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Original Research

Can Biased Energy-Saving Policy Improve Enterprises' Total Factor Productivity? Evidence from China

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Abstract

Making environmental regulation (ER) in line with local development reality is the key to promoting regional coordinated development. Current research mainly concentrates on the overall effect of ER or the policy effect of some specific regulations. In reality, the ERs are not always one-size-fits-all, and the evaluation of the biased ER's effect is mostly overlooked. This paper takes the biased energy-saving policy (BESP) of 13th Five Year Plan as an example and identifies the impact of the BESP on enterprises' total factor productivity (TFP) based on a Difference-in-Difference model. Our results suggest that the BESP has significant promotion on the enterprises' TFP. When considering the heterogeneity of enterprise and industrial characteristics, it can be found that large-scale, state-owned enterprises as well as enterprises with capital-intensive show more significant promotion effect from the BESP. Moreover, enterprises in high-energy consumption and low-tech industries also reveal more significant policy effect. Further, the results of the mechanism analysis indicate that the BESP promotes the enterprises' TFP mainly through enhancing technical-focused investment preference and narrowing technical gap within the industry. Our research fills the gap in the study of biased ER, which provides a new orientation for realizing the carbon neutrality goal.

Keywords: biased energy-saving policy, total factor productivity, investment preference, technical gap, Difference-in-Difference

Introduction

Ever since the 1980s, the Chinese government has put energy-saving policies in a prominent position to alleviate persistent energy shortages. However, the extensive characteristic of energy consumption still exists widely in China owing to the lack of systematic supporting policies. Especially, China's continuous industrial expansion has led to a sharp rise in energy demand after the accession to the World Trade Organization (WTO). During the years 2002 to 2004, the energy intensity of China increased from 1.16 tce/10000 yuan to 1.28 tce/10000 yuan [1]. Thus, China's 11th five-year plan (11th FYP) takes the reduction of energy intensity as a restrictive index to make up for the shortage of single total amount

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control, which is proposed to be 20% lower than that in 2005. After that, the 12th FYP and 13th FYP further take the targets as the overall constraint objectives with 16% reduction compared to 2010 and 15% reduction compared to 2015, respectively. Many sources fully acknowledge the effective roles of 11th FYP and 12th FYP on energy intensity reduction [2-3]. What's more, the 13th FYP achieved about 22% reduction in national energy intensity, which far exceeds its targets[1]. In terms of region, most provinces have achieved or even exceeded the energy-saving goal in 13th FYP. There is no doubt that the energy-saving policies in recent years have been quite successful in controlling energy consumption.

However, it is noteworthy that the energy-saving policies are not one-size-fits-all. The Chinese government decomposes the proposed energy-saving goal into every province. Concretely, different provinces are allocated with different energy-saving targets according to their regional development, industrial structure and historical energy consumption since 11th FYP. According to "13th Five Year Plan of Comprehensive Work on Energy Saving and Emission Reduction" in China (13th CEE), the average energy intensity reduction targets of eastern and central provinces are 16.09% and 15.63%, respectively, which are both higher than the national target of 15%. While the average target of western provinces is only 13.42%, and that of Tibet, Qinghai and Xinjiang are even only 10% (see Table 1 for detail)[2]. Obviously, compared to the energy-saving targets in the eastern and central provinces with higher energy efficiency, provinces in the western region enjoy bias because of the backward development. Promoting the economic development of less-developed regions and realizing the national energy-saving target, which are the initial intention of biased energy-saving policy (BESP). But it is arguably whether it could inspire the development of less-developed regions since it may cause biased regions to be satisfied with the current situation and standstill. Actually, the average GDP growth rate of the western region was 8.39% during the period of 13th FYP, which was higher than 6.93% in eastern region and 6.94% in the central region. We can preliminarily believe that the BESP is conducive to the economic development of biased regions. However, as the main subject of production and energy-saving, it is essential to further explore the economic effect and internal impact mechanisms of the BESP from the perspective of enterprises. Compared with other economic indicators, the total factor productivity (TFP) can not only measure the change of enterprises' technology level effectively, but also intuitively reflect the adjustment of enterprises' production activities, which can better reflect the quality of economic development. Therefore, this paper attempts to explore the impact mechanisms of the BESP on enterprises' TFP.

Current studies mainly concentrate on the effects of one-size-fits-all environmental regulation (ER) or a specific environmental policy on the enterprises' TFP. The main conclusions can be divided into three categories: positive effect [4-7], negative effect [8-9] and nonlinear effect [10-11]. However, few scholars have studied the policy effects of differentiated ER. From a macro perspective, regional differences in energy-saving targets have led to the "westward migration" of high-energy consumption industries, and it has caused the problem of "carbon leakage" [12]. In addition, Li et al. [2] concluded that the industrial migration not only reduces the energy consumption in the eastern region, but also brings technological progress and scale effect to the western region, which is a win-win situation. When it comes to micro view, Chen and Chen [13] found that industrial migration caused by differentiated energy-saving targets may lead to the decline of enterprises' energy efficiency. The empirical analysis conducted by Yang et al. [14] using the data of Chinese industrial enterprises also reached the same conclusion. In reality, the internal impact mechanisms of differentiated ER on enterprises is usually overlooked, which should be explored to achieve a win-win situation between economic development and environmental protection. Therefore, this paper takes the BESP of 13th CEE as an example and identifies the effect of the BESP on enterprises' TFP. Concretely, the BESP is taken as a quasi-natural experiment with the enterprises located in the biased regions as experimental group and others as control group. The Difference-in-Difference (DID) model is constructed to estimate the effect of the BESP on enterprises' TFP, which can effectively avoid the endogenous problem. Moreover, we further explore the heterogeneity and impact mechanisms of the BESP on enterprises' TFP from multi aspects.

The contributions of this paper are as follows. Firstly, this paper might be the first to examine the energy-saving policies from a regional bias perspective. We particularly focus on the enterprises located in the biased regions and evaluate the effect of the BESP on enterprises' TFP. Secondly, this paper constructs a framework for the policy effect of the BESP and provide a more thorough assessment which overcomes the endogenous problem. Finally, through the micro-empirical evaluation of biased policies' effects, this paper provides a theoretical basis for the developing countries to reasonably formulate regional energy-saving policies in the background of carbon neutrality.

