promoting GTFP, that is, the total output and strategic output passed the 10% and 1% significance tests, respectively. However, the green innovation input has an inhibitory effect on enterprise GTFP. Based on the principal–agent theory, with the in-depth development of the system of separation of two powers, managers often regard innovation opportunistically and behave in their own self-interest, which increases the risk of enterprise operation and stock price collapse to a certain extent. In addition, with the increase in R&D investment and personnel, problems such as resource redundancy and low efficiency may occur, which may reduce the enterprise's GTFP. However, the improvement of the green innovation output of enterprises will promote the upgrading of enterprise technology, drive the improvement of enterprise operation efficiency, improve green output, and then reduce the production

and operation costs and unexpected output of enterprises, so as to promote the steady improvement of GTFP.

Table 6. Impact results of regional social capital on GTFP and enterprise green innovation.

	(1)	(2)	(3)	(4)	(5)	(6)
	gtfp	**rdcr**	**rdpr**	**toegp**	**sgio1**	**sgio2**
rsc	0.0481 ***	2.8135 ***	0.4308 ***	0.1240 ***	0.1218 ***	0.0445
	(0.0038)	(0.3369)	(0.0484)	(0.0454)	(0.0382)	(0.0324)
_cons	0.9993 ***	−24.1158 ***	−0.9980 ***	−6.2719 ***	−5.4416 ***	−3.5796 ***
	(0.0221)	(1.9620)	(0.2821)	(0.2646)	(0.2222)	(0.1886)
Control	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed	Yes	Yes	Yes	Yes	Yes	Yes
Ind fixed	Yes	Yes	Yes	Yes	Yes	Yes
N	8244	8244	8244	8244	8244	8244
r2	0.5801	0.3888	0.6545	0.1531	0.1445	0.1294
r2_a	0.5789	0.3872	0.6536	0.1508	0.1422	0.1270
F	516.1594	237.7329	707.9772	67.5476	63.0992	55.5195

Note: Standard errors in parentheses *** $p < 0.01$.

Table 7. Impact of enterprise green innovation on TFP.

	(1)	(2)	(3)	(4)	(5)
	gtfp	**gtfp**	**gtfp**	**gtfp**	**gtfp**
rdcr	−0.0010 ***				
	(0.0001)				
rdpr		−0.0019 **			
		(0.0009)			
toegp			0.0016 *		
			(0.0009)		
sgio1				0.0006	
				(0.0011)	
sgio2					0.0039 ***
					(0.0013)
_cons	1.1582 ***	1.1734 ***	1.1814 ***	1.1755 ***	1.1857 ***
	(0.0176)	(0.0176)	(0.0184)	(0.0184)	(0.0181)
Control	Yes	Yes	Yes	Yes	Yes
Year fixed	Yes	Yes	Yes	Yes	Yes
Ind fixed	Yes	Yes	Yes	Yes	Yes
N	8244	8244	8244	8244	8244
r2	0.5752	0.5721	0.5720	0.5719	0.5723
r2_a	0.5741	0.5710	0.5709	0.5707	0.5712
F	506.0812	499.6614	499.4325	499.1672	500.0970

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5.3. Path Inspection

In order to further explore whether enterprise green innovation is the path for regional social capital to affect GTFP, this paper uses the research methods of Baron and Kenny [79] as a reference to test the mediation effect. As shown in Tables 8 and 9, through the path analysis, Sobel and Bootstrap tests, the indirect effect of regional social capital on enterprise GTFP through the path of enterprise green innovation capital investment is $\beta1\omega2 = -0.0086$, and it was significant at the level of 1%, and the 95% confidence interval is $[-0.0104, -0.0067]$. The confidence interval excluding 0 indicates a significant indirect effect. However, the sign of indirect effect ($\beta1\omega2 = -0.0086$) is opposite to the sign of direct effect ($\omega1 = 0.0698$), indicating that the indirect effect of enterprise green innovation capital investment between regional social capital and enterprise GTFP is the "masking effect." In addition, the other four paths do not pass the test, so there is no mediation effect.

