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Analysis of the Impacts of Economic Growth Targets and Marketization on Energy Efficiency: Evidence from China

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Abstract: OEnergy efficiency is a vital factor to promote sustainable development. In this paper, the directional distance function–global Malmquist–Luenberger model (DDF-GML) is applied to measure the energy efficiency levels of 30 provinces in China from 2000 to 2017. Simultaneously, the impacts of the economic growth targets and marketization on energy efficiency are empirically tested using the generalized system moment estimation (SYS-GMM) and mediation effect model. The statistical results reveal that energy efficiency is on the rise every year as a whole. Mediated by marketization, economic growth targets inhibit energy efficiency by distorting marketization. Moreover, there is significant regional heterogeneity in the impacts of economic growth targets on energy efficiency. The inhibition effect of economic growth targets on energy efficiency in the eastern region is greater than in the central and western regions. The above empirical results are determined to be robust through testing.

Keywords: economic growth target; marketization; energy efficiency; mediation effect model

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1. Introduction

Driven by economic growth targets, China's rapid economic development has been accompanied by increasing energy consumption and total carbon emissions. The conflicts between the environment, energy, and economic growth are becoming increasingly prominent [1,2]. This energy consumption, which is dominated by fossil energy, has brought serious environmental pollution to China. Among the pollution sources, China's wastewater, sulfur dioxide, haze, and carbon dioxide emissions are the highest in the world [3]. Having low energy efficiency not only wastes limited energy supplies but also causes a sharp increase in carbon emissions [4]. In order to achieve sustainable economic development and fulfill the international commitments stipulated in the Paris Climate Agreement, the Chinese government has set a series of development goals to reduce energy consumption and carbon emissions. For example, by 2030, China's energy consumption will be below 6 billion tons of standard coal [5]. Simultaneously, in order to combat global warming, a commitment was made to achieve peak carbon levels by 2030. China, as the world's largest consumer of energy, is a major source of carbon emissions [6]. However, improving energy efficiency is a crucial way to achieve the carbon peak target. Energy efficiency improvements will reduce energy use, thus solving the energy dilemma in general [7]. Furthermore, improving energy efficiency has become one of the crucial objectives of energy and climate policies, as well as a fundamental way to ensure energy security and sustainable development [4,7]. Market-oriented economic structural reforms can help promote factor market development, which can be further improved to achieve the fundamental role of market mechanisms in resource allocation [8]. With the improvement of marketization, the flow of factors becomes more rapid, and advanced energy-saving and emissions reduction technologies can also be popularized on a large scale and quickly, thus improving energy efficiency [9]. However, under the special institutional background, the constraints of economic growth targets set by governments at all levels in China will affect the operation of the market, which will have a significant impact on marketization. In the past, many local governments took the typical approach of hard constraints on economic growth targets [10].

However, such a phenomenon is rooted in the typical vertical management mode and the incentive model of the "achievement evaluation index award" in Chinese administration. For all levels of government, a top-down incentive system of targets has been constructed [11,12]. Generally speaking, the setting of the economic performance target of the local government at the same level is often influenced by the "layer-on-layer" aspects of the economic performance targets of the government at the next level, while the setting of economic growth targets also exists in "top-down scale competition" [13]. In a competitive environment where economic growth is the goal, local governments tend to adopt short-term economic behavior to achieve their stated economic growth targets. The resulting economic consequences include market segmentation and factor distortions, which hinder the marketization process.

Moreover, local governments have focused on pursuing economic growth and blindly expanding the size of the economy to achieve economic growth targets. In particular, the expansion of energy-intensive industries continues to increase the demands for fossil energy (see Figure 1). At the same time, economic competition between regions has gradually increased. In order to achieve economic growth targets, this economic approach also shows multidimensional competition, such as competition for labor, competition for capital, and competition for taxes. The "pollution paradise" effect and "factor curse trap" caused by blind competition will strengthen the path dependence on pollution-oriented economic growth, which will have an impact on energy efficiency [14,15].

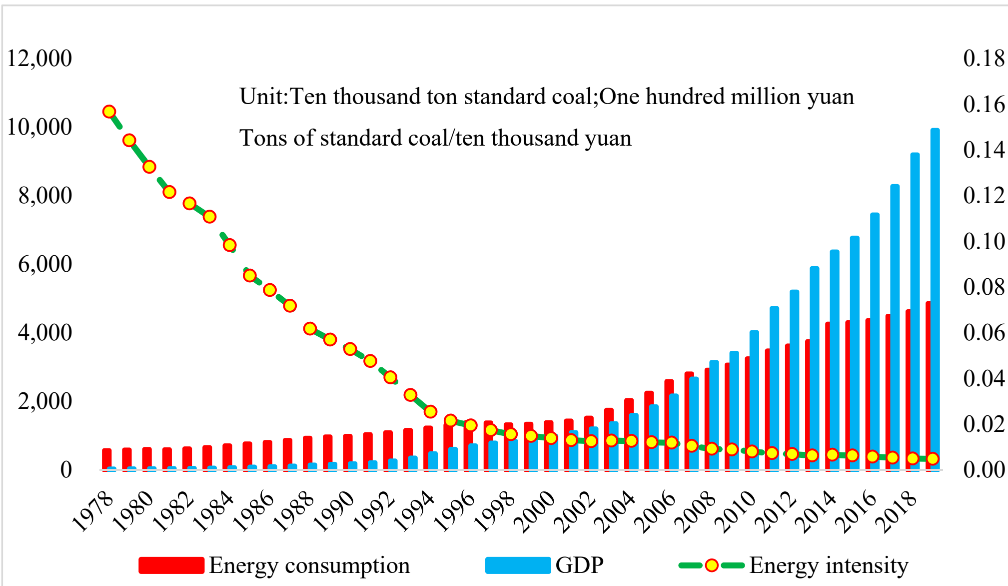


Figure 1. Energy consumption and energy intensity.

So how does the economic growth target affect energy efficiency? How does marketization serve economic growth goals and energy efficiency? It is important to analyze the mechanism of the Chinese government's economic growth targets and the impacts of marketization on energy efficiency in order to promote energy efficiency in China to reduce carbon emissions and to achieve carbon peak levels at an early date.

To sum up, the contributions of this study are as follows. First, the theoretical mechanism of the impacts of economic growth targets and marketization on energy efficiency are systematically explored by combining the economic growth targets and marketization into a unified analytical framework. Secondly, the dynamic panel system–generalized moment method (SYS-GMM) is used to investigate the impacts of economic growth targets on China's provincial energy efficiency to alleviate the possible endogenous problems. Thirdly, we examine the transmission mechanism of the impacts of economic growth targets on energy efficiency by using marketization as a mediation variable.

The rest of this paper is arranged as follows. Section 2 involves a literature review, Section 3 involves model setting and data description, Section 4 presents the empirical results, Section 5 presents a discussion of the empirical results, and Section 6 presents research conclusions and policy recommendations.