The remaining of this paper provides more detailed discussions about the impact of the BESP on enterprises' TFP. As to detail, Section 2 constructs the research framework of this paper and proposes research hypothesis. Section 3 is the research design, including

1 The data comes from the National Bureau of Statistics.

2 In this paper, we define the areas where the energy-saving target in the 13th CEE is lower than the national level as biased region.

Table 1. Control objectives of energy intensity of 13th CEE.

Province	Reduction goal	Province	Reduction goal	Province	Reduction target
Beijing	17	Shanxi	15	Inner Mongolia	14
Tianjin	17	Jilin	15	Guangxi	14
Hebei	17	Heilongjiang	15	Chongqing	16
Liaoning	15	Anhui	16	Sichuan	16
Shanghai	17	Jiangxi	16	Guizhou	14
Jiangsu	17	Henan	16	Yunnan	14
Zhejiang	17	Hubei	16	Tibet	10
Fujian	16	Hunan	16	Shaanxi	15
Shandong	17			Gansu	14
Guangdong	17			Qinghai	10
Hainan	10			Ningxia	14
				Xinjiang	10
Eastern average	16.09%	Central average	15.63%	Western average	13.42%

empirical model construction and variable definition, followed by Section 4 which presents the regression results and cause analysis. And we conclude this paper and put forward some helpful policy recommendations in Section 5.

Theoretical Analysis and Research Hypotheses

The purpose of formulating the BESP is to promote the economic development of less-developed regions and realize energy conservation. However, whether the BESP can inspire the development of less-developed regions is still controversial. Based on the previous research, the BESP's impact on the enterprises' TFP is discussed from two aspects, including resource priority and industrial migration [15]. From the perspective of resource priority, it is apparent that the BESP lays easier energy-saving requirements for the enterprises in biased regions, which allows them to meet the energy-saving requirements without substantial reduction of production. Thus, it can be assumed that the BESP can ease the enterprises' cost burden and allow more resources for innovative activities. Nevertheless, some studies raise the opposite opinion. Given the support of the BESP, the enterprises can survive even with low TFP, which will probably lead to the "low-locked" phenomenon in biased regions.

As for industrial migration, the BESP may result in the migration of high-energy consumption industry to the biased regions since the differentiated energy-saving requirements among regions, which will lead to the competitive effect and technical spillover effect. Concretely, on one hand, the high-energy consumption industries are mainly come from the east of China with relatively stricter regulations and higher production efficiency compared to those in biased regions. Thus, the migration of enterprises with higher efficiency will intensify the market competition in biased regions, which compresses the living space of enterprises with lower efficiency. On the other hand, the technical spillover from enterprises with higher production efficiency may also be conducive to promoting enterprises' TFP in biased regions. Thus, based on the analysis above, we put forward the following hypothesis.

Hypothesis 1a: The BESP has a positive impact on enterprises' TFP.

Hypothesis 1b: The BESP has a negative impact on enterprises' TFP.

As a kind of ER, the effects of the BESP on enterprises' TFP might vary with the heterogeneities at enterprise and industrial levels [16-17]. In terms of enterprises' characteristics, enterprises with larger size and state-owned may have advantages in risk-sharing and financing channels, as well as in the negotiation ability, which are conducive to derive more significant benefits and withstand the negative impacts from the BESP [18-19]. Moreover, the physical capital owned by enterprises is relatively difficult to be replicated by competitors, which can help enterprises realize economies of scale and scope [20]. Therefore, capital-intensive enterprises are more likely to benefit from the investment expansion under the BESP and avoid to be squeezed out by other enterprises. From an industrial characteristics' standpoint, the BESP may have little impact on enterprises with lower energy consumption and higher technology as they have already met the energy-saving requirements. On the contrary, the BESP may show more significant effects on enterprises with higher energy consumption and lower technology.

The **Hypothesis 2** is proposed.

Hypothesis 2: The impacts of the BESP on enterprises' TFP vary due to different characteristics at enterprise (size, ownership and factor intensity) and industrial (energy consumption situation and technical content of industry) levels.

Further, the BESP may influence the enterprises' TFP mainly through changing the investment preference and technical gap.

(1) Investment preference: The resource priority and industrial migration caused by the BESP may exacerbate the market uncertainty in the biased regions. Thus, enterprises are likely to make adjustment on investment preference under the BESP, which will influence the enterprises' TFP. The adjustments can be divided into two categories, including the technical-focused investment preference and the quasi-financial-focused investment preference [21-22]. On one hand, given the backdrop of industrial migration, enterprises in biased regions may choose to increase technical-focused investment to avoid profit compression and response to market competition [23]. Industrial migration also improves the technical availability of enterprises in the biased region, and technical spillover greatly reduces the cost and risk of imitation innovation, which further enhances the technical-focused investment preference of enterprises. Further, the upgrading of existing production processes is conducive to narrowing the gap of production efficiency between enterprises in biased regions and relocated enterprises, which can effectively improve the resource allocation, thus promoting the enterprises' TFP [24]. However, technical-focused investment often means long-term, high risk and investment, which may be detrimental to improve TFP by forming sunk costs and breaking the capital chain.

On the other hand, many enterprises would prefer financial investment to offset the risks caused by innovation failure and changes in the external environment due to the adverse characteristics of technical-focused investment [25]. For the enterprises which are unable to bear innovation risks, investment in quasi-financial assets such as financial assets, derivative financial assets or real estate is conducive to easing the financial constraints as well as providing funds for enterprises' innovation and resource allocation [26], thus further improving the enterprises' TFP [27]. However, irrational allocation of financial assets may also lead to asset bubbles and the breakage of capital chain, which may do harm to the enterprises' TFP [28]. To sum up, the BESP may affect the enterprises' TFP by changing their investment preference.

(2) Technical gap: There is a significant technical gap between enterprises in biased regions and the other enterprises in the non-biased regions [29]. Actually, the large technical gap is detrimental for enterprises to absorb technical spillovers and may cause market share decline of enterprises in biased regions [30]. The BESP's impacts on the technical gap are uncertain. On one hand, the industrial migration brought by the BESP may spread advanced technology, production and management experience to the biased regions, which help to reduce enterprises' learning cost and innovation risks of biased regions, as well as increase the human capital stock [31]. Thus, the BESP promotes the enterprises' TFP in biased regions through narrowing the technical gap. On the other hand, the resource priority brought by the BESP will probably lead to the "low-locked" phenomenon in biased regions, which may further cause the widening of technical gap. Thus, the BESP will also damage the TFP of enterprises in biased regions through widening the technical gap.

