



Wage Gaps in Energy Industry: The Role of Sector

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Although wage gaps brought about by differences between sectors has been widely discussed, its specificity in the energy industry has received little attention. Due to the nature of the Chinese energy sector as a monopoly and to the influence of the Soviet Union, the wages of public sector employees in the energy industry in China are much less influenced by market mechanisms and are much higher than those in the private sector. This paper is the first article to explore the impact of the public sector on wage gaps in the energy industry using the China Urban Household Survey for 2004, 2008, and 2013. The cross-sectional regression results show a significant and continuous wage premium exists between sectors, although the size of the premium declined slightly over time. The Blinder-Oaxaca decomposition finds unexplainable part and discrimination dominates the wage gaps. The quantile regression results show that education and work experience have significant effects on low- and middle-wage groups. The heterogeneity analysis considers two sub-industries and finds that the wage gaps between the two sectors are much higher in the extractive segment of the energy industry than in the production and supply sector of the industry. The results of the study reveal that market-oriented reforms in China are not yet complete, because the obvious premium on wages in the public sector means they are not determined by market mechanisms. Finally, the paper provides policy recommendations from three perspectives: further market-oriented reform, elimination of discrimination, and education and vocational training.

Keywords: wage gaps, energy industry, public sector, private sector, Blinder-Oaxaca decomposition, quantile regression

1 INTRODUCTION

Since the twenty-first century, the public sector in China has gradually concentrated itself into monopolistic industries that are the lifeblood of the national economy, mainly in important areas. As a state-owned monopoly, the energy industry is highly representative of the path taken during China's economic transition. State-owned enterprises in the energy industry enjoy privileges not available to privately owned firms and are supported by the government in several respects. One, state-owned enterprises in the energy industry receive financial subsidies and preferential access to resources. For example, state-owned energy enterprises can often obtain land directly from the government itself. Two, due to pressure from local governments, most banks are more willing to lend money to state-owned energy enterprises than to privately owned energy companies. Third, the government has historically strictly restricted entry of privately owned energy enterprises to oil and

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gas markets. Although the government has tried in recent years to open the energy market, privately owned energy companies still face many obstacles.

At the same time, China's transition from planned economy to market economy means that wages in the private sector are subject to forces to which wages in the public sector are not. The resulting gap in wages between sectors causes distortions in the allocation of human capital, i.e., an asymmetric flow of labor between public sector and private sector employers. In China, state-owned enterprises are often called "iron rice bowls", meaning workers in those companies enjoy 1) jobs for life and 2) wages that will be determined by the government, rather than by the market. Although the government provides private sector companies with guides to suggested (not mandated) wages, among employers in the private sector, market factors remain decisive in determining wages.

Workers, naturally, responded to these differences: not surprisingly, given the gap in wages between public and private sector employers, workers, especially the highly educated, tend to apply to and accept offers from public sector employers. As a result, the supply of highly educated and skilled workers willing to work in the private sector is significantly less than the demand for such workers. To compete with their public sector counterparts, private sector employers (especially small, privately held companies) must offer higher wages to educated and skilled workers, which significantly increases labor costs for those companies. What is more, for most employees working in the private sector, especially those working for large companies, wages are easily manipulated. Some large enterprises deliberately suppress workers' wages and practice wage discrimination against specific labor groups to reduce costs and increase profits. In the absence of effective labor market regulation, it is difficult to effectively curb the dual problems of low wages and long labor hours in the private sector. In short, wages in the public sector are substantially higher, and more stable, than those in the private sector.

Unreasonable wage gaps between sectors of the economy distort the allocation of human capital and affect social stability as well. Although previous studies have addressed the wage gap between public sector and private sector employers, those studies have been general in their approach. The energy industry, as a representative monopolistic industry, is particularly under-researched in terms of human resources and wages, due both to the characteristics and classifications of the industry itself (labor-intensive or technology-intensive; exploration, excavation or refining sub-industries). In the context of the monopolistic nature of the energy industry in China, its unique wage determination mechanism, and the lack of research in the literature, it is important to explore in depth whether and to what extent wage gaps in the energy industry are due to differences in ownership. The results of that inquiry may not only explain existing distortions in the allocation of labor but also further emphasize the need for market-oriented reforms that will allow the market to play a decisive role in wage determination.