2. Literature Review

2.1. Economic Growth Targets and Energy Efficiency

Improving energy efficiency is a vital part of tackling climate change, sustainable economic development, and energy security. Economic growth is accompanied by the growth of energy demands. There is a strong correlation between energy demands and energy efficiency [16]. However, under the current special political system in China, the central government has developed a set of top-down target incentive systems based on the incentive model of performance reward [11,12]. The setting of economic growth targets caused by local government competition not only leads to "bottom-to-bottom competition" and the "green paradox" effect among governments, but also to the extensive development of the local economy by local governments at the cost of destroying the environment, which inhibits the improvement of energy efficiency [15,17]. Simultaneously, the local government economic growth targets inhibit the growth of public service expenditure, such as spending on education, science, and technology, and indirectly hinders the improvement of energy efficiency [4,18]. Additionally, under the influence of economic growth targets, local government competition is intensified and the vassal-like economy is not conducive to green economic transformation [19]. Furthermore, under the competition of pursuing economic performance targets, local governments are over-investing in industrial capacity at the expense of the environment in order to achieve economic growth, which is not conducive to the improvement of energy efficiency [20].

Some scholars believe that although China's economy has achieved rapid growth driven by economic growth goals, such targets may promote energy efficiency through the transformation of China's economy [21–23]. Driven by economic growth targets, local economic development promotes financial development and technological progress, providing a financial guarantee for energy structure adjustment and efficiency improvement [24]. Additionally, economic development also increases the financial revenues of local governments, which helps them to vigorously develop new energy industries and subsidize new energy consumption, which can optimize the energy structure and improve energy efficiency [25]. Moreover, some scholars have found that in middle- and high-income countries, economic growth reduces energy intensity, while sharing economies, in particular, will promote sustainable economic development and improve energy efficiency [26,27].

2.2. Marketization and Energy Efficiency

With the enhancement of economic development, the market economic system, and the allocation of certain factors, energy efficiency is improved accordingly [28]. The market is both a tool used for resource allocation and an incentive mechanism. First of all, marketization promotes innovation [29]. Duanmu et al. (2018) [30] believe that a high degree of marketization and market competition is conducive to the development of technology markets, which play positive roles in energy conservation, emissions reduction, and the improvement of energy efficiency. At the same time, Chen and Huang (2016) [31] pointed out that under market integration conditions, the free flow of factors can promote the optimization of the economic structure, enterprise competition, and technological innovation, which is conducive to improving energy efficiency. Secondly, marketization is conducive to reducing financing costs. The greater the degree of marketization, the greater the flexibility of the economic growth, while more efficient factor substitution is conducive to reducing the costs and risk of innovation for firms [28,32]. Thirdly, the improvement of energy marketization affects energy supply and demand through energy pricing and optimizes energy structures, which is conducive to the improvement of energy utilization efficiency [28,33,34].

To sum up, the existing literature focused on the relationships between economic growth targets and energy efficiency and between marketization and energy efficiency. The relationship between the three factors is relatively less pronounced, so an in-depth investigation on the relationship between economic growth target, marketization, and energy efficiency was not conducted. In other words, these studies did not further reveal the impacts of economic growth targets on energy efficiency, which is not conducive to a more comprehensive study of the causes of China's energy efficiency and the impacts of economic growth targets. Given this, this paper places marketization within the framework of the impacts of economic growth targeting energy efficiency, studies the impact mechanism of economic growth targets in terms of energy efficiency, and uses the mediating effect model to identify the mediation effect mechanism of marketization.

3. Methods

3.1. Calculation Method of Energy Efficiency

3.1.1. Directional Distance Function (DDF)

According to the directional distance function set by Chung et al. (1997), undesired outputs are included in the input–output efficiency evaluation and the directional distance function is defined to realize the increasing and decreasing constraints of desired outputs and undesired outputs [35].

We assume that there are n decision units (DMU), each of which utilizes i inputs ($x = (x_1, x_2, \cdots, x_i)R_i^+$) to obtain j undesired outputs $y = (y_1, y_2, \cdots, y_j)R_j$ and m undesired outputs ($b = (b_1, b_2, \cdots, b_m) \in R_m^+$).

We set the directivity vector as $g = (g_y, g_b)$, whereby t represents time, then the directivity distance function of the t period is: $D^t(x^t, y^t, b^t; g) = \sup\{\gamma | (y^t + \gamma g_y, b^t - \gamma g_b) \in P^t(x^t)\}$, where x^t is the vector of the input capital, labor, and energy in period t; y^t and b^t are the vectors of the desired output and undesired output in period t, respectively; γ is the directional distance function used for maximizing the desired output and minimizing the undesired output in period t.

$P^t(x^t) = \{(y^t, b^t) | x^t \Rightarrow (y^t, b^t), t = 1, 2, \cdots, T\}$ is the production possibility set of the current period, which includes both the desired output and undesired output. The undesired output has weak disposability. If $D^t(x^t, y^t, b^t; g) = 0$, indicating that under the condition of certain input factors, the input–output efficiency of the decision-making unit is optimal. If $D^t(x^t, y^t, b^t; g) = 0$, this shows that the input–output efficiency of the decision-making unit has potential improvement space. Simultaneously, the larger the value, the lower the input–output efficiency, the greater the potential improvement space.

By changing the above directional vector, the linear programming formulation of the directional distance function is obtained, which is represented by the undesired output emission efficiency model and the desired output efficiency model. The models are as follows:

$$\alpha^* = \min\alpha$$
$$s.t.\begin{cases} x\lambda \le x_k, y\lambda \ge y_k, b\lambda = \alpha b_k \\ \lambda \ge 0 \end{cases}$$

where α^* is the optimal solution of the emission efficiency model of the undesired output; x, y, and b represent the factor input, desired output, and undesired output values, respectively; x_k, y_k, and b_k are the factor input, desired output, and undesired output values of the kth decision unit, respectively; λ is the weight coefficient vector of the evaluated unit in the effective decision unit combination; α is the ratio of the potential optimal undesired output to the actual undesired output ($0 < \alpha \le 1$) of the decision-making unit under the given conditions of the factor input and desired output; $(1-\alpha)$ represents the potential for emissions reduction of the undesired output. The higher the α value is, the higher the undesired output emission efficiency, the higher the input–output efficiency, and the smaller the undesired output emissions reduction potential. The undesired output model is set as follows:

$$\beta^* = \max\beta$$
$$s.t.\begin{cases} x\lambda \le x_k, y\lambda \ge (1+\beta)y_k, b\lambda = b_k \\ \lambda \ge 0 \end{cases}$$

where β^* is the optimal solution of the undesired output efficiency model and β is the expansion potential of the undesired output under the constraint of undesired output. The higher the value of β, the lower the desired output efficiency of the decision unit, the lower the input–output efficiency, and the greater the expansion potential of the desired output.

3.1.2. Global Malmquist–Luenberger Index (GML)

GML index has the characteristics of transitivity and cycle accumulation. It overcomes the shortcomings of the traditional ML index because of the advantages of intertemporal comparison when it studies efficiency. Therefore, this paper uses the GML index analysis method to study energy efficiency under the constraints of carbon emissions and environmental pollution. According to the GML index method constructed by Oh (2010), the GML index from the "t" period to "t + 1" period defined by the directional distance function is as follows [36]:

$$\mathrm{GML}_{t+1}^{t}\left(x^t, y^t, b^t, x^{t+1}, y^{t+1}, b^{t+1}\right) = \frac{1+D^G\left(x^t,y^t,b^t\right)}{1+D^G\left(x^{t+1},y^{t+1},b^{t+1}\right)}$$
$$= \frac{1+D^t\left(x^t,y^t,b^t\right)}{1+D^{t+1}\left(x^{t+1},y^{t+1},b^{t+1}\right)} \times \left[\frac{1+D^G\left(x^t,y^t,b^t\right)}{1+D^t\left(x^t,y^t,b^t\right)} \times \frac{1+D^{t+1}\left(x^{t+1},y^{t+1},b^{t+1}\right)}{1+D^G\left(x^{t+1},y^{t+1},b^{t+1}\right)}\right]$$
$$= \mathrm{EC}_{t+1}^{t} \times \mathrm{TC}_{t+1}^{t}$$