Therefore, this paper proposes the following hypothesis:

Hypothesis 3a: The BESP affects enterprises' TFP through investment preference.

Hypothesis 3b: The BESP affects enterprises' TFP through technical gap.

Material and Methods

Empirical Strategy

This paper takes the BESP of 13th CEE as a quasi-natural experiment, measuring the bias of energy-saving policy in various regions, and studies it by Difference-in-Difference model. The specific baseline regression model is shown below:

$$TFP_{it} = \beta_0 + \beta_1 Did_{it} + X_{it}\zeta + \alpha_i + \lambda_t + \theta_c + \mu_{it} \quad (1)$$

where subscripts i and t represent enterprise i and year t, respectively. TFP_{it} is the TFP of enterprise i in period t. Did_{it} is a dummy variable and $Did_{it} = treat_i \times post_t$. The enterprises in the research sample are divided into experimental group and control group according to the 13th CEE. The experimental group includes enterprises in areas where the reduction target of energy intensity in the 13th CEE is less than the national target and $treat_i = 1$. Otherwise, it is the control group and $treat_i = 0$. When the time is the year of 13th CEE implementation (2017) or later, $post_{it} = 1$, otherwise, $post_{it} = 0$[3]. In addition, X_{it} is control variable matrix, α_i, λ_t, θ_c represent enterprise, year and industrial fixed effect, respectively. μ_{it} is the stochastic error term.

From the perspective of impact mechanisms, the BESP may influence enterprises' TFP by changing the investment preference and technical gap. Referring to Wen and Ye [32], the following mediating model is constructed for empirical test on the basis of model (1):

$$M_{it} = \beta_0' + \beta_1' Did_{it} + X_{it}\zeta' + \alpha_i + \lambda_t + \theta_c + v_{it} \quad (2)$$

3 The first year of the 13th FYP is 2016, but the 13th CEE was released on January 5, 2017.

$$TFP_{it} = \beta_0^* + \beta_1^* Did_{it} + \beta_2^* M_{it} + X_{it}\zeta^* + \alpha_i + \lambda_t + \theta_c + \kappa_{it} \quad (3)$$

where M_{it} is the mediating variables, including technical-focused investment (Tfi), quasi-financial-focused investment (Qffi) and technical gap (Teg). The meanings of other variables are the same as the above. It should be further explained that mediating effects are met when β_1 in model (1), β'_1 in model (2), β^*_1 and β^*_2 in model (3) are statistically significant at the same time, and $|\beta_1|>|\beta^*_1|$.

Variables and Data

Dependent Variable

The enterprises' TFP is the core dependent variable of this paper. The estimated methods for TFP which are mostly used in current literature include parametric, non-parametric and semi-parametric methods. Actually, there exists mutual causality problem between TFP and its factor selection. Moreover, the sample selection problem cannot be overlooked as well. More specifically, fierce market competition will force enterprises with lower TFP to withdraw from the market, which results in the overestimation of the average TFP [33]. Therefore, this paper employs the OP method to estimate enterprises' TFP to avoid both the simultaneous and sample selection problems [34]. The average value of enterprises' TFP between experimental and control groups in 2012-2019 is shown in Fig. 1. As shown in Fig. 1, the time trend of TFP between the experimental group and the control group remained approximately parallel before the implementation of 13th CEE (2017), and the mean value of TFP in the control group was significantly higher than that in the experimental group. Since 2017, the average value of TFP in the experimental group is about to equal that of the control group, and then exceeds. Therefore, it can be preliminary inferred that the BESP has a significant positive impact on enterprises' TFP.

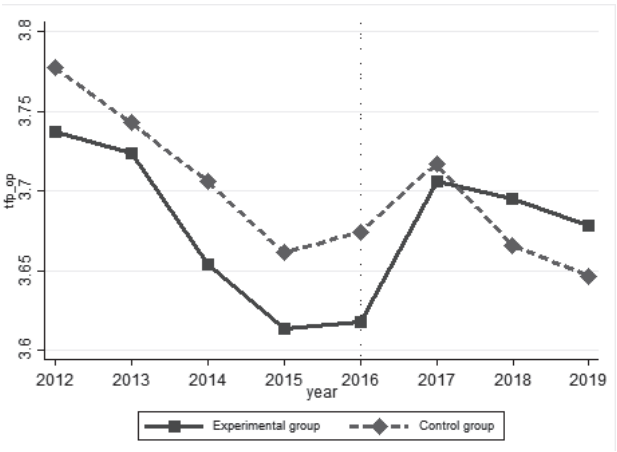

Fig. 1. Comparison of enterprises' TFP mean.

Other Variables

Referring to current studies, the following variables are controlled [35-36]: enterprises' scale (Size), debt asset ratio (Lev), profitability (Roa), growth (Grow), nature of equity (Neq), the largest shareholder's shareholding ratio (Top1); liquidity (Liqui), equity ratio (Equr). The impact of the BESP on enterprises' TFP may be heterogeneous among various enterprises and industries. Thus, this paper divides the samples according to the total assets, ownership and the factor intensity. The industrial heterogeneity is analyzed through distinguishing by the energy consumption situation[4] and industrial technology content[5]. The definitions and calculation methods of control variables are shown in Table 2.

Data Sources and Descriptive Statistics

This paper takes A-share listed enterprises from 2012 to 2019 as the research sample. To guarantee the effectiveness of empirical research, we exclude the following enterprises: (1) enterprises from financial industry; (2) enterprises listed on China's A and B share market at the same time. Finally, an unbalanced panel data with 20040 observations are obtained. The initial data comes from CSMAR, Wind and Royal Flush ifinD database. All continuous variables are winsorized to eliminate the influence of extreme values. Descriptive statistics and definitions of variables are shown in Table 2. The variance inflation factor (VIF) and correlation analysis of variables used in the baseline regression is shown in Table 3. It can be found from Table 3 that the VIF of all variables is less than 5, and each variable are met correlation analysis, indicating that there is no multicollinearity problem in this model.

Results and Discussion

Analysis of The Baseline Regression Results

In this paper, model (1) is regressed by gradually adding control variables to ensure robustness[6]. The baseline estimation results are shown in Table 4. It can be found that the coefficient of Did term

4 According to the "Letter of the General Office of The Chinese National Development and Reform Commission on Clarifying Matters Related to the Implementation of Phased Power Cost ReductionPolicies".