Table 8. Path analysis.

	gtfp	rdcr	rdpr	toegp	sgio1	sgio2	gtfp	gtfp	gtfp	gtfp	gtfp
rsc	0.0613 *** (0.0036)	5.8461 *** −0.3653	1.8894 *** −0.0671	0.0035 (0.0426)	0.0337 (0.0355)	−0.057 * −0.0303	0.0698 *** (0.0036)	0.0616 *** (0.0038)	0.0612 *** (0.0036)	0.0614 *** (0.0036)	0.0611 *** (0.0036)
rdcr							−0.0014 *** (0.0001)				
rdpr								−0.0002 (0.0006)			
toegp									−0.0025 ** (0.0009)		
sgio1										−0.0038 ** (0.0011)	
sgio2											−0.0016 ** (0.0013)
_cons	0.8163 *** (0.0116)	−27.5983 *** (2.0559)	−9.7492 *** −0.3775	−4.9977 *** (0.2398)	−4.5388 *** (0.1998)	−2.5396 *** (0.1706)	0.7757 *** (0.0205)	0.8146 *** (0.0213)	0.8036 *** (0.0211)	0.7988 *** (0.0211)	0.8122 *** (0.0208)
N	8244	8244	8244	8244	8244	8244	8244	8244	8244	8244	8244
r2	0.5316	0.1341	0.2015	0.1023	0.107	0.0797	0.5418	0.5316	0.532	0.5323	0.5317
r2_a	0.531	0.1331	0.2005	0.1012	0.1059	0.0786	0.5411	0.531	0.5314	0.5316	0.5311
F	934.39	127.55	207.71	93.79	98.68	71.28	884.74	849.36	850.76	851.6	849.63
Sobel				−0.0086 *** (Z = −10.32) −0.0003(Z = −0.2915) − 8.845×10^{-6} (Z = −0.0812) −0.0001(Z = −0.9155) 0.00009(Z = −1.02)							

Standard errors in parentheses* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 9. Bootstrap Test of green innovation output.

Indirect Effect	Correlation Coefficient			Bootstrap Inspection	
	Coefficient	Standard Deviation	Level of Significance	BootLLCL	BooULCL
rdcr	−0.0086	0.0009	<0.05	−0.0104	−0.0067
rdpr	−0.0003	0.0012	>0.05	−0.0027	0.0021
toegp	-8.85×10^{-6}	0.0001	>0.05	−0.0002	0.0002
sgio$_1$	−0.0001	0.0001	>0.05	−0.0003	0.0001
sgio$_2$	0.0001	0.0001	>0.05	−0.0001	0.0002

5.4. Expansibility Analysis

5.4.1. The Influence of Regional Social Capital on the GTFP and Green Innovation of Heterogeneous Enterprises

In order to further test the influence of regional social capital on GTFP and enterprise green innovation, this paper divides enterprises into state-owned enterprises and private enterprises, according to the nature of controlling shareholders, as shown in Table 10. The impact of regional social capital on state-owned enterprises is basically consistent with the full sample regression; it has a positive promoting effect on the GTFP and green innovation input of private enterprises, but it has an inhibitory effect on green innovation output, which passed 1% and 5% significance tests, respectively. With improved regional social capital and the entry of external resources, the competition among enterprises has gradually increased. In order to stabilize their political status and performance, state-owned enterprise managers will increase research and development and promote green innovation, which will further improve GTFP. However, most private enterprises are small in scale, and there are various obstacles to their development. This means that, although the improvement of regional social capital can bring funds and talent and promote R&D investment, innovation output has certain periodicity and contingency and is closely related to the strength of enterprises [7]. In the face of fierce competition among enterprises, the managers of private enterprises may pay more attention to the investment in low-cost areas to obtain a cheap labor force and then quickly obtain profits while paying less attention to the green innovation output of enterprises.

5.4.2. Impact of Different Life Cycles of Enterprises

This paper further examines the influence of regional social capital on GTFP through the life cycle of the enterprise. As listed in Table 11, regional social capital has a positive role in promoting the GTFP of enterprises in different life cycles, passing the 1% significance tests, respectively, and has a more significant impact on enterprises in the start-up period and recession period, with a coefficient of 0.0532 and 0.0659, respectively. Specifically, the improvement of regional social capital and the optimization of the external environment will bring more convenience and resources to the development of enterprises and then play

a role in promoting the improvement of GTFP; at the same time, affected by the life cycle, most start-ups are responsive, and enterprises in the recession period are more likely to obtain the favorable impact brought by the optimization of the external environment in order to revitalize them and promote their sustainable development. Therefore, the impact of regional social capital on GTFP is more significant.

Table 10. Heterogeneity analysis.