where $D^G(x,y,b) = \sup\left\{\gamma \middle| (y+\gamma y, b-\gamma b) \in P^G\right\}$ is the global directional distance function, $P^G(x)$ is the global production possibility set, which is the union of all current production possibility sets; GML_{t+1}^{t}, EC_{t+1}^{t} and TC_{t+1}^{t} are the input–output efficiency, the change of technical efficiency, and the technical progress of the decision-making unit across two periods, respectively. If GML_{t+1}^{t}, EC_{t+1}^{t} and TC_{t+1}^{t} are greater than 1, they represent the improvement of the input–output efficiency, technical efficiency, and technical progress, respectively. If GML_{t+1}^{t}, EC_{t+1}^{t} and TC_{t+1}^{t} are less than 1, they represent the reduction of input–output efficiency, technical efficiency, and technical retrogression, respectively. Therefore, through the analysis of the GML index, we can observe the changing trends of energy efficiency and the change of influencing factors, so as to provide more accurate improvement schemes for energy utilization in various provinces.

We calculate the GML index, the demand solution for different directional distance functions in the above formula. For the "t" period and "t + 1" period, the directional distance function and the global directional distance function can be obtained via the following linear programming:

$$D^t\left(x^t, y^t, b^t\right) = \max\beta$$
$$s.t.\begin{cases} x\lambda \le x_k^t, y\lambda \ge (1+\beta)y_k^t, b\lambda = (1-\beta)b_k^t \\ \lambda \ge 0 \end{cases} \quad \text{(a)}$$
$$D^{t+1}\left(x^{t+1}, y^{t+1}, b^{t+1}\right) = \max\beta$$
$$s.t.\begin{cases} x\lambda \le x_k^{t+1}, y\lambda \ge (1+\beta)y_k^{t+1}, b\lambda = (1-\beta)b_k^{t+1} \\ \lambda \ge 0 \end{cases} \quad \text{(b)}$$
$$D^G\left(x^t, y^t, b^t\right) = \max\beta$$
$$s.t.\begin{cases} x\lambda \le x_k^t, y\lambda \ge (1+\beta)y_k^t, b\lambda = (1-\beta)b_k^t \\ \lambda \ge 0 \end{cases} \quad \text{(c)}$$
$$D^G\left(x^{t+1}, y^{t+1}, b^{t+1}\right) = \max\beta$$
$$s.t.\begin{cases} x\lambda \le x_k^{t+1}, y\lambda \ge (1+\beta)y_k^{t+1}, b\lambda = (1-\beta)b_k^{t+1} \\ \lambda \ge 0 \end{cases} \quad \text{(d)}$$

3.2. *Economic Strategy*

3.2.1. Econometric Model Setting

When analyzing energy efficiency, most scholars ignore the systematic bias caused by the time lag effect [37]. This paper introduces a dynamic model with a lag period of explained variables. There may be a reverse causal relationship between the core explanatory variables and the explained variables. Therefore, the systematic generalized moment estimation (SYS-GMM) proposed by Arelelano and Bond (1991) is adopted in this paper to estimate the empirical results. The econometric model set is as follows [38]:

$$\mathrm{EE}_{it} = \alpha \mathrm{EE}_{it-1} + \beta_0 + \beta_1 \mathrm{TAR}_{it} + \beta_2 X_{it} + u_i + v_t + \varepsilon_{it} \quad (1)$$

Among them, i represents the region t represents the year; β represents the coefficient vector; u is the region-fixed effect; v is the time-fixed effect; ε is the random disturbance term. The dependent variable is energy efficiency (EE). The core explanatory variable is TAR, which is the economic growth target set by the local government. Here, X is a group of control variables, mainly including technological innovation, industrial structure, urbanization, foreign direct investment, and foreign trade dependence.

3.2.2. Mediation Effect Model

It has been shown above that the economic growth target has a certain internal influence on energy efficiency and marketization is closely related to energy efficiency. As an important factor affecting energy efficiency, what role does marketization play in the impacts of economic growth targets on energy efficiency? Does marketization act as an intermediary variable to transmit the impacts of economic growth targets on energy efficiency? We use Figure 2 to briefly depict the impact of economic growth targets and marketization on energy efficiency.

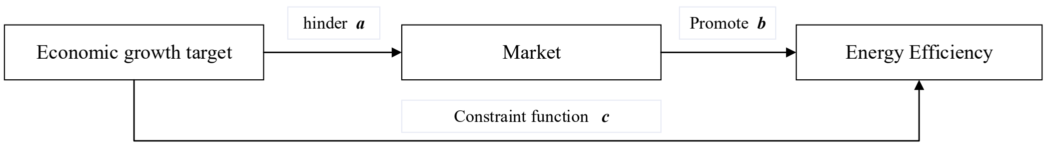


Figure 2. Mediating mechanism.

Therefore, this paper uses the stepwise regression method proposed by Baron and Kenny (1986) to test the mediation effect of marketization [39]. In order to intuitively describe the verification procedure of the mediation effect, the mediation effect model is first simplified into Equations (2)–(4). Equations (2)–(4) are set as follows.

$$\mathrm{EE}_{it} = \alpha \mathrm{EE}_{it-1} + c \cdot \mathrm{TAR}_{it} + \beta X_{it} + \varepsilon_1 \quad (2)$$

$$\mathrm{Market}_{it} = \alpha \mathrm{EE}_{it-1} + a \cdot \mathrm{TAR}_{it} + \beta X_{it} + \varepsilon_2 \quad (3)$$

$$\mathrm{EE}_{it} = \alpha \mathrm{EE}_{it-1} + c' \cdot \mathrm{TAR}_{it} + b \cdot \mathrm{MAR}_{it} + \beta X_{it} + \varepsilon_3 \quad (4)$$

where market represents the level of marketization, c represents the total effect, and $c = a * b + c'$. Here, $a * b$ represents the mediation effect and c' represents the direct effect. Certain control variables are represented by X.

In this paper, the stepwise regression method is used to test the mediating effect. In the first step, the total effect of the economic growth target on energy efficiency in Equation (2) is investigated, as well as assessing whether the measure coefficient c is significant. The second step is to investigate the effect of the economic growth target on the marketization degree and the impact of marketization on energy efficiency in Equations (3) and (4), and whether the measure coefficients a and b are significant. If a and b are significant, it is proven that there is a mediation effect. The third step is to examine the direct effect of the economic growth target on energy efficiency in Equation (4).

3.3. Variable Definitions

3.3.1. Explained Variable: Energy Efficiency (EE)

Energy efficiency is the capacity level for economic output based on energy input, which is usually estimated through the stochastic frontier or Banker Charnes Cooper of data envelopment analysis (DEA-BCC) model or slack based measure-data envelopment analysis (SBM-DEA) method [40,41]. In this paper, undesired carbon dioxide and environmental pollution are considered when energy efficiency is measured. Therefore, the DDF-GML model is used in this paper to calculate the energy efficiency of 30 provinces in China from 2000 to 2017 as a dependent variable [42–44]. The input–output indicators are shown in Table 1.