5 According to the "Statistical Classification of Intellectual Property (Patent) Intensive Industries of the Chinese National Office of Statistics (2019)".

6 Due to space limitation, the previous results are not reported in Table 4.

Table 2. Descriptive statistics of variables.

Variable	Obs.	Mean	S.D.	Min	Max	Definition
TFP	20,040	3.6925	0.7372	0.3987	7.8562	TFP calculated using the OP method
Did	20,040	0.0341	0.1816	0	1	Dummy variable, 1 or 0
Size	20,040	22.1973	1.2845	19.2506	26.4077	Logarithm of total assets
Lev	20,040	0.4297	0.2096	0.0400	0.9478	Total liabilities/total assets
Roa	20,040	0.0337	0.0694	-0.5779	0.2073	Net profit / total assets
Grow	20,040	0.1821	0.4921	-0.6418	5.6154	Growth rate of operating revenue
Neq	20,040	0.3497	0.4769	0	1	Dummy variable, Neq = 1 if the enterprise is state-owned, otherwise, Neq = 0
Top1	20,040	34.4038	14.7447	8.260	75.78	Shareholding ratio of the largest shareholder
Liqui	20,040	0.4374	0.2033	0.0347	0.9220	Total non-current assets / total assets
Equr	20,040	1.1284	1.2928	0.0167	8.9757	Total liabilities/total owner's equity
Tfi	20,040	0.3182	0.5967	0	5.7832	Net intangible assets / (net fixed assets + net construction in progress)
Qffi	20,040	0.4456	2.0242	0	26.4170	(Trading financial assets + derivative financial assets + investment real estate) / (net fixed assets + net construction in progress)
Teg	20,040	0.2494	0.2435	0.0055	1	The ratio of labor productivity of enterprise to the maximum labor productivity in the industry

Table 3. VIF test and correlation analysis.

	VIF	TFP	Size	Lev	Roa	Grow	Neq	Top1	Liqui	Equr
TFP	--	1.000								
Size	1.55	0.514***	1.000							
Lev	3.62	0.386***	0.494***	1.000						
Roa	1.27	0.085***	0.011	-0.337***	1.000					
Grow	1.05	0.134***	0.031***	0.019***	0.177***	1.000				
Neq	1.24	0.136***	0.352***	0.284***	-0.060***	-0.076***	1.000			
Top1	1.12	0.132***	0.219***	0.050***	0.132***	-0.015**	0.243***	1.000		
Liqui	1.08	-0.179***	0.157***	0.053***	-0.109***	-0.038***	0.167***	0.003	1.000	
Equr	3.03	0.316***	0.400***	0.815***	-0.264***	0.016**	0.242***	0.053***	-0.026***	1.000

is statistically significant positive at the level of 1%, and it is still stable when control variables are gradually added, indicating that the BESP can promote enterprises' TFP. Moreover, the coefficient of Did term is 0.048 with all the control variables added, which demonstrates 0.048 units promotion effect of the BESP on enterprises' TFP. Theoretically, the BESP brings resource priority to the biased regions and leads to industrial westward migration. These factors can improve the TFP of enterprises located in biased region by alleviating the pressure of energy-saving costs, improving the financial situation and releasing technical spillover. The conclusions above verify **Hypothesis 1a**. As to the results of control variables, the coefficients of Size, Lev, Roa and Grow are statistically positive, revealing that these factors are conducive to the promotion of enterprises' TFP. While effects of Neq, Top1, Liqui and Equr on enterprises' TFP are significantly negative, which are consistent with the conclusions of other scholarly works [37-40].

Robustness Test

Parallel Trend Hypothesis Test

A precondition of the DID model is that the trend between experimental and control groups are the same before the policy implementation. Therefore, we use

Table 4. The results of baseline regression.

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP	TFP	TFP	TFP	TFP	TFP
Did	0.047***	0.046***	0.045***	0.046***	0.048***	0.048***
	(2.998)	(3.092)	(3.006)	(3.090)	(3.286)	(3.332)
Size	0.246***	0.212***	0.212***	0.212***	0.228***	0.230***
	(40.058)	(35.397)	(35.456)	(35.486)	(39.228)	(39.423)
Lev	0.201***	0.154***	0.158***	0.158***	0.206***	0.280***
	(8.286)	(6.633)	(6.772)	(6.780)	(9.073)	(9.653)
Roa	1.281***	0.991***	0.990***	0.997***	0.903***	0.906***
	(32.072)	(25.331)	(25.307)	(25.435)	(23.661)	(23.762)
Grow		0.166***	0.166***	0.166***	0.163***	0.163***
		(37.387)	(37.271)	(37.326)	(37.862)	(37.758)
Neq			-0.054***	-0.058***	-0.047***	-0.047***
			(-2.905)	(-3.081)	(-2.593)	(-2.593)
Top1				-0.001***	-0.002***	-0.002***
				(-2.820)	(-4.644)	(-4.637)
Liqui					-0.731***	-0.741***
					(-32.207)	(-32.475)
Equr						-0.015***
						(-4.110)
_cons	-1.999***	-1.191***	-1.182***	-1.141***	-1.193***	-1.236***
	(-10.220)	(-6.295)	(-6.248)	(-6.017)	(-6.482)	(-6.707)
N	20040	20040	20040	20040	20040	20040
Industrial effects	Yes	Yes	Yes	Yes	Yes	Yes
Individual effects	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.226	0.286	0.286	0.286	0.328	0.329

Note: ***, ** and * indicate significant levels at 1%, 5% and 10%, respectively, and t values are in parentheses (hereinafter same)

the event study method proposed by Jacobson et al. [41] to estimate the impact of the BESP by year. The corresponding model is constructed as follows:

$$TFP_{it} = \beta_0 + \sum_{t=2012}^{2019} \beta_t Treat_i \times \chi_t + X_{it}B + \alpha_i + \lambda_t + \theta_c + \mu_{it} \quad (4)$$

where 2017 is the period of policy implementation and β_t is the estimated coefficients in the period 2012-2019. Fig. 2 presents the estimated coefficients of β_t under the 90% confidence interval. It can be found that all coefficients are insignificant before the implementation of the 13th CEE, which means no significant difference in enterprises' TFP between the experimental group and the control group before 2017. By contrast, the coefficients are significantly positive after the policy implementation, indicating the BESP has a positive impact on enterprises' TFP, and there is no time lag.