	State−Owned Enterprise						Private Enterprise					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	gtfp	rdcr	rdpr	toegp	sgio1	sgio2	gtfp	rdcr	rdpr	toegp	sgio1	sgio2
rsc	0.0708 ***	3.2566 ***	0.3125 ***	0.4066 ***	0.3753 ***	0.2064 ***	0.0276 ***	1.9807 ***	0.3961 ***	−0.1108 **	−0.0882 **	−0.1016 ***
	(0.0070)	(0.6453)	(0.0806)	(0.0802)	(0.0702)	(0.0570)	(0.0042)	(0.3551)	(0.0571)	(0.0547)	(0.0440)	(0.0390)
_cons	0.7274 ***	−31.9028 ***	−0.8352 *	−8.0070 ***	−6.8753 ***	−5.0681 ***	1.3519 ***	−20.0893 ***	−1.3169 ***	−3.9712 ***	−3.5218 ***	−1.6840 ***
	(0.0371)	(3.4345)	(0.4292)	(0.4269)	(0.3737)	(0.3036)	(0.0267)	(2.2612)	(0.3639)	(0.3484)	(0.2801)	(0.2487)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ind fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3157	3157	3157	3157	3157	3157	5087	5087	5087	5087	5087	5087
r2	0.4211	0.3674	0.5409	0.2102	0.1890	0.1972	0.6577	0.4314	0.7454	0.1141	0.1144	0.0821
r2_a	0.4170	0.3629	0.5377	0.2047	0.1833	0.1916	0.6562	0.4289	0.7443	0.1102	0.1105	0.0781
F	103.6035	82.7172	167.8651	37.9132	33.2014	34.9941	442.3013	174.6266	673.7778	29.6410	29.7214	20.5879

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 11. Impact of different life cycles of enterprises.

	Startup	Growth Period	Maturity Period	Recession Period
	(1)	(2)	(3)	(4)
	Gtfp	gtfp	gtfp	gtfp
rsc	0.0532 ***	0.0420 ***	0.0453 ***	0.0659 ***
	(0.0093)	(0.0060)	(0.0067)	(0.0092)
_cons	1.0899 ***	0.9411 ***	0.9238 ***	1.2783 ***
	(0.0586)	(0.0334)	(0.0390)	(0.0605)
Control	Yes	Yes	Yes	Yes
Year fixed	Yes	Yes	Yes	Yes
Ind fixed	Yes	Yes	Yes	Yes
N	1001	2694	3182	1367
r2	0.6622	0.6009	0.5314	0.6488
r2_a	0.6546	0.5976	0.5281	0.6431
F	87.1268	182.7762	162.8416	112.8610

Note: Standard errors in parentheses *** $p < 0.01$.

5.4.3. Regulatory Effect of Financing Constraints

This paper uses the multiplication term Rsc*sa of regional social capital (RSC) and financing constraints (SA) to test the regulatory effect of financing constraints. As shown in Table 12, financing constraints have a positive moderating effect on the relationship between regional social capital and the GTFP of the whole sample and state-owned enterprises, while having a restraining effect on the relationship between it and the GTFP of private enterprises. Most state-owned enterprises are large, so in the case of a certain regional social capital, when the enterprise faces financing constraints, it will prompt managers to pay more attention to the efficiency and effect of the use of funds and then have a positive adjustment to its GTFP. However, although the private enterprise system is flexible, it is generally small in scale, is easily affected by the internal and external environment, and generally lacks financing channels. Therefore, with the improvement of financing constraints, corporate innovation and production and operation efficiency will be affected, so financing constraints have an inhibitory effect on the relationship between regional social capital and private enterprise GTFP.

Table 12. Adjustment effect analysis.

	Full Sample	State−Owned breakEnterprise	Private Enterprise
	(1) **gtfp**	**(2)** **gtfp**	**(3)** **gtfp**
rsc	0.0461 *** (0.0040)	0.0665 *** (0.0070)	0.0331 *** (0.0045)
sa	−0.0167 *** (0.0059)	−0.0463 *** (0.0104)	0.0129 * (0.0068)
rsc * sa	0.0036 ** (0.0014)	0.0111 *** (0.0024)	−0.0041 ** (0.0016)
_cons	0.9750 ***	0.7571 ***	1.2635 ***
Control	Yes	Yes	Yes
Year fixed	Yes	Yes	Yes
Ind fixed	Yes	Yes	Yes
N	8244	3157	5087
r2	0.5806	0.4249	0.6593
r2_a	0.5794	0.4205	0.6576
F	474.1347	96.4027	408.0877

Note:Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5.4.4. Macro Path Analysis