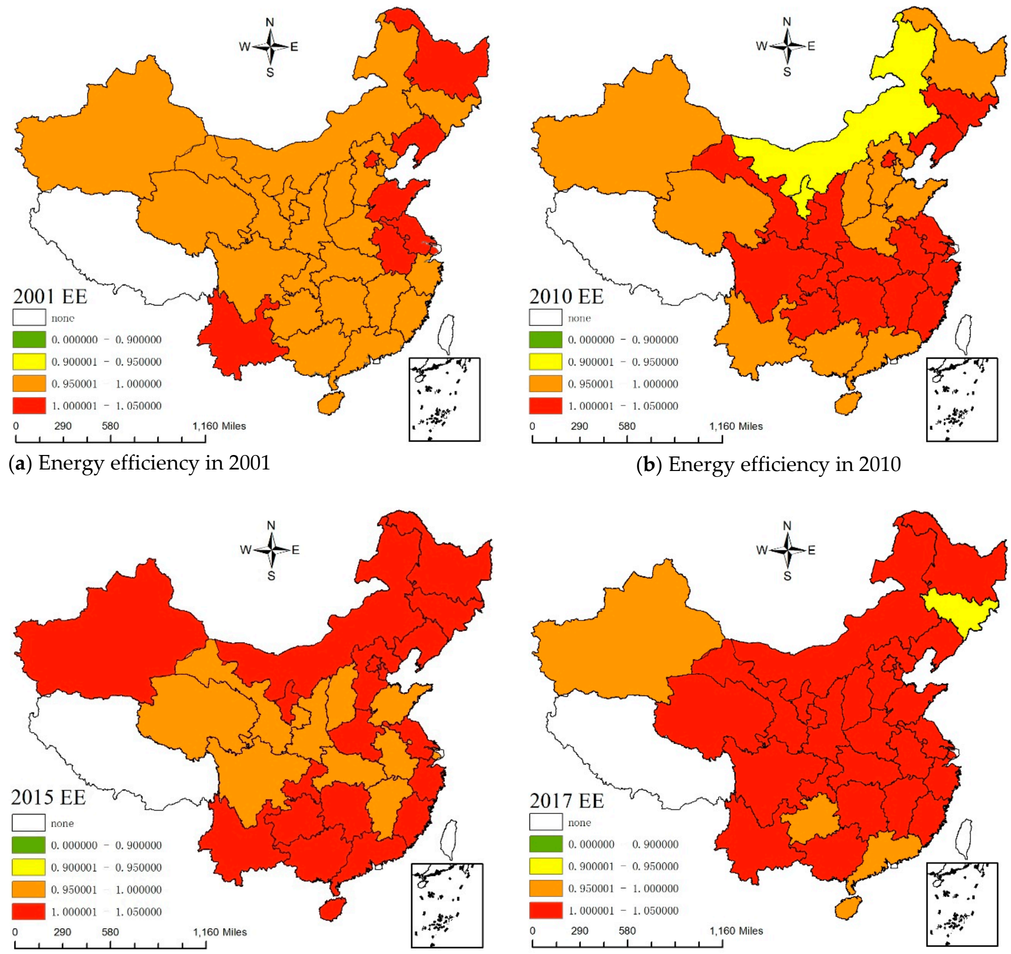
Table 1. Descriptions of variables.

Variables		Definition	References
Expect output	RGDP	Real GDP of each province based on the year 2000 (100 million yuan)	Lin and Du (2013) [45]
Unexpected output	CO_2	Provincial CO_2 Emissions	Gao and Zhang (2019) [46]
	SO_2	Provincial SO_2 Emissions	Xu et al. (2020) [47]
	Smoke (Dust)	Provincial Smoke (dust) Emissions	Xu et al. (2020) [47]
	Wastewater	Provincial Wastewater Emissions	Xu et al. (2020) [47]
	Solid waste	Provincial Solid Waste Emissions	Xu et al. (2020) [47]
Input	Labor	Employment by provinces at year-end	Wang et al. (2020) [2]
	Capital	Perpetual Inventory Method (PIM) is used to calculate the capital stock at 2000 comparable prices. A capital depreciation rate of 10.96% was selected	Jun et al., (2004); Shan, (2008); Chen, (2015); Peterman, (2016); Xu, (2020) [48–52]
	Energy	The total consumption of coal, oil, and natural gas (converted into standard coal)	Lin and Du (2015) [45]

It is estimated that from 2000 to 2017, China's overall energy efficiency showed an increasing trend, and the specific changes are shown in Figure 3. Figure 3 visually depicts the evolution trend of energy efficiency during the study period. Specifically, the dynamic evolution trend shows that at the beginning of 2001, the areas with higher energy were mainly in Beijing, Heilongjiang, Yunnan, and East China (see Figure 3a). In 2010, the regions with high energy efficiency were mainly located in the Yangtze River economic belt (see Figure 3b). The results of the energy efficiency changes in 2015 and 2017(see Figure 3c,d) show that energy efficiency across the country is improving, which is closely related to China's concept of green development, indicating that China's sustainable development capacity is gradually increasing.

3.3.2. Core Explanatory Variable: Economic Growth Target (TAR)

Referring to Liu et al. (2020), the economic growth target is mainly measured by the expected economic growth rate mentioned in the annual work reports of provincial governments [1]. Table 2 shows the economic growth target data for China's central government and provincial local governments. It is obvious that the economic growth target for local governments is higher than that for the central government, and that the economic growth target of local governments shows obvious heterogeneity.



(**a**) Energy efficiency in 2001 (**b**) Energy efficiency in 2010

(**c**) Energy efficiency in 2015 (**d**) Energy efficiency in 2017

Figure 3. Trends in energy efficiency.

Table 2. Comparison of China's economic growth targets (%).

Year	The Central Government	The Local Government		
		Mean	Minimum	Maximum
2001	7	8.74	7	10
2002	7	8.72	7	10
2003	7	9.27	7.5	11.5
2004	7	9.68	8	13
2005	8	10.23	8.5	15
2006	8	10.31	8.5	15
2007	8	10.33	9	15
2008	8	10.97	9	15
2009	8	10.05	8	13
2010	8	10.28	8	13
2011	8	10.83	8	13.5
2012	7.5	11	8	14
2013	7.5	10.57	7.5	14
2014	7.5	9.6	7.5	12.5
2015	7	8.1	6	10
2016	6.5–7	7.62	6	10
2017	6.5	7.55	5.5	10
2018	6.5	7.2	5	10
2019	6–6.5	6.91	4.5	9

Source: Central and provincial government reports over the years.

3.3.3. Mediation Variable: Marketization (MAR)

In the existing literature research, production methods and trade law are mostly used to calculate the market-oriented indicators. However, the above measurement methods show inherent defects and it is difficult to form a panel database [53–55]. Referring to Ming and Zhao (2009) [56] and Sun and Cheng (2019) [57], the relative price index analysis method was applied to calculate the market index. We first measured the market segmentation index of 65 pairs of neighboring provinces and then merged the indices of 65 pairs of neighboring provinces to get the market segmentation index of each province and its neighboring provinces. For example, the market segmentation index for Sichuan is the average of the market segmentation indices between Sichuan and Chongqing, between Sichuan and Shanxi, between Sichuan and Gansu, between Sichuan and Yunnan, between Sichuan and Qinghai, and between Sichuan and Tibet. The market segmentation indices for the other provinces and cities were measured similarly. Thus, a total of 510 (=30 × 17) market segmentation values were obtained, which respectively represented the changes of market segmentation degree between 30 provinces and all neighboring provinces in 17 years. Marketization (MAR) was then expressed using the inverse of market segmentation.