Therefore, this paper takes the energy industry, which has not been explored in the extant literature, as a case study of the wage gaps between the public and private sectors, especially wage gaps

caused by non-market factors such as discrimination and monopolistic behavior.

Specifically, this paper is concerned with four research questions: 1) What is the overall wage gap between the public and private sectors in the energy industry? 2) What are the main factors influencing the wage gap between sectors in the energy industry? 3) How is the wage gap in the energy industry distributed across the spectrum of wages? 4) Do the results differ by subindustry (such as extraction compared to production) within the larger energy industry?

The subsequent sections of this paper are organized as follows. **Section 2** reviews the literature on the theory of wage gaps and the results of previous empirical studies of intersectoral wage gaps. **Section 3** discusses the methodology and data of the study. **Section 4** presents the empirical regression results, including Blinder–Oaxaca (BO) decomposition, quantile regression and heterogeneity analysis. **Section 5** concludes the paper and makes some policy recommendations.

2 LITERATURE REVIEW

2.1 Theories of Wage Gaps

The determination of wages is one of the core issues of labor economics research, and wage gaps among labor groups have naturally received the attention of many economists. Four theories of wage gaps are widely studied: 1) the compensatory wage differential theory; 2) the neoclassical school theory; 3) discrimination; and 4) wage gaps due to labor market segmentation. This subsection first reviews the compensatory and human capital theories of wage gaps; then explains the theory of wage gaps due to discrimination; and finally reviews wage gaps due to labor market segmentation resulting from institutional and social factors. The article seeks to apply the relevant theories to analyze the wage gaps between sectors of the energy industry in China.

Smith (2010) provides one of the earliest explanations of wage gaps. He first proposed the theory of compensating wage gaps, hypothesizing that even if the labor market is perfectly competitive, different types of jobs will nevertheless differ significantly in terms of working conditions and working environment. The differences in working conditions and working environment will lead to wage gaps as companies make an extra effort to "compensate" workers for unfavorable working conditions and working environments.

Human capital theory (Willis, 1986) seeks to explain the gaps in wages between workers mainly from the supply side of the labor force, i.e., from the perspective of the labor force itself. In a perfectly competitive labor market, wages of laborers tend to be equal across the board because it is assumed that laborers are fungible and perfectly substitutable for each other. In reality, however, there is heterogeneity among workers' human capital due to differences in innate endowments, education or training received, which differences prevent workers from being perfect substitutes for each other. In the short run, the

TABLE 1 | Classification of the energy industry.

Classification	Statement
Extractive	Including mining and washing of solid ore, liquid ore and gas deposits
Coal mining	
Coal mining	Including anthracite, bituminous coal, lignite mining and washing
Coal washing	
Oil and gas extraction	
Natural crude oil Extraction	
Natural gas extraction	
Oil shale mining industry	
Electricity and steam production and supply	
Electricity production	
Thermal power	Thermal power stations are included
Hydropower	
Nuclear power	
Other powers	Including solar power, wind power, geothermal power, tidal power, etc.
Electricity supply	
Steam and hot water	Including the production, supply, sale, maintenance and management of steam and hot water
Gas production and supply	
Gas production	Natural gas production is included
Gas supply	Including gas, liquefied petroleum gas and natural gas storage, transmission and distribution, sales, maintenance and management

Source: *Industrial classification and codes for national economic activities (GB/T 4754-94)*.

heterogeneity of human capital allows workers to be differentially productive and eventually leads to differences in wage gaps. In the long run, although labor will move to higher-wage positions, this movement will be hindered by the constraints of human capital requirements. Thus, Willis argues, wage gaps arising from differences in human capital will persist.

Becker (2009) proposed the theory of discriminatory preference. Labor market discrimination refers to the unequal treatment in the labor market, due to external forces, of laborers who are equally qualified and equally productive. Labor market discrimination can manifest itself as wage discrimination, employment discrimination, occupational discrimination, or human capital investment discrimination. For example, the public sector prefers to hire urban workers; the private sector prefers to hire male workers. Occupational discrimination refers to discrimination that occurs when a worker's skills satisfy the employer's requirements, but the worker's non-economic characteristics lead the employer to treat him or her differently in the job search process.