Placebo Test

Table 4 shows that the BESP can improve enterprises' TFP, but the conclusion may be affected by other policies or random factors. Referring to Cai et al. [42], we conduct a placebo test by randomly choosing experimental and control groups. Specifically, we re-estimate the baseline model containing all control variables through 500 random samples. The kernel density and scatter plot of 500 times' coefficient, as well as p value of Did term are shown in Fig. 3. It can be

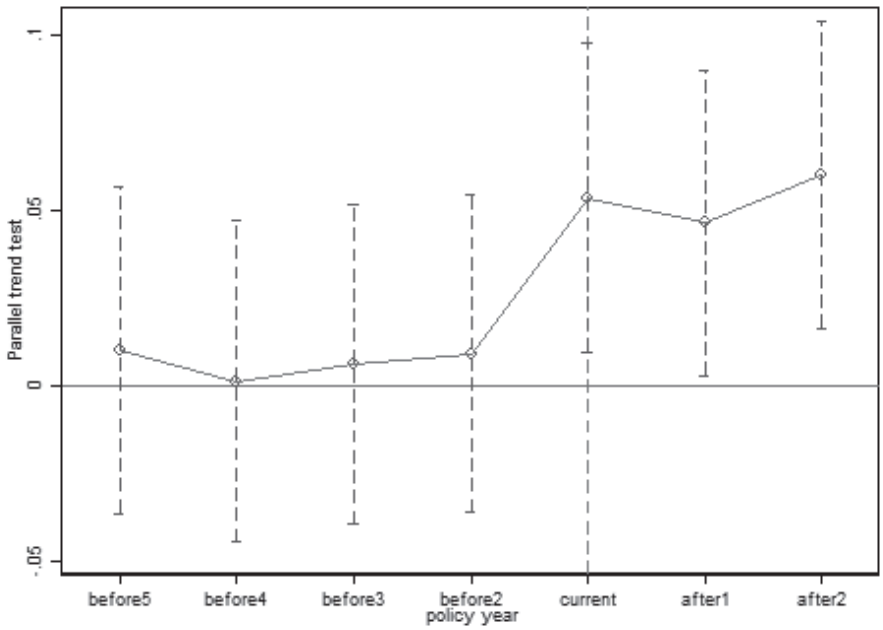

Fig. 2. Parallel trend test.

found from Fig. 3 that most of the estimated coefficients are not statistically significant at conventional levels, and the distributions center of kernel density are around zero. In addition, the vertical line represents the value of the coefficient in the actual baseline model, which shows a significant outlier. This result indicates that enterprises' TFP is not affected when the experimental group and control group are randomly selected. Thus, our estimation is robust.

Other Robustness Tests

This paper also tests the robustness of baseline regression from the following perspectives: (1) Since we study the unbalanced panel of enterprises with 2012-2019, whose number of cross-sectional units is much more than time series, the heteroscedasticity problem needs to be fully considered. Model (1) is re-estimated by Panel Corrected Standard Errors Model (PCSE). (2) Referring to Cui and Jiang [43], we shorten the sample year to 2014-2019 to ensure

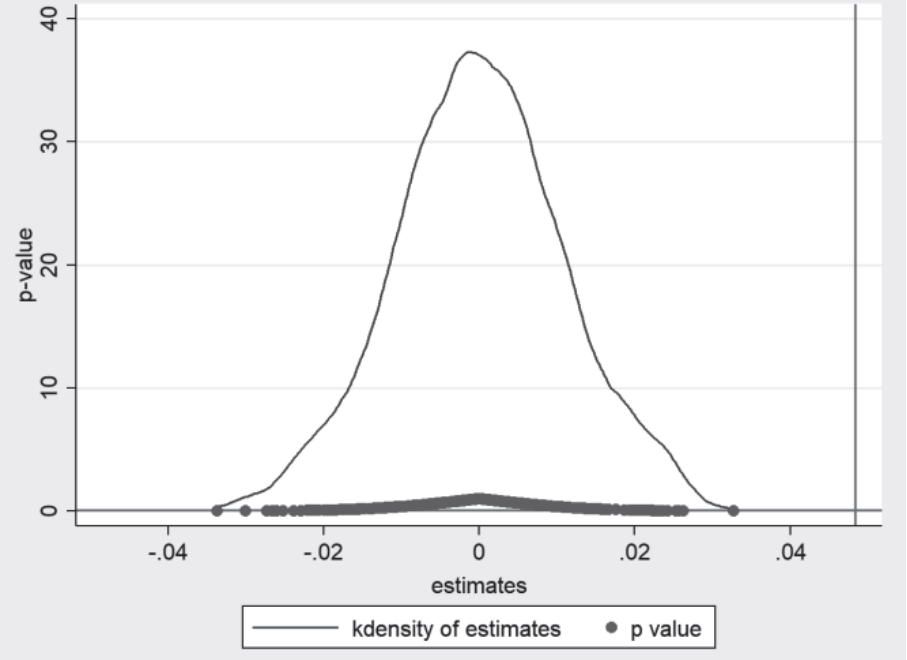

Fig. 3. The result of placebo test.

Table 5. The results of robustness test.

	(1)	(2)	(3)	(4)	(5)
	PCSE	Shorten periods	Eliminate two-way effects	IV	PSM-DID
	TFP	TFP	TFP	TFP	TFP
Did	0.048***	0.043***	0.031*	0.046**	0.092***
	(3.197)	(2.910)	(1.861)	(2.153)	(2.907)
Size	0.230***	0.218***	0.122***	0.228***	0.205***
	(27.491)	(30.393)	(16.823)	(33.924)	(10.598)
Lev	0.280***	0.236***	0.262***	0.274***	0.235***
	(7.282)	(7.057)	(7.379)	(8.318)	(2.787)
Roa	0.906***	0.821***	0.638***	0.839***	1.184***
	(16.769)	(21.213)	(12.555)	(21.040)	(9.386)
Grow	0.163***	0.164***	0.115***	0.163***	0.170***
	(22.247)	(36.010)	(23.263)	(35.208)	(14.130)
Neq	-0.047**	-0.069***	-0.082***	-0.052**	-0.103**
	(-2.200)	(-3.285)	(-3.655)	(-2.562)	(-1.973)
Top1	-0.002***	-0.002***	-0.000	-0.002***	-0.006***
	(-3.745)	(-4.173)	(-0.918)	(-4.715)	(-4.337)
Liqui	-0.741***	-0.728***	-0.531***	-0.752***	-0.766***
	(-23.596)	(-27.243)	(-18.924)	(-28.995)	(-10.916)
Equr	-0.015***	-0.020***	-0.004	-0.018***	-0.018**
	(-2.854)	(-4.760)	(-0.928)	(-4.543)	(-2.028)
_cons	-1.120***	-0.892***	1.106***	-1.116***	-0.566
	(-4.319)	(-4.033)	(4.940)	(-5.418)	(-1.283)
N	20040	15879	16814	16814	3073
Control variables	Yes	Yes	Yes	Yes	Yes
Industrial effects	Yes	Yes	Yes	Yes	Yes
Individual effects	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.896	0.329	0.188	0.333	0.465