3.3.4. Control Variables

In order to control the influence of other factors on energy efficiency, the following control variables were introduced in this paper, namely industrial structure (IND), urbanization (URB), technological innovation level (PAT), foreign direct investment (FDI), and foreign trade dependence (OPE). According to the Petty–Clark theorem, the industrial structure shows the trend of evolution from the primary industry to the secondary industry and the tertiary industry in turn. Therefore, referring to Ren and Zhu (2017), we constructed "IND = P + 2 * S + 3 * T" to measure the industrial upgrading, where P, S, and T represent the proportion of the added value of the primary industry, the secondary industry, and the tertiary industry in the total regional output value, respectively [58]. Urbanization (URB) has a significant impact on energy efficiency. Here, we use population urbanization to measure the urbanization level. Technological innovation is conducive to improving energy efficiency [59–64]. Referencing to Li et al. (2020), the number of patents granted is selected as the proxy variable of technological innovation (PAT) [61]. Opening up to the outside world plays an important role in promoting energy efficiency [41]. In this paper, the proportion of foreign direct investment in GDP is selected to measure the degree of foreign direct investment (FDI). The ratios of provinces and cities and total import and export trade to GDP are used to measure the degree of foreign trade dependence (OPE).

3.4. Data Rresources

In this paper, the data mainly come from the China Statistical Yearbook, China Environment Statistical Yearbook, China Energy Statistical Yearbook, Wind Economic Database, China's central and provincial governments' government work reports, Five-Year Plan for National economic and Social Development, China Marketization Index Report, and China Points Provinces Marketization Index Report (2016). For the missing data, this paper uses the moving average and interpolation method. Definitions of variables are shown in Table 3.

Table 3. Definitions of variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
EE	510	0.9993	0.0274	0.8223	1.2345
TAR	510	9.6387	1.6293	5.5000	15.0000
MAR	510	6.2036	1.8733	2.3700	11.1100
IND	510	229.9035	19.8463	179.7971	301.0635
PAT	510	2.3340	4.5640	0.0007	33.2652
URB	510	50.5246	14.8156	23.9600	89.6000
FDI	510	2.5452	2.1815	0.0400	14.6500
OPE	510	0.3124	0.3845	0.0200	1.7200

4. Empirical Results

4.1. Benchmark Regression Analysis

In order to ensure the robustness of the results, the regression results for the panel fixed effect model (FE), panel random effect model (RE), and SYS-GMM are also presented in this paper (see Table 4). The regression results show that the economic growth target inhibits the improvement of energy efficiency, while the coefficient of the economic growth target is significantly negative at the level of 1%.

Table 4. Benchmark regression results.

Variables	FE	FE	RE	RE	SYS-GMM	SYS-GMM
L.EE					0.051	0.066
					(0.033)	(0.055)
TAR	−0.002 ***	−0.002 ***	−0.003 ***	−0.002 ***	−0.003 ***	−0.002 ***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
PAT		−0.0006		−0.00005		−0.0003
		(0.000)		(0.000)		(0.000)
IND		−8.49e-06		0.00002		−0.00008
		(0.000)		(0.000)		(0.000)
URB		0.0012 ***		0.0005 ***		0.001 ***
		(0.000)		(0.000)		(0.000)
FDI		0.0003		−0.0003		−0.001 ***
		(0.001)		(0.001)		(0.000)
OPE		0.0075		−0.0046		−0.001
		(0.012)		(0.005)		(0.005)
AR(1)					−1.8118	−1.9501
					[0.0700]	[0.0512]
AR(2)					−1.0756	−0.96514
					[0.2821]	[0.3345]
Sargan test					27.85219	24.19096
					[1.0000]	[1.0000]
Obs	510	510	510	510	480	480
N	30	30	30	30	30	30

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

4.2. Mediation Effect Analysis

It has been proven above that the economic growth target has a significant negative impact on energy efficiency, so this paper uses the mediation effect model to test the mediation effect of marketization (see Table 5). This paper continues to use the SYS-GMM model to regression Equations (2)–(4) step by step, and the estimated results are shown in Table 5. From the estimation results, Column (1) represents the benchmark estimation results of the economic growth target on energy efficiency (EE). The estimated coefficient of the economic growth target is negative and significant at the level of 10%, indicating that the economic growth target has a significant inhibiting effect on the improvement of the energy efficiency level. In column (2), the estimated coefficient of the economic growth target is significantly negative and is significant at the level of 1%, indicating that the economic growth target has a significant inhibitory effect on the market. In column (3), the target coefficient of the economic growth is negative and significant at the level of 10%, while the market coefficient is positive and significant at the level of 1%.

Table 5. Mediation effect results.

Variables	(1)	(2)	(3)
	EE	MAR	EE
L.EE	0.071		0.072 ***
	(0.056)		(0.010)
TAR	−0.0031 *	−0.131 ***	−0.0027 ***
	(0.002)	(0.051)	(0.001)
MAR			0.002 ***
			(0.000)

Table 5. *Cont.*

Variables	(1)	(2)	(3)
	EE	**MAR**	**EE**
PAT	−0.000	0.152 ***	−0.000 ***
	(0.000)	(0.031)	(0.000)
IND	−0.000	0.002	0.000
	(0.000)	(0.008)	(0.000)
URB	0.001 **	0.032 **	0.001 ***
	(0.000)	(0.013)	(0.000)
FDI	−0.000	0.224 ***	−0.001 *
	(0.001)	(0.087)	(0.000)
OPE	−0.006	0.851 *	−0.008 ***
	(0.004)	(0.482)	(0.002)
AR(1)	−1.80	1.05	−1.85
	[0.072]	[0.294]	[0.064]
AR(2)	−1.06	−1.54	−1.04
	[0.287]	[0.123]	[0.300]
Sargan test	185.73	1036.32	183.74
	[0.000]	[0.000]	[0.000]
Obs	480	510	480
N	30	30	30

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

4.3. Heterogeneity Analysis

Due to the vast size of China, there are significant differences in the degrees of economic development and industrial structure layouts of different regions. Therefore, local economic growth targets may lead to regional heterogeneity in energy efficiency in different regions. In order to identify such heterogeneity, this paper expands the analysis of regional heterogeneity and further tests the robustness of the empirical results (Table 6). Considering the number of samples, this paper selected the eastern region as one group and the central region and western region as another group to conduct the heterogeneity analysis. The local government economic growth target for the influence of energy efficiency has obvious regional heterogeneity. In the eastern region, the economic growth target inhibits the energy efficiency and is significant at the 1% level. For the central and western regions, although the economic growth target has a significant impact on energy efficiency at the level of 5%, its effect is less than that of the eastern regions. The impact of marketization on energy efficiency in eastern China is higher than in central and western China.

Table 6. Regional heterogeneity results.