To explain wage gaps caused by labor market segmentation, Doeringer and Piore (2020) devised the dual labor market theory. This theory suggests that the labor market is divided into two labor markets with different characteristics—the primary market and the secondary market—due to exogenous and endogenous factors such as social and institutional factors. The primary market has a good working environment and high wages, with employers mostly in highly competitive capital-intensive or technology-intensive industries. According to Doeringer and Piore, the labor supply in the primary market is dominated by the labor force within that particular industry and wages in the primary market are determined by the internal regulations of the

enterprises in that market. In contrast, the secondary market has poor working environments and low wages, with employers mostly in labor-intensive industries with low competitiveness. Labor to supply the secondary market comes primarily from outside the primary market, and wages in the secondary market are determined mainly through the supply and demand mechanism. Because such a segmented labor market is not perfectly competitive, barriers between the two labor markets make it difficult for workers to move between the two markets, resulting in wage gaps between the different labor markets.

2.2 Empirical Studies of Wage Gaps

2.2.1 Wage Gaps in Developed Countries

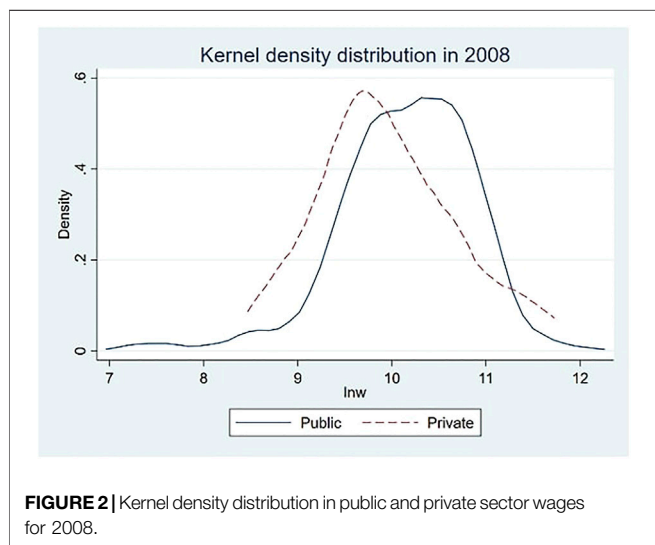
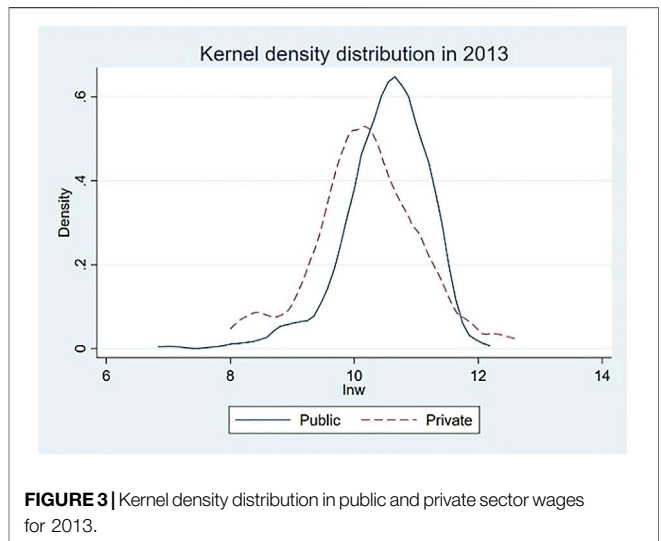
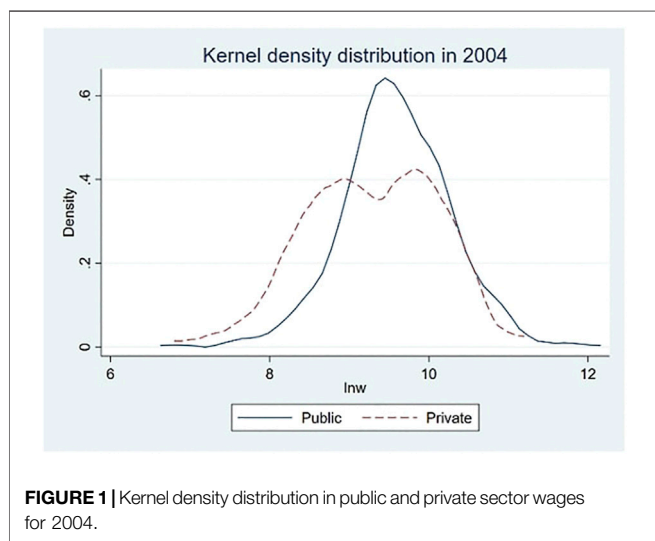
Scholars in developed countries have long studied wage gaps between the public and private sectors, and there is a rich literature on which to draw.