In the context of accelerating the promotion of the dual carbon goal in China, in order to further explore the impact path of regional social capital on enterprise GTFP, this paper uses Model 1, 2 and 4 to test in the three macro dimensions of fiscal decentralization, urbanization and CO_2 emission levels in each province. The results are shown in Tables 13 and 14. Through the test, this paper shows that the indirect effects of regional social capital on enterprise GTFP through regional fiscal decentralization, urbanization level and CO_2 emissions are 0.0112, 0.0939 and -0.0089, respectively, and are significant at the level of 1% and excluding zero in the 95% confidence interval, indicating that the indirect effect is significant. Among them, the sign of indirect effect of fiscal decentralization is the same as the sign of direct effect, while the signs of indirect effect of urbanization and CO_2 emissions are opposite to the signs of direct effect, indicating that fiscal decentralization has a partial mediating effect on regional social capital and enterprise GTFP, while urbanization and CO_2 emissions have "masking effects."

Table 13. Macro path test.

	gtfp	fd	ul	co$_2$	gtfp	gtfp	gtfp
rsc	0.0612 *** (0.0036)	0.0251 *** −0.0017	0.5268 *** (0.0083)	0.3298 *** (0.0345)	0.0501 *** (0.0036)	−0.0326 *** (0.0041)	0.0702 *** (0.0036)
fd					0.4461 ** (0.0228)		
ul						0.1783 *** (0.0044)	
co$_2$							−0.0271 *** (0.0011)
_cons	0.8163 *** (0.0205)	−0.0964 *** (0.0096)	1.089 *** (0.0468)	11.9991 *** (0.1941)	0.8593 *** (0.0202)	0.6221 *** (0.0194)	1.1418 *** (0.024)
N	8244	8244	8244	8244	8244	8244	8244
r2	0.5316	0.0974	0.4066	0.0679	0.5523	0.6089	0.5623
r2_a	0.531	0.0963	0.4059	0.0668	0.5517	0.6084	0.5617
F	934.39	88.86	51.13	59.99	923.15	1165.36	961.42
Sobel			0.0112 **($Z = 11.69$)	0.0939 ***($Z = 34.02$)	−0.0089 ***($Z = -8.886$)		

Standard errors in parentheses ** $p < 0.05$, *** $p < 0.01$.

Table 14. Bootstrap Test of Macro Path.

Indirect Effect	Correlation Coefficient			Bootstrap Inspection	
	Coefficient	Standard Deviation	Level of Significance	BootLLCL	BooULCL
fd	0.0112	0.0008	<0.05	0.0096	0.0127
ul	0.0939	0.0029	<0.05	0.0882	0.0995
CO_2	−0.0089	0.0011	<0.05	−0.0112	−0.0066

As an important part of the market economy system, fiscal decentralization has a significant impact on the initiative of the central and local governments. The higher the level of fiscal decentralization is, the higher the degree of financial freedom of local governments is. Therefore, with the improvement of regional social capital and fiscal decentralization, local governments can become more willing to support the innovation and transformation development of local enterprises, improve their green development ability and level, and ultimately promote the high-quality development of regional economy. The improvement of urbanization levels will promote the interactive development and resource sharing between cities and enterprises, which will enhance the ability to coordinate development between regions and enterprises, thus promoting green development. However, with the improvement of regional social capital level, the competition among enterprises has gradually intensified. In order to obtain short-term competitive advantages and benefits, the enterprise may increase carbon dioxide emissions to a certain extent, but ultimately it will enhance the enterprise's awareness of environmental protection and long-term development, and achieve the improvement of the enterprise's GTFP.

5.5. Robustness Test

(1) Reconstruct the subsample. In accordance with the "Guidelines for Industry Classification of Listed Companies" issued by the CSRC, this paper deletes public utility enterprises and retains a new sample of real estate, comprehensive industry and industrial enterprises, etc., to test the model. As shown in Table 15, the regression results are basically consistent with the main regression, which proves that the conclusions of this paper are still stable after reconstructing the subsample. (2) Perform the instrumental variable test. In order to solve the endogeneity problem caused by missing variables, this paper uses the instrumental variable method to test the main model, using the lag period of regional social capital (rsc2) as the instrumental variable of regional social capital and using the Tobit two-step method to test the model. As shown in Table 16, the regression results are consistent with the main regression, and there are no weak instrumental variables or over-identification problems, which proves that the conclusion is still robust after solving the possible endogeneity problems.