the balance of years before and after the 13th CEE implementation. (3) The model (1) is re-estimated with all continuous control variables lag for one year to eliminate the possible two-way impact between control and dependent variables. (4) The biased regions are not randomly selected, they may still be affected by other potential factors in the same period. The Instrumental Variable Method (IV) is used to estimate the baseline model to solve the possible endogenous problem. Referring to Lv et al. and Qi et al. [44-45], one-period lag of Did is used as the instrumental variable. (5) The Propensity Score Matching method (PSM) is used to control the estimation bias caused by sample selection. Concretely, we take all the control variables as the characteristic variables and use the 1:1 nearest neighbor matching method. Table 5 shows the results of all tests in this part. We can find that the results in columns (1) to (5) are consistent with Table 4, which verifies the robustness of the above conclusion.

Heterogeneity Analysis

The baseline regression result indicates that the BESP can promote enterprises' TFP, but different results may be presented when considering the characteristics of enterprises and industries. Therefore, this part will examine the impacts of the BESP on enterprises' TFP from different levels to further test **Hypothesis 2**.

Analysis of Heterogeneity in Enterprises' Characteristics

According to Hypotheses Section, the BESP may have different effects on enterprises' TFP due to varying scale, ownership and factor intensity. The enterprises are divided into small, medium and large-scale according to the total assets, as well as state-owned and non-state-owned depending on the ownership. Columns (1) to (5) in Table 6 show the corresponding regression results. The coefficients of Did term in columns (3) and (4) are positive at 5% and 1% significance levels, respectively, indicating that the BESP significantly promotes the TFP with large-scale and state-owned enterprises, but has no significant impact on small and medium-sized and non-state-owned enterprises. The reasons are as follows. Large-scale and state-owned enterprises benefit more from the resource priority and can better cope with the competitive pressure due to the advantages in capital and negotiation. On the other hand, this paper calculates the ratio of net fixed assets to the number of employees and uses the median as the basis to divide the enterprises into capital-intensive and labor-intensive enterprises. It can be found from columns (6) to (7) in Table 6 that the BESP has a significantly positive impact on capital-intensive enterprises' TFP, while the impact on the TFP of labor-intensive enterprises is not significant. Capital-intensive enterprises have more material capital

Table 6. The results of enterprises' heterogeneity analysis.

	Size			Ownership		Factor intensity	
	Small	Mid	Large	State-owned	Non-state owned	Capital-intensive	Labor-intensive
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Did	0.017	0.027	0.044**	0.076***	0.034	0.048***	0.015
	(0.539)	(1.054)	(2.180)	(4.013)	(1.575)	(2.719)	(0.609)
Size	0.237***	0.215***	0.194***	0.177***	0.239***	0.219***	0.227***
	(14.839)	(10.402)	(14.452)	(17.228)	(32.238)	(24.252)	(25.910)
Lev	0.243***	0.345***	0.373***	0.363***	0.250***	0.170***	0.424***
	(5.343)	(5.888)	(5.511)	(7.107)	(6.865)	(4.207)	(9.888)
Roa	0.563***	0.729***	1.442***	1.286***	0.819***	1.096***	0.639***
	(9.541)	(12.192)	(17.364)	(15.492)	(18.911)	(20.088)	(12.380)
Grow	0.213***	0.178***	0.123***	0.163***	0.167***	0.185***	0.155***
	(26.730)	(22.670)	(18.477)	(23.141)	(31.189)	(29.459)	(27.113)
Neq	-0.026	-0.109***	-0.064**	--	--	-0.017	-0.079***
	(-0.749)	(-3.480)	(-1.998)	--	--	(-0.646)	(-3.182)
Top1	-0.002***	0.001	-0.002***	-0.005***	0.001	-0.004***	-0.002***
	(-2.674)	(0.777)	(-3.815)	(-7.804)	(1.624)	(-6.803)	(-3.055)
Liqui	-0.595***	-0.788***	-0.771***	-0.642***	-0.723***	-0.752***	-0.643***
	(-15.720)	(-17.226)	(-15.631)	(-15.800)	(-25.525)	(-21.775)	(-19.132)
Equr	-0.006	-0.019**	-0.028***	-0.014***	-0.019***	-0.009*	-0.037***
	(-0.993)	(-2.284)	(-4.766)	(-2.881)	(-3.541)	(-1.893)	(-6.216)
_cons	-0.927*	-0.618	-0.236	0.041	-1.680***	-0.955***	-1.101***
	(-1.946)	(-1.275)	(-0.747)	(0.145)	(-6.790)	(-3.033)	(-3.294)
N	6613	6613	6814	7008	13032	10020	10020
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.338	0.295	0.260	0.340	0.338	0.357	0.336

than labor-intensive enterprises, which can expand the resources priority and competitive advantages brought by BESP, and further realize economies of scale and scope. On the contrary, labor-intensive enterprises are more likely to reduce profit shares or even exit the market under the fierce market competition brought by the BESP. Therefore, the positive impact of the BESP on capital-intensive enterprises' TFP are more obvious.

Analysis of Heterogeneity in Industrial Characteristics

In this part, the heterogeneous industrial effects of the BESP on the enterprises' TFP are explored. Columns (1) and (2) in Table 7 represent the regression results of enterprises in high and low-energy consumption industries, respectively. The coefficient of Did term in column (1) is positive at the 1% significance level while column (2) is not significant. Thus, the BESP only promotes enterprises' TFP with high-energy consumption but has no impact on the low-energy consumption industry. The results above proved that enterprises with high-energy consumption do not have to significantly reduce output due to the lower energy-saving target. Moreover, it can be found from column (3) and (4) in Table 7 that the promotion of the BESP on low-tech enterprises' TFP is statistically significant. Compared to high-tech enterprises, the production technology of low-tech enterprises is easily promoted. Thus, technical progress in low-tech enterprises

Table 7. The results of industrial heterogeneity analysis.