Many scholars who have studied wage gaps between sectors in developed countries have found that a wage premium is prevalent in the public sector (Bailey, 1977; Gunderson, 1979; Krueger, 1988; Melly, 2005). Mueller (1998) used quantile regressions to empirically test for wage gaps between the public and private sectors in Canada and showed that government workers are paid more, i.e., there is a wage premium in the public sector. Hospido and Moral-Benito (2016) studied the wages of public sector companies and non-public-sector companies in Spain and found a significant wage premium for public-sector labor, compared to the non-public-sector, but further found the wage gap between the two sectors is reduced by about ten percent after accounting for selectivity bias in the labor force. Gimpelson et al. (2019) studied the change in the wage gap between the public and non-public sectors in Russia between 2005 and 2015 and found that the

TABLE 2 | Definition of variables.

	Variables	Statement
Dependent variable	InW	Logarithmic of monthly wage
Independent variable		
Personal characteristics	Gender	Female = 1, Male = 0
	Marital status	Married = 1, Single or other = 0
	Ethnicity	Han ethnicity = 1, Other ethnicities = 0
Human capital characteristics	Education	Elementary = 6 years, Middle school = 9 years, High school = 12 years, College = 16 years, Graduate and above = 18 years
	Work experience	Number of years working
Employment characteristics	Occupation	Technicians = 0, Heads of enterprises and institutions = 1, Clerical staff = 2, Commercial staff = 3, Service work = 4, Production and transport = 5, Others = 6
Regional characteristics	Region	Liaoning = 0, Sichuan = 1, Guangdong = 2, Shanghai = 3

Source: China Urban Household Survey (2004, 2008, and 2013).



wage gap between the two sectors has persisted and actually increased with time.

The role of gender in wage gaps is a central topic of current research. Castagnetti and Giorgetti (2019) studied the gender wage gap between public and private sector companies in Italy and found that the “ceiling effect” of the gender wage gap exists only in the public sector. Singleton (2019) used data on public and private sector employers and employees in the UK from 2002 to 2016 and found that men had no significant wage premium in the public sector, while women had a 4% wage premium in the public sector compared to the non-public sector. Kerrissey and Meyers (2021) and Mueller (2022) both found that females tend to have larger public-sector wage premiums than their male counterparts. Kerrissey and Meyers (2021) further demonstrated that the union wage premium is higher for Black and women workers in the US public sector, which we refer to as “an intersectional union premium.”

TABLE 3 | Statistical description by sector and year.