Table 15. Robustness test-reconstruct the subsample.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	gtfp	rdcr	rdpr	toegp	sgio1	sgio2	gtfp	gtfp	gtfp	gtfp	gtfp
rsc	0.0454 ***	1.5240 ***	0.3118 ***	0.0925 *	0.0887 **	0.0553					
	(0.0038)	(0.3452)	(0.0486)	(0.0492)	(0.0406)	(0.0365)					
rdcr							−0.0010 ***				
							(0.0001)				
rdpr								−0.0010			
								(0.0010)			
toegp									0.0049 ***		
									(0.0009)		
sgio1										0.0049 ***	
										(0.0011)	
sgio2											0.0063 ***
											(0.0013)
_cons	1.0697 ***	−24.5344 ***	−1.1988 ***	−7.2098 ***	−6.1520 ***	−4.3455 ***	1.2178 ***	1.2358 ***	1.2694 ***	1.2645 ***	1.2620 ***
	(0.0227)	(2.0332)	(0.2861)	(0.2897)	(0.2393)	(0.2148)	(0.0181)	(0.0179)	(0.0190)	(0.0191)	(0.0187)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ind fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7022	7022	7022	7022	7022	7022	7022	7022	7022	7022	7022
r2	0.6243	0.4199	0.6902	0.1874	0.1805	0.1499	0.6196	0.6169	0.6183	0.6178	0.6182
r2_a	0.6232	0.4181	0.6892	0.1850	0.1781	0.1474	0.6184	0.6157	0.6171	0.6167	0.6170
F	553.9190	241.2444	742.5185	76.8799	73.4298	58.7796	542.9154	536.7496	539.9395	538.9166	539.6736

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 16. Endogenous test-instrumental variable method.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	rsc	gtfp	rdcr	rdpr	toegp	sgio1	sgio2
rsc1	1.0108 ***						
	(0.0016)						
rsc		0.0504 ***	2.8386 ***	0.4747 ***	0.1232 **	0.1212 ***	0.0428
		(0.0041)	(0.3438)	(0.0531)	(0.0490)	(0.0412)	(0.0348)
_cons	−0.0081	0.9956 ***	−23.5294 ***	−1.1251 ***	−6.3822 ***	−5.5972 ***	−3.5847 ***
	(0.0066)	(0.0239)	(2.0211)	(0.3124)	(0.2878)	(0.2423)	(0.2046)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ind fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7328	7328	7328	7328	7328	7328	7328
r2	0.9810	0.5704	0.3743	0.6393	0.1547	0.1460	0.1302
r2_a	0.9810	0.5691	0.3725	0.6382	0.1523	0.1435	0.1277

Note: Standard errors in parentheses ** $p < 0.05$, *** $p < 0.01$.

6. Concluding Discussion

This study takes the panel data of 30 provinces in China from 2011 to 2019 as a sample, builds a regional social capital evaluation index system and uses the super-SBM model to measure the enterprise GTFP. Additionally, this study brings regional social capital, enterprise green innovation and GTFP into the unified framework for the first time, and uses OLS and Tobit two-step methods to draw the following conclusions:

(1) Regional social capital has a positive role in promoting GTFP and green innovation input, the total output of green patents and the substantive green innovation output of enterprises, and has no significant impact on the strategic green innovation of enterprises. The heterogeneity test found that the influence of regional social capital on the state-owned enterprises is consistent with that of the whole sample; it has a positive promoting effect on the GTFP and green innovation input of private enterprises but has an inhibitory effect on their green innovation output. In addition, regional social capital has a positive role in promoting the GTFP of enterprises in different life cycles, especially for enterprises in the start-up or recession period.

(2) The total output of the green innovation and strategic green output of enterprises have a positive role in promoting GTFP, and the green innovation capital investment has a masking effect between regional social capital and enterprise GTFP. Further inspection shows that fiscal decentralization in each province has a partial mediation effect between regional social capital and enterprise GTFP, while urbanization level and CO_2 emissions have a masking effect. Financing constraints have a positive moderating effect on the relationship between the regional social capital and GTFP of the whole sample and state-owned enterprises, while they have an inhibitory effect on the relationship between it and the GTFP of private enterprises.

The existing research does not directly incorporate regional social capital, enterprise green innovation and GTFP into the same framework, and only some scholars have analyzed the relationship between corporate green innovation and GTFP, and the corresponding conclusions are basically consistent with this paper, so most of the conclusions in this paper have certain originality.