	Energy consumption situation		Technical content of Industry	
	High	Low	High	Low
	(1)	(2)	(3)	(4)
Did	0.096***	0.021	0.014	0.055***
	(3.669)	(1.220)	(0.746)	(2.583)
Size	0.115***	0.244***	0.225***	0.209***
	(7.571)	(37.638)	(30.518)	(20.716)
Lev	0.178***	0.326***	0.324***	0.188***
	(2.732)	(10.070)	(9.351)	(3.850)
Roa	1.067***	0.877***	0.949***	0.907***
	(10.556)	(21.417)	(21.939)	(13.298)
Grow	0.134***	0.171***	0.158***	0.178***
	(12.350)	(36.583)	(28.703)	(27.002)
Neq	-0.027	-0.040**	-0.029	-0.095***
	(-0.658)	(-1.986)	(-1.340)	(-3.086)
Top1	-0.001*	-0.001***	-0.003***	-0.001
	(-1.702)	(-3.095)	(-6.039)	(-1.477)
Liqui	-0.702***	-0.727***	-0.673***	-0.764***
	(-12.900)	(-28.633)	(-24.007)	(-20.157)
Equr	0.001	-0.021***	-0.024***	-0.009
	(0.224)	(-5.002)	(-4.928)	(-1.588)
_cons	1.937***	-1.574***	-0.989***	-0.719***
	(5.920)	(-8.074)	(-6.133)	(-2.591)
N	3177	16863	11718	8322
Control variables	Yes	Yes	Yes	Yes
Industrial effects	Yes	Yes	Yes	Yes
Individual effects	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes
R-squared	0.280	0.342	0.322	0.323

is more likely to achieve by absorbing technical diffusion under the BESP. What's more, due to resource priority brought by the BESP, enterprises with lower technology can even promote TFP without innovation through increase production and improve operating conditions. By contrast, enterprises with higher technology cannot benefit from the BESP because they have met the national energy-saving goals due to product structure and technical level.

Regression results and analysis in this section indicate that the BESP has heterogenous policy impact on enterprises' TFP, which confirms **Hypothesis 2**.

Table 8. Regression results of mechanism analysis.

	Investment preference				Technical gap	
	(1)	(2)	(3)	(4)	(5)	(6)
	Tfi	TFP	Qffi	TFP	Teg	TFP
Did	0.054***	0.046***	-0.084	0.049***	0.019***	0.035***
	(2.667)	(3.166)	(-1.182)	(3.384)	(2.649)	(2.588)
Tfi		0.046***				
		(8.352)				
Qffi				0.009***		
				(5.396)		
Teg						0.691***
						(46.512)
Size	0.108***	0.225***	-0.094***	0.231***	0.030***	0.209***
	(13.283)	(38.444)	(-3.305)	(39.581)	(10.351)	(38.050)
Lev	-0.172***	0.288***	-0.838***	0.287***	0.040***	0.252***
	(-4.244)	(9.942)	(-5.903)	(9.897)	(2.842)	(9.234)
Roa	-0.008	0.907***	-0.538***	0.911***	0.172***	0.787***
	(-0.159)	(23.821)	(-2.886)	(23.896)	(9.224)	(21.878)
Grow	0.007	0.162***	-0.020	0.163***	0.029***	0.143***
	(1.140)	(37.760)	(-0.945)	(37.828)	(13.556)	(35.057)
Neq	0.079***	-0.051***	-0.106	-0.046**	-0.000	-0.047***
	(3.139)	(-2.801)	(-1.199)	(-2.545)	(-0.032)	(-2.744)
Top1	-0.000	-0.002***	0.005***	-0.002***	-0.000	-0.002***
	(-0.166)	(-4.636)	(2.676)	(-4.752)	(-0.203)	(-4.855)
Liqui	0.320***	-0.756***	-0.370***	-0.738***	-0.220***	-0.589***
	(10.044)	(-33.090)	(-3.319)	(-32.353)	(-19.656)	(-27.130)
Equr	-0.005	-0.015***	0.004	-0.015***	0.003	-0.017***
	(-1.040)	(-4.051)	(0.212)	(-4.122)	(1.570)	(-4.932)
_cons	-2.130***	-1.137***	2.596***	-1.258***	-0.011	-1.228***
	(-8.287)	(-6.173)	(2.882)	(-6.831)	(-0.121)	(-7.084)
N	20040	20040	20040	20040	20040	20040
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Industrial effects	Yes	Yes	Yes	Yes	Yes	Yes
Individual effects	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.085	0.331	0.067	0.330	0.164	0.406

Mediating Effect Analysis

The above regression results and analysis suggest that the BESP can promote enterprises' TFP, and it has heterogeneity among different enterprises and industries. However, the mechanisms are not clear. This part will explore the impact mechanisms of the BESP on enterprises' TFP from investment preference and technical gap.

Investment Preference

Technical-focused and quasi-financial-focused investment are used to describe enterprises' investment preference. Column (1) to (4) in Table 8 present the mediating test results of enterprises' investment preference. It can be found that the mediating test process is satisfied when Tfi is the mediating variable, but quasi-financial investment did not since the coefficient of Did term in column (3) is not significant, which indicates that enterprises prefer to improve their TFP level through increasing technical-focused investment under the BESP. The possible reasons are below. The technical spillover brought by the BESP has significantly reduced the imitation innovation cost. Enterprises are also willing to increase technical-focused investment under the market competition. All the above result in improvement of enterprises' TFP. In addition, the main purpose of enterprises engaging in quasi-financial-focused investment is to increase external financing and improve their financial situation. However, the BESP has improved the financial situation of enterprises in the biased region because they do not have to reduce production significantly. Moreover, the irrational allocation of financial assets may easily lead to loss-making in financial investment [46-47]. The reasons mentioned above further reduce enterprises' willingness on quasi-financial-focused investment. In summary, enterprises tend to prefer technical-focused investment rather than quasi-financial-focused investment under the BESP implementation. Therefore, the result in columns (1) to (4) at Table 8 verify **Hypothesis 3a**.