		2004		2008		2013	
		PUSs	PRSs	PUBs	PRSs	PUBs	PRSs
Personal characteristics	InW	9.60	9.28	10.16	9.94	10.51	10.19
	Gender	24.53%	36.00%	29.21%	28.10%	21.63%	27.73%
	Marital status	89.25%	90.67%	91.68%	92.56%	90.47%	93.28%
Human capital characteristics	Ethnicity	95.79%	97.33%	94.00%	96.69%	94.42%	98.32%
	Education	11.48	11.63	12.11	11.98	12.36	11.63
	Work experience	22.02	21.49	20.70	18.97	23.59	23.51
Employment characteristics (occupation)	Technicians	16.59%	8%	3.68%	8.26%	2.09%	1.68%
	Manager of enterprises	3.50%	0%	31.53%	28.93%	31.16%	24.37%
	Clerk staff	23.36%	24%	31.33%	20.66%	26.05%	23.53%
	Commerce staff	0%	1.33%	3.29%	11.57%	0.70%	6.72%
	Service staff	5.37%	8%	0%	0.83%	0.23%	0.84%
	Production and transport	50%	57.33%	28.63%	20.66%	38.14%	36.13%
	Others	1.17%	1.33%	1.35%	9.09%	1.63%	6.72%
Regional characteristics (Province)	Liaoning	61.68%	65.33%	57.83%	34.71%	67.91%	57.98%
	Shanghai	5.37%	1.33%	0.97%	1.65%	3.26%	3.36%
	Guangdong	15.65%	17.33%	18.18%	28.93%	9.30%	18.49%
	Sichuan	17.29%	16%	23.02%	34.71%	19.53%	20.17%

Source: China Urban Household Survey (2004, 2008, and 2013).

2.2.2 Wage Gaps in Developing Countries

The intersectoral wage gap in developing countries, especially in Asia and Africa, has attracted increasing academic attention in recent years. Using nationally representative household surveys from 68 developing countries, Gindling et al. (2020) found that the public sector typically pays a wage premium. Hyder and Reilly (2005) used quantile regression to analyze Pakistani data and found that the wages of public sector workers were higher than those in the private sector, with the difference decreasing as the percentile of wage distribution increased within the sector. Further, Hakro et al. (2021) found that individuals with higher levels of education were more likely to choose the public sector in Pakistan and that the wage gap was reflected in higher income levels. Clark et al. (2021) used data from Malaysia to show that wages are higher for public sector employees and that gender and racial wage differentials have declined.

Research on intersectoral wage gaps in Africa has recently seen rapid growth. Botchway and Asiedu (2020) analyzed the Ghanaian labor market from 2009 to 2015 and found that the employee characteristics observed explain only 36% of intersectoral wage gaps, which is mainly reflected among lower-wage groups. El-Haddad and Gadallah (2021) and Shahen et al. (2020) investigated the case of Egypt using RIF and Oaxaca–Blinder decomposition and found a widening intersectoral wage gap. Aderemi and Alley (2019) also showed that the wage gap between sectors was concentrated in the low-income group because of educational differences between workers in the respective sectors. Kwenda and Ntuli (2018) similarly confirmed wage gaps in South Africa using cross-sectional data and showed that wage gaps there follow an inverted U-shaped distribution.

2.2.3 Wage Gaps in China and in the Energy Industry

Although China has been officially reformed and open to the West since 1978, studies of wage gaps between sectors still date

mainly back to the twenty-first century. Scholars have tried to analyze wage gaps in China from different perspectives and over different time periods, but the studies are not systematic and sometimes reach contradictory conclusions.

For example, Démurger et al. (2012) analyzed changes in wage gaps between the public and private sectors in 2002 and 2007 for local residents in urban China and found that the wage gap between sectors declined over the period, which also means the trend of convergence was in favor of employers in the private sector and in the semi-public sector. On the other hand, Nawakitphaitoon et al. (2016) used the Urban Household Survey (UHS) to find that the average earnings of workers in the public sector were much higher than their counterparts in the mid-2000s following sectoral reforms, and that the difference tended to widen over time.

Liu et al. (2017) used a multilevel approach with microdata from just one percent of the total population to show that wage gaps vary considerably across regions because of the interaction between market expansion and state intervention. Using a difference-in-difference estimation, Song (2016) showed that in urban China, the public sector discriminates more against rural hukou holders than does the private sector. Whalley and Xing (2016) made it clear that wages in the public sector are increasing more rapidly than those in the private sector. As a result, if additional labor is allocated to the private sector, urban wage inequality may widen further. Wang and Xie (2015) evaluated income and happiness and found that public sector employees report significantly higher levels of happiness than their private sector peers. Gustafsson and Wan (2020) caution that foreign firms also generate a revenue premium that may need to be considered separately.