China, as the largest developing country with vast territory, numerous nationalities and diverse cultures, has great differences in regional development. As a synthesis of various intangible resources in the region, regional social capital is considered to be another important factor in promoting economic growth, after physical capital and human capital, and can cause regional differences. Therefore, in the context of countries around the world jointly coping with environmental problems and the Chinese government fully implementing the "dual carbon" goal and promoting high-quality development, this paper constructs a regional social capital index based on existing research, and studies whether regional social capital has an impact on enterprise green innovation and GTFP, and whether enterprise green innovation, fiscal decentralization, urbanization and carbon

dioxide emissions are specific impact paths. This paper quantifies the relationship between regional social capital and enterprise green innovation and GTFP and answers the above questions. Additionally, this paper enriches the research scope of regional social capital, puts forward new ideas for scholars to further study Chinese development modes, and hopes to provide a reference for policy formulation and enterprise green innovation strategy selection in China and other developing countries.

Therefore, we hope to provide corresponding theoretical support and suggestions for government policy formulation and enterprise development through the above research, as follows:

(1) Promote the transformation and upgrading of the industrial structure and enhance the vitality of the market. At present, China is in a deep-water period of economic transformation and development, and the domestic and foreign environment is complex and changeable. In the post-epidemic era, the government should accelerate the upgrading of the regional industrial structure on the basis of consolidating primary industries and further increasing the proportion of secondary and tertiary industries, enhancing the vitality of the market, promoting the improvement of regional social capital and creating a more harmonious social environment and business atmosphere for the development of enterprises. In addition, the central government should improve the financial freedom of local governments, further formulate relevant fiscal and tax policies to support the green innovation of enterprises in areas with high social capital levels, and enhance the financial and personnel support for enterprise innovation, so that the role of local governments can be fully played, and ultimately promote the improvement of the green innovation capabilities of enterprises and high-quality economic development.

(2) Coordinate regional planning and further improve infrastructure construction. On the basis of the original infrastructure construction in the region, the government should further enhance the overall planning of the region, especially in the central and western regions; that is, it should increase capital investment, reduce regional differences and improve regional urbanization level and density; and further improve the assessment and evaluation system, promoting the real implementation of the project so that the role of infrastructure construction can be effectively played. At the same time, through the construction of new infrastructure, the level of urbanization can be improved, the development distance between cities can be shortened, the attractiveness of the region can be improved, the flow of innovation funds and personnel can be promoted, and then various supporting resources can be provided for the continuous green innovation of enterprises.

(3) Increase policy inclination and improve the green innovation level of key enterprises. As the main force of China's economic development, the growth of state-owned enterprises and mature enterprises plays an irreplaceable role in the country's economic development. Therefore, government departments should increase innovation funds and policy support for state-owned and growing and mature enterprises to promote regional enterprise green innovation, such as by providing interest-free loans to enterprises, increasing government R&D subsidies and scientific research incentives, and reducing corporate income tax. At the same time, with reference to state-owned enterprises, the state should further introduce new policies to support the technological innovation of private enterprises, and guide them in an orderly manner so as to realize collaborative innovation and promote the sustainable development of enterprises.

(4) Increase investment in environmental protection to promote green and sustainable economic and social development. Under China's requirement to achieve carbon peaking and carbon neutrality, all regions should enhance environmental protection awareness, increase environmental protection expenditure, and establish a green and low-carbon reward system for enterprises and a punishment system for excessive pollution. Support the construction and development of new energy enterprises, and eliminate outdated production capacity in order to create a good external environment for the realization of the dual carbon goal and the green development of enterprises. At the same time, special personnel should be organized to go to first-line enterprises to give lectures and actively

guide green innovation in enterprises, and further understand the actual difficulties existing in the enterprise, help it solve the problems in the development process in time, and then promote the green innovation of the enterprise and improve the production and operation efficiency of the enterprise.

(5) Give full play to the role of the main body of enterprise innovation and comprehensively improve the efficiency of enterprise green innovation. Under its own original system and mechanism, an enterprise should make further scientific adjustments, that is, improve the internal capital budget and final accounting system and the promotion system of scientific research personnel, ensure the investment direction and efficiency of scientific research funds and the development of personnel, and ensure the efficiency and effect of innovation. At the same time, through technological green innovation, enterprises can reduce unnecessary investment to reduce the operating costs of the enterprise, thereby improving the GTFP of the enterprise. The government and industry departments should establish an annual green innovation company and project selection system to stimulate the vitality of green innovation by rewarding the advanced and encouraging the backward so as to achieve the high-quality and sustainable development of enterprises.

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