Variables	(1)	(2)	(3)	(4)
	Eastern Region	**Eastern Region**	**Central and Western Regions**	**Central and Western Regions**
L.EE	0.193 **	0.496 **	0.175 ***	0.165 **
	(0.081)	(0.243)	(0.047)	(0.068)
TAR	−0.004 ***	−0.024 ***	−0.001 ***	−0.002 **
	(0.001)	(0.008)	(0.000)	(0.001)
MAR		0.008 *		0.003 *
		(0.005)		(0.001)
PAT		−0.002 ***		0.000
		(0.001)		(0.001)
IND		−0.005 ***		−0.000
		(0.002)		(0.000)
URB		0.004 ***		0.001 ***
		(0.002)		(0.000)

Table 6. *Cont.*

Variables	(1)	(2)	(3)	(4)
	Eastern Region	**Eastern Region**	**Central and Western Regions**	**Central and Western Regions**
FDI		−0.008 ***		−0.001
		(0.003)		(0.001)
OPE		0.070 **		−0.025
		(0.028)		(0.023)
AR(1)	−2.4	−1.69	−1.81	−1.90
	[0.016]	(0.091)	[0.070]	[0.058]
AR(2)	0.49	−0.22	−0.84	−0.82
	[0.626]	[0.824]	[0.399]	[0.414]
Sargan test	72.99	171.3	151.24	176.05
	[0.000]	[0.000]	[0.000]	[0.000]
Obs	176	176	320	320
N	11	11	19	19

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

4.4. Robustness Test

In order to analyze the accuracy of the conclusions obtained under the above full sample conditions, this paper conducts robustness tests for the following two aspects. (1) Replacing the explained variable: Referring to the measurement method of energy efficiency mentioned above, we re-test and regress the empirical results. The relevant results are shown in columns (1) and (2) in Table 7. The economic growth target still has an inhibiting effect on energy efficiency and is significant at the 1% level. (2) Endogeneity: Considering the endogeneity of the economic growth target, this paper selects the lag period of the economic growth target as its instrumental variable and uses the two-stage least squares method (2SLS) to regrow again [62]. The results are shown in columns (3) and (4) in Table 5. The economic growth target is still suppressed the energy efficiency, and significant at the 1% level. In conclusion, after replacing the explained variables and examining the endogeneity of the economic growth target, the impact of the economic growth target on energy efficiency remains consistent with the previous study, which verifies the robustness of the results.

Table 7. Robustness test.

Variables	(1)	(2)	(3)	(4)
	GMM	**GMM**	**2SLS**	**2SLS**
L.EE	0.0345 *	−0.082 ***		
	(0.020)	(0.028)		
TAR	−0.0217 ***	−0.014 ***	−0.003 ***	−0.003 ***
	(0.002)	(0.001)	(0.001)	(0.001)
PAT		−0.004 ***		−0.000
		(0.002)		(0.000)
IND		0.001 ***		0.000
		(0.000)		(0.000)
URB		0.004 ***		0.001 ***
		(0.001)		(0.000)
FDI		−0.002		−0.000
		(0.002)		(0.001)
OPE		−0.099 ***		−0.005
		(0.027)		(0.005)
CONS	1.1797 ***	0.777 ***	1.025 ***	0.993 ***
	(0.029)	(0.059)	(0.009)	(0.026)

Table 7. *Cont.*

Variables	(1)	(2)	(3)	(4)
	GMM	GMM	2SLS	2SLS
AR(1)	−1.4483	−1.4485		
	[0.1475]	[0.1475]		
AR(2)	1.0475	0.9033		
	[0.2949]	[0.3664]		
Sargan test	29.3019	25.6893		
	[1.000]	[1.000]		
Obs	480	480	480	480
N	30	30	30	30

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

5. Discussion

5.1. Discussion of the Results of the Benchmark Regression

Table 4 implies that the economic growth target has a significant negative impact on energy efficiency, which is similar to the research results shown by Zhang et al. (2020) [63]. First, the economic growth target, as the core indicator used to guide economic development, not only directly distorts the structure of government public expenditure, but also restricts investment in environmental protection and scientific and technological research and development, and ultimately inhibits the improvement of energy efficiency. Second, in order to achieve the economic growth target, local governments prefer subsidies to support "zombie enterprises" with high energy consumption and low innovation, which not only leads to lags in upgrading industrial structures, but also is not conducive to the improvement of energy efficiency. Third, the economic growth target formulated by local governments is more in pursuit of a single form of economic growth, the regulation of environmental pollution and carbon emission is relatively relaxed, and the "pollution paradise" effect remains stubborn and difficult to remove, thus reducing the energy efficiency of the region.

5.2. Discussion of Mediating Effect Results

Table 5 shows that the economic growth target inhibits marketization. Marketization has a positive impact on reducing energy efficiency. The central government's intention in setting economic growth targets is to promote the efficient allocation of production factors, however at the same time it also restricts the free flow of production factors, which leads to the distortion of the factor market. The blocked factor flow is not conducive to the technological progress of the energy industry, which further inhibits the improvement of energy efficiency. At the same time, the improvement of marketization reduces the distortion of factors, which provides a foundation for the efficient operation of the energy market, especially the marketization of energy prices, which lays a foundation for the regulation of energy consumption. At the same time, marketization is conducive to technology research and development in high-energy-consuming industries, reducing energy consumption and improving energy efficiency. Moreover, the marketization of energy prices also provides conditions for energy substitution and provides a market for the mutual substitution of traditional fossil energy with new energy sources, which is conducive to promoting the research and development of new energy sources and promoting the improvement of energy efficiency.

5.3. Discussion of Heterogeneous Results

The heterogeneity analysis shows that the impact of China's economic growth target on energy efficiency presents significant regional heterogeneity. In the eastern region, the economic growth target results in greater inhibition on energy efficiency, while the economic growth target for the central and western regions has little inhibitory effect on energy efficiency. The reasons are as follows. First, although the degree of marketization in the eastern region is relatively high, the marketization process is inhibited under the influence of the economic growth target, which leads to the slow improvement of energy efficiency. However, for the central and western regions, the level of marketization itself is relatively low and the inhibitory effect of the economic growth target on marketization is not fully reflected. Additionally, the central and western regions are in the primary stage of industrialization and their energy demands are relatively low, so the marginal inhibitory effect of economic growth targets on energy efficiency is relatively limited. Second, the central and western regions are rich in energy resources, in addition to coal, oil, natural gas and other traditional fossil energy sources, solar energy, wind energy, hydropower, and other new energy resources. With the support of national projects, such as those involving gas and power transmission from west to east, the restraining effect of local economic growth targets on energy efficiency in the central and western regions has been reduced. The eastern region is the center of China's economic development, and a large amount of energy is transported from the central and western regions. The economic growth target of local governments has a greater impact on energy consumption and has a strong inhibitory effect on energy efficiency.

6. Conclusions and Policy Implications

In this paper, the DDF-GML model is applied to calculate the energy efficiency of 30 provinces in China from 2001 to 2017. Through the SYS-GMM model and mediation effect model, the influence of economic growth targets and marketization on energy efficiency is empirically tested. The main research conclusions are as follows.

First, energy efficiency in China's regions as a whole shows an upward trend. Second, economic growth targets inhibit energy efficiency. Third, the mediating effect reveals that under the mediating effect of marketization, the economic growth targets can inhibit energy efficiency by distorting marketization. Fourth, the impact of China's regional economic growth targets on energy efficiency is heterogeneous. Even though economic growth targets in the east or the midwest inhibit energy efficiency, compared with the central and western regions, the economic growth target in the eastern region has a stronger inhibitory effect on energy efficiency. Based on the above research conclusions, we propose the following policy implications.