Scholars now agree that state-owned monopolies in China contribute to wage premiums. Li et al. (2015) showed that the public sector is concentrated in upstream industries and has

TABLE 4 | Estimated result of wage function by year.

	2004				2008			2013	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sector	0.316*** (0.087)	0.296*** (0.083)	0.286*** (0.078)	0.216*** (0.071)	0.184** (0.072)	0.190*** (0.071)	0.326*** (0.074)	0.223*** (0.074)	0.178** (0.073)
Gender		-0.167** (0.069)	-0.177*** (0.065)		-0.103* (0.062)	-0.107* (0.061)		-0.093 (0.073)	-0.122* (0.072)
Marital status		0.085 (0.121)	0.204* (0.115)		0.241** (0.107)	0.237** (0.105)		0.114 (0.120)	0.097 (0.118)
Ethnicity		0.202 (0.150)	0.089 (0.142)		-0.013 (0.119)	-0.036 (0.118)		-0.128 (0.139)	-0.071 (0.138)
Education		0.0825*** (0.015)	0.0793*** (0.014)		0.0570*** (0.012)	0.0524*** (0.012)		0.0634*** (0.015)	0.0648*** (0.015)
Exp		0.0592*** (0.016)	0.0548*** (0.015)		0.017 (0.012)	0.0191* (0.012)		0.0268** (0.012)	0.0314*** (0.012)
Exp2		-0.00110*** (0.000)	-0.00107*** (0.000)		0.000 (0.000)	0.000 (0.000)		0.000 (0.000)	-0.000539** (0.000)
Occupation (technicians)									
Manager of enterprises		-0.060 (0.185)	0.090 (0.175)		0.047 (0.137)	0.041 (0.135)		0.163 (0.214)	0.143 (0.210)
Clerical staff		-0.073 (0.096)	-0.045 (0.091)		-0.106 (0.139)	-0.129 (0.136)		0.001 (0.216)	-0.019 (0.212)
Commerce staff		0.060 (0.667)	0.268 (0.629)		-0.193 (0.180)	-0.284 (0.178)		-0.335 (0.299)	-0.408 (0.294)
Service staff		-0.246* (0.147)	-0.153 (0.140)		-0.637 (0.693)	-0.890 (0.680)		-1.285** (0.535)	-1.272** (0.527)
Production and transport		-0.205** (0.090)	-0.131 (0.089)		-0.150 (0.142)	-0.145 (0.140)		0.005 (0.215)	-0.090 (0.212)
Others		-0.079 (0.278)	-0.099 (0.261)		-0.118 (0.208)	-0.081 (0.203)		-0.016 (0.274)	-0.060 (0.269)
Province (Liaoning)									
Shanghai			0.622*** (0.132)			0.297 (0.258)			0.310* (0.167)
Guangdong			0.536*** (0.081)			0.254*** (0.073)			-0.409*** (0.097)
Sichuan			-0.014 (0.078)			-0.178*** (0.066)			-0.143* (0.075)
Constants	9.280*** (0.08)	7.579*** (0.31)	7.546*** (0.30)	9.943*** (0.06)	8.916*** (0.29)	8.995*** (0.29)	10.19*** (0.07)	9.132*** (0.35)	9.211*** (0.34)
N	503	503	503	637	637	637	549	549	549
adj. R ²	0.024	0.155	0.251	0.013	0.085	0.123	0.032	0.111	0.145

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

Source: China Urban Household Survey (2004, 2008, and 2013).

monopoly status. Li et al. (2015) therefore conclude that upstream state-owned enterprises will gain rent through monopoly status by building a general equilibrium model. Lin et al. (1998) and Xu (2011) also demonstrate how the central government has attempted to improve the performance of state-owned enterprises, while retaining state ownership and control over a significant swath of the economy. Liu et al. (2017) started from government regulation of industries and found that regulation increases the wage gap between the monopolistic and non-monopolistic sectors of state-owned enterprises, while strong redistributive power increases wage premiums. Lin (2021) points out that monopolistic Chinese state-owned enterprises are concentrated in water, electricity, gas, telecommunications, roads, railways, ports, and financial institutions.