Technical Gap

The input and output of innovation activities are usually used to measure the technical level of enterprises. The former includes R&D personnel and funds, and the latter is the number of patent applications and authorizations. However, many scholars pointed out that R&D personnel and funds are not suitable to represent enterprises' technical level due to the characteristics of high failure rate and substantial uncertainty in R&D activities [48-49]. Moreover, the number of patent applications and authorizations in 2019 has not been fully counted. Thus, the reliability of the data is poor. Therefore, referring to Wu et al. [50], we use the labor productivity of enterprise as the measurement of the enterprises' technical level, and further divide it by the maximum value of labor productivity in the industry to represent the technical gap. The calculation method is as follows:

$$Teh_{cit} = \frac{(Sales\ revenue_{cit} + Inventory\ change_{cit})}{Number\ of\ employees_{cit}} \tag{5}$$

$$Teg_{cit} = \frac{Teh_{cit}}{\max(Teh_{cit})} \tag{6}$$

Where *Teh* and *Teg* represents enterprises' technical level and technical gap. max(Teh_{cit}) is the maximum value of labor productivity of industry c in period t. Obviously, the larger value of Teg_{cit}, the smaller technical gap between enterprise i and the most advanced enterprise in industry c. The corresponding regression results are shown in columns (5) to (6) in Table 8. The results demonstrate that the BESP significantly narrows the technical gap by approximately 0.019 units, and it helps to improve enterprises' TFP. Enterprises migrating due to the BESP bring technical spillover to the biased regions, which will enhance the innovative ability of enterprises. In addition, due to the complementarity of technology and human capital, the BESP will also increase the human capital stock in biased regions under the action of market mechanism. All of these can help the enterprise in biased regions to narrow the technical gap with enterprises in developed regions and further increase their TFP. Thus, **Hypothesis 3b** stands.

Conclusions

It is essential to make differentiated ER in line with local development reality to realize regional coordinated development. Exiting research mainly discussed the overall effect of ER or evaluated the impact of a single environmental policy, while scarcely considering the differentiated policy target. This paper innovatively focuses on a significant meaningful topic regarding the BESP. Concretely, this paper explores the impact of BESP on enterprises' TFP based on the sample of China's listed enterprises from 2012 to 2019 at the micro-level, and tests the reliability of the baseline conclusion by a series of robustness tests. Moreover, we examine the heterogeneous impacts of the BESP on enterprises' TFP from the perspectives of different enterprise and industrial characteristics, and further test the internal impact mechanisms. The main conclusions are as follows: (1) In general, the BESP can significantly promote enterprises' TFP, which is no time lag. (2) When considering the heterogeneity of enterprise and industrial characteristics, it can be found that large-scale, state-owned enterprises as well as enterprises with capital-intensive show a more significant promotion effect of the BESP. Moreover, enterprises in high-energy consumption and low-tech

industries also reveal a more significant policy effects. (3) The BESP promotes the enterprises' TFP mainly through enhancing technical-focused investment preference and narrowing technical gap within the industry. These findings support the view that that differential ER which fully considers the local practical condition is conducive to achieving a win-win goal between economic development and environmental protection.

Based on the conclusion drawn above, some helpful policy recommendations can be proposed. There are considerable differences in industrial and energy structure between different regions in China. It is also an indisputable fact that high-energy consumption industries are widely distributed in inland provinces with rich energy. With the acceleration of industrialization and western migration of industries, the proportion of high-energy consumption industries in the west will continue to increase. Therefore, it is suggested to keep on implementing common but differentiated energy-saving objectives according to the practical conditions of different provinces, so as to minimize the total social cost of energy conservation. Moreover, it is necessary to establish a national compensation mechanism and support funding to promote energy conservation and emission reduction in the western region, especially showing concern for the development of coal polygeneration technology in areas where take the coal as the primary energy.

In addition, the government should formulate differentiated policy combinations according to different types of enterprises. Specifically, energy conservation policy should be combined with other policy instrument, such as subsidies, tax returns and credit support. It is necessary to create a better environment for enterprises, and improve the production efficiency of enterprises under the energy-saving pressure. What's more, governments should pay attention to guide the enterprises in high-tech industries and low-energy consumption industries to develop in scale and further improve core technological innovation capability. Finally, the establishment of high-tech industrial parks is essential to exert the effect of technical diffusion. Enterprises should consciously expand their production potential set by increasing the proportion of technical investment, and narrowing the technical gap within the industry to avoid market contraction.

The research still has some limitations. First, we didn't concentrate on the policy response of unlisted industrial enterprise because the data of whole industrial enterprises in recent years is not available and unreliable. It can be used as a future research direction. Second, due to the limitation of listed enterprises' data collection, other factors affecting the implementation effect of the BESP, such as energy price and energy consumption structure, are not included in the empirical model. We should consider these factors if data are available in the future.

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Conflict of Interest

The authors declare no conflict of interest

Appendix The Balance Test of PSM

Table A1. Balance test of PSM-DID.

Variables	Sample	Mean		Bias		T-test	
		Treated	Control	%bias	&reduct| bias|	t	p>|t|
Size	Unmatched	22.323	22.186	10.9		4.14	0.000
	Matched	22.323	22.331	-0.6	94.5	-0.17	0.868
Lev	Unmatched	0.4775	0.4258	24.7		9.63	0.000
	Matched	0.4775	0.4828	-2.5	89.9	-0.71	0.481
Roa	Unmatched	0.0231	0.0346	-16.7		-6.45	0.000
	Matched	0.0231	0.0257	-3.9	76.8	-1.10	0.270
Grow	Unmatched	0.1787	0.1824	-0.7		-0.29	0.769
	Matched	0.1787	0.1737	0.9	-32.4	0.27	0.790
Neq	Unmatched	0.5163	0.3349	37.3		14.80	0.000
	Matched	0.5163	0.5328	-3.4	90.9	-0.95	0.344
Top1	Unmatched	34.832	34.366	3.1		1.22	0.221
	Matched	34.832	34.845	-0.1	97.2	-0.03	0.980

Table A1. Continued.

Liqui	Unmatched	0.5084	0.4311	37.5		14.80	0.000
	Matched	0.5084	0.5008	3.7	90.1	1.02	0.308
Equr	Unmatched	1.3721	1.1068	19.3		7.96	0.000
	Matched	1.3721	1.3918	-1.4	92.6	-0.38	0.707
$P>Chi^2$	Unmatched	0.000					
	Matched	0.715					

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