Policymakers should change the extensive development model as soon as possible and focus on improving the quality and efficiency of economic growth, so as to help regions get rid of the shackles of the extensive development model as soon as possible and promote the improvement of energy efficiency. At the same time, we should coordinate the relationship between economic growth and environmental protection, positively guide local government behavior with high-quality economic development goals, and speed up the clearance of the backward industrial production capacity with the help of market mechanisms, so as to achieve consistency in terms of the goals of energy consumption reduction, environmental governance, and energy efficiency improvement. The government's interventions and control on the pricing power of factors should be reduced and the integration of the regional factor market should be promoted. Each region also needs to constantly improve the institutional norms of the energy factor market and improve energy efficiency according to the regional circumstances. Policymakers should encourage investment in energy technology innovation, pay attention to the cultivation of energy science and technology talents, support the development of energy-saving and -efficient industries, and create a good policy environment for the development and utilization of energy-saving technologies, so as to promote the supply-side reform in the energy field and strengthen the driving role of technological innovation in improving energy efficiency. Policymakers also need to further improve the performance appraisal and accountability systems related to pollution reductions, so as to strengthen the performance appraisal systems for energy and the environment and to improve the efficiency of energy utilization.

Although this paper analyzes the impacts of economic growth targets and marketization on energy efficiency, it does not provide a detailed investigation due to the limited sample of provincial panel data. Especially in the analysis of subregional heterogeneity, the empirical results are not satisfactory due to the small number of research samples. In the future, it is necessary to study the relationships between the economic growth targets and energy efficiency at the prefecture and city levels, and to further analyze the transmission path of the impacts of the economic growth target on energy efficiency.

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References

1. Liu, D.; Xu, C.; Yu, Y.; Rong, K.; Zhang, J. Economic growth target, distortion of public expenditure and business cycle in China. *China Econ. Rev.* **2020**, *63*, 101373. [CrossRef]
2. Wang, K.L.; Zhao, B.; Ding, L.L.; Miao, Z. Government intervention, market development, and pollution emission efficiency: Evidence from China. *Sci. Total Environ.* **2020**, *757*, 143738. [CrossRef]
3. Wang, J.; Lv, K.; Bian, Y.; Cheng, Y. Energy efficiency and marginal carbon dioxide emission abatement cost in urban China. *Energy Policy* **2017**, *105*, 246–255. [CrossRef]
4. Liu, H.; Zhang, Z.; Zhang, T.; Wang, L. Revisiting China's provincial energy efficiency and its influencing factors. *Energy* **2020**, *208*, 118361. [CrossRef]
5. Hou, J.; Teo, T.S.; Zhou, F.; Lim, M.K.; Chen, H. Does industrial green transformation successfully facilitate a decrease in carbon intensity in China? An environmental regulation perspective. *J. Clean. Prod.* **2018**, *184*, 1060–1071. [CrossRef]
6. Su, H.; Liang, B. The impact of regional market integration and economic opening up on environmental total factor energy productivity in Chinese provinces. *Energy Policy* **2020**, *148*, 111943. [CrossRef]
7. Goh, T.; Ang, B.W. Four reasons why there is so much confusion about energy efficiency. *Energy Policy* **2020**, *146*, 111832. [CrossRef]
8. Neumayer, E. In defence of historical accountability for greenhouse gas emissions. *Ecol. Econ.* **2000**, *33*, 185–192. [CrossRef]
9. Hettige, H.; Mani, M.; Wheeler, D. Industrial pollution in economic development: The environmental kuznets curve revisited. *J. Dev. Econ.* **2000**, *62*, 445–476. [CrossRef]
10. Brender, A.; Drazen, A. Elections, leaders, and the composition of government spending. *J. Public Econ.* **2013**, *97*, 18–31. [CrossRef]
11. Blanchard, O.; Shleifer, A. Federalism with and without political centralization. China versus Russia. *Harv. Inst. Econ. Res. Work. Pap.* **2000**, *48*, 171–179.
12. Tsui, K.Y.; Wang, Y. Between separate stoves and a single menu: Fiscal decentralization in China. *China Q.* **2004**, *177*, 71–90. [CrossRef]
13. Chen, W.; Zhang, Y. Population urbanization competition among prefecture-level cities in china based on two-regime spatial econometrics. *J. Chin. Econ. Bus. Stud.* **2020**, *18*, 73–89. [CrossRef]
14. Mahmood, H.; Alkhateeb, T.; Al-Qahtani, M.; Allam, Z.; Ahmad, N.; Furqan, M. Energy consumption, economic growth and pollution in Saudi Arabia. *Manag. Sci. Lett.* **2020**, *10*, 979–984. [CrossRef]
15. Wu, H.; Li, Y.; Hao, Y.; Ren, S.; Zhang, P. Environmental decentralization, local government competition, and regional green development: Evidence from China. *Sci. Total Environ.* **2020**, *708*, 135085. [CrossRef]
16. Bilgen, S.E.L.Ç.U.K. Structure and environmental impact of global energy consumption. *Renew. Sustain. Energy Rev.* **2014**, *38*, 890–902. [CrossRef]

17. Kim, J.; Wilson, J.D. Capital mobility and environmental standards: Racing to the bottom with multiple tax instruments. *Jpn. World Econ.* **1997**, *9*, 537–551. [CrossRef]
18. Nie, L.; Zhang, Z. 'Neighbors as Competitors' or 'Neighbors as Partners': How Does Market Segmentation Affect Regional Energy Efficiency in China? *Work. Pap.* 2019. [CrossRef]
19. Li, J.; Lin, B. Ecological total-factor energy efficiency of China's heavy and light industries: Which performs better? *Renew. Sustain. Energy Rev.* **2017**, *72*, 83–94. [CrossRef]
20. Liu, S.; Liu, F.; Wang, Y. Economic Growth Target, Heterogeneous Environmental Regulation and Capacity Utilization. *Bus. Res.* **2020**, *62*, 21–33. (In Chinese)
21. Zhou, X.; Song, M.; Cui, L. Driving force for China's economic development under Industry 4.0 and circular economy: Technological innovation or structural change? *J. Clean. Prod.* **2020**, *271*, 122680. [CrossRef]
22. Zhou, Y.; Li, J. Big Data Industrial Agglomeration Promoting Regional Innovation: Comparison between Guangzhou and Zhaoqing in China. In In Proceedings of the E3S Web of Conferences, Nanjing, China, 18–20 December 2020.
23. Ferraris, A.; Santoro, G.; Pellicelli, A.C. "Openness" of public governments in smart cities: Removing the barriers for innovation and entrepreneurship. *Int. Entrep. Manag. J.* **2020**, *16*, 1259–1280. [CrossRef]
24. Polzin, F.; Sanders, M. How to finance the transition to low-carbon energy in Europe? *Energy Policy* **2020**, *147*, 111863. [CrossRef]
25. Huberman, N.; Pearlmutter, D.; Gal, E.; Meir, I.A. Optimizing structural roof form for life-cycle energy efficiency. *Energy Build.* **2015**, *104*, 336–349. [CrossRef]
26. Sener, S.; Karakas, A.T. The effect of economic growth on energy efficiency: Evidence from high, upper-middle and lower-middle income countries. *Procedia Comput. Sci.* **2019**, *158*, 523–532. [CrossRef]
27. Dabbous, A.; Tarhini, A. Assessing the impact of knowledge and perceived economic benefits on sustainable consumption through the sharing economy: A sociotechnical approach. *Technol. Forecast. Soc. Chang.* **2019**, *149*, 119775. [CrossRef]
28. Fan, Y.; Liao, H.; Wei, Y.M. Can market oriented economic reforms contribute to energy efficiency improvement? *Evid. China Energy Policy* **2007**, *35*, 2287–2295. [CrossRef]
29. Goldman, D.B.; Klier, T.; Walstrum, T. Evidence on the Within-Industry Agglomeration of R&D, Production, and Administrative Occupations. Working Paper. **2016**. Available online: https://ssrn.com/abstract=2885722 (accessed on 10 April 2021).
30. Duanmu, J.L.; Bu, M.; Pittman, R. Does market competition dampen environmental performance? Evidence from China. *Strateg. Manag. J.* **2018**, *39*, 3006–3030. [CrossRef]
31. Chen, X.; Huang, B. Club membership and transboundary pollution: Evidence from the European Union enlargement. *Energy Econ.* **2016**, *53*, 230–237. [CrossRef]
32. Zhang, T.; Yue, H.; Zhou, J.; Wang, H. Technological innovation paths toward green industry in China. *Chin. J. Popul. Resour. Environ.* **2018**, *16*, 97–108. [CrossRef]
33. Shao, S.; Tian, Z.; Fan, M. Do the rich have stronger willingness to pay for environmental protection? New evidence from a survey in China. *World Dev.* **2018**, *105*, 83–94. [CrossRef]
34. Zhao, X.-G.; Hu, S.-R. Does market-based electricity price affect China's energy efficiency? *Energy Econ.* **2020**, *91*, 104909.
35. Chung, Y.H.; Färe, R.; Grosskopf, S. Productivity and Undesirable Outputs: A Directional Distance Function Approach. *J. Environ. Manag.* **1997**, *51*, 229–240. [CrossRef]
36. Oh, D. A global Malmquist-Luenberger productivity index. *J. Product. Anal.* **2010**, *34*, 183–197. [CrossRef]
37. Wang, H.; Wang, M. Effects of technological innovation on energy efficiency in China: Evidence from dynamic panel of 284 cities. *Sci. Total Environ.* **2020**, *709*, 136172. [CrossRef] [PubMed]
38. Arellano, M.; Bond, S. Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Rev. Econ. Stud.* **1991**, *58*, 277–297. [CrossRef]
39. Baron, R.M.; Kenny, D.A. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *J. Personal. Soc. Psychol.* **1986**, *51*, 1173–1182. [CrossRef]
40. Zhang, K.; Shao, S.; Fan, S. Market integration and environmental quality: Evidence from the Yangtze river delta region of China. *J. Environ. Manag.* **2020**, *261*, 110208. [CrossRef]
41. Pan, X.; Guo, S.; Han, C.; Wang, M.; Song, J.; Liao, X. Influence of FDI quality on energy efficiency in China based on seemingly unrelated regression method. *Energy* **2020**, *192*, 116463. [CrossRef]
42. Chambers, R.G.; Chung, Y.; Färe, R. Benefit and distance functions. *J. Econ. Theory* **1996**, *70*, 407–419. [CrossRef]
43. Pastor, J.T.; Lovell, C.K. A global Malmquist productivity index. *Econ. Lett.* **2005**, *88*, 266–271. [CrossRef]
44. Jiang, Y.; Wang, H.; Liu, Z. The impact of the free trade zone on green total factor productivity—Evidence from the Shanghai pilot free trade zone. *Energy Policy* **2021**, *148*, 112000. [CrossRef]
45. Lin, B.; Du, K. Energy and CO_2 emissions performance in China's regional economies: Do market-oriented reforms matter? *Energy Policy* **2015**, *78*, 113–124. [CrossRef]
46. Gao, Y.; Zhang, M. The measure of technical efficiency of China's provinces with carbon emission factor and the analysis of the influence of structural variables. *Struct. Chang. Econ. Dyn.* **2019**, *49*, 120–129. [CrossRef]
47. Xu, C.; Bin, Q.; Shaoqin, S. Polycentric spatial structure and energy efficiency: Evidence from China's provincial panel data. *Energy Policy* **2020**, *149*, 112012. [CrossRef]
48. Zhang, J.; Wu, G.-y.; Zhang, J.-p. The Estimation of China's provincial capital stock: 1952–2000. *Econ. Res. J.* **2004**, *10*, 35–44. (In Chinese)

49. Shan, H.J. Reestimating the capital stock of China: 1952–2006. *J. Quant. Tech. Econ.* **2008**, *10*, 17–31. (In Chinese)
50. Chen, S. Environmental pollution emissions, regional productivity growth and ecological economic development in China. *China Econ. Rev.* **2015**, *35*, 171–182. [CrossRef]
51. Peterman, W.B. The effect of endogenous human capital accumulation on optimal taxation. *Rev. Econ. Dyn.* **2016**, *21*, 46–71. [CrossRef]
52. Xu, M.; Lin, B.; Wang, S. Towards energy conservation by improving energy efficiency? Evidence from China's metallurgical industry. *Energy* **2020**, *216*, 119255. [CrossRef]
53. Young, A. The Razor's Edge: Distortions and Incremental Reform in the People's Republic of China. National Bureau of Economic Research. *Quart. J. Econ.* **2000**, *115*, 1091–1135. [CrossRef]
54. Naughton, B. How Much Can Regional Integration Do to Unify China's Markets? Working Paper. 2000. Available online: https://kingcenter.stanford.edu/sites/default/files/publications/58wp (accessed on 10 April 2021).
55. Poncet, S. Domestic Market Fragmentation and Economic Growth in China. 2003. Available online: http://hdl.handle.net/10419/115967 (accessed on 10 April 2021).
56. Ming, L.; Zhao, C. Market Segmentation of Economic Growth-Why Economic Openness May Enhance Local Conservation? *Econ. Res. J.* **2009**, *44*, 42–52. (In Chinese)
57. Sun, B.; Cheng, Z. Research on industrial pollution discharge mechanism of market integration: Taking the Yangtze River Economic Belt as an example. *China Environ. Sci.* **2019**, *39*, 868–878. (In Chinese)
58. Ren, L.; Zhu, D. The environmental Kuznets Curve Hypothesis in China. *Econ. Trends* **2017**, *11*, 58–73. (In Chinese)
59. Bashir, M.A.; Sheng, B.; Doğan, B.; Sarwar, S.; Shahzad, U. Export product diversification and energy efficiency: Empirical evidence from OECD countries. *Struct. Chang. Econ. Dyn.* **2020**, *55*, 232–243. [CrossRef]
60. Lv, Y.; Chen, W.; Cheng, J. Effects of urbanization on energy efficiency in China: New evidence from short run and long run efficiency models. *Energy Policy* **2020**, *147*, 111858. [CrossRef]
61. Li, J.; Song, H.; Sun, W.; Sun, P.; Hao, J. Measuring Performance and its influence factors of National Sustainable Development Pilot Zones in Shandong, China. *J. Clean. Prod.* **2020**, *289*, 125620. [CrossRef]
62. Bian, Y.; Song, K.; Bai, J. Market segmentation, resource misallocation and environmental pollution. *J. Clean. Prod.* **2019**, *228*, 376–387. [CrossRef]
63. Zhang, J.; Wang, J.; Yang, X.; Ren, S.; Ran, Q.; Hao, Y. Does local government competition aggravate haze pollution? A new perspective of factor market distortion. *Socio-Econ. Plan. Sci.* **2020**, 100959. [CrossRef]
64. Zhang, C.; Lin, Y. Panel estimation for urbanization, energy consumption and CO_2 emissions: A regional analysis in China. *Energy Policy* **2012**, *49*, 488–498. [CrossRef]