Current energy research in China concentrates on the low carbon roadmap and carbon neutral pathway. Li K et al. (2022) assessed the historical carbon reduction in building

operations. Zhang et al. (2022) covered the research gap on a carbon abatement assessment tool between the US and China. Xiang et al. (2022a) analyzed the historical emission reduction using LASSO-WOA approach. Xiang et al. (2022b) used PyLMDI to compute carbon emission reduction in buildings. Sun et al. (2022) presented a summary of carbon peak and carbon neutrality (CPCN) in buildings using a bibliometric approach.

Many scholars have tried to interpret equality from energy and environment perspectives. Zhao et al. (2022) found that regional inequalities in technology innovation associated with renewables may lead to insufficient growth in innovation over the long-term. Xiao et al. (2022) urged the government to adopt differentiated environmental policies for low-income and high-income groups. Li G et al. (2022) proved that the development of digital finance promotes the integration of green technology innovation capabilities, thereby alleviating environmental inequality.

TABLE 5 | Blinder–Oaxaca decomposition results.

	Characteristic effects		Price effects	
	Values	Percentage (%)	Values	Percentage (%)
2004				
WGs				
0.316	0.021	6.74	0.295	93.26
Gender	0.019	91.08	0.018	6.17
Marital status	-0.004	-19.03	0.041	14.08
Ethnicity	-0.004	-17.37	0.010	3.34
Education	-0.010	-45.10	-1.484	-503.61
Experience	0.005	23.58	-0.194	-65.92
Occupation	0.011	51.40	-0.097	-32.82
Province	0.003	15.44	-0.113	-38.38
Constant	0.000	0.00	2.113	717.14
2008				
WGs				
0.213	0.052	24.47	0.161	75.53
Gender	-0.001	-2.21	0.020	12.13
Marital status	-0.002	-3.80	-0.144	-89.08
Ethnicity	0.001	1.44	-0.232	-144.17
Education	0.006	10.80	-0.808	-500.93
Experience	0.014	26.67	-0.026	-16.33
Occupation	0.006	12.04	0.041	25.46
Province	0.029	55.06	-0.310	-192.40
Constant	0.000	0.00	1.621	1005.31
2013				
WGs				
0.326	0.068	20.92	0.258	79.08
Gender	0.004	5.52	0.075	28.91
Marital status	-0.003	-4.60	-0.322	-125.02
Ethnicity	0.002	2.99	-0.080	-30.98
Education	0.035	51.15	-0.966	-374.85
Experience	0.001	0.90	0.084	32.41
Occupation	0.014	20.91	-0.098	-38.17
Province	0.016	23.13	0.002	0.64
Constant	0.000	0.00	1.565	607.06

Source: China Urban Household Survey (2004, 2008, and 2013).

To summarize, although there has been substantial research on intersectoral inequality, energy and environment, no studies have been conducted on inequality due to sectoral differences in the energy industry in China, especially the labor wage gap. This article contributes to filling that gap in research.

3 METHODS AND DATA

3.1 Models

To measure wage structure, we use an ordinary least squares (OLS) model based on variable means and a quantile regression model (Koenker & Bassett, 1978). These models are expressed below:

$$\begin{aligned} \ln W_i &= \alpha + \beta_p Pub_i + \beta_x X_i + u_i \\ \ln W_{\theta i} &= \alpha_{\theta} + \beta_{\theta(p)} Pub_{\theta i} + \beta_{\theta X} X_{\theta i} + u_{\theta i} \end{aligned} \tag{1}$$

where i denotes workers, θ is an index indicating the wage percentile, $\ln W_i$ indicates the dependent variable (as a logarithm of the monthly wage), and Pub is a dummy variable

expressing worker choice. If a worker chooses to work in the public sector, then $Pub = 1$; $Pub = 0$ for the other choice. X are factors affecting wages and β are the estimated coefficients of X . Further, α is a constant and u is the error term. β_p and $\beta_{\theta(p)}$ express wage gaps between sectors.

Blinder–Oaxaca decomposition methods are used to decompose wage gaps and identify the relative importance of the various factors. Blinder–Oaxaca decomposition is based on variable means (Blinder, 1973; Oaxaca, 1973). Wages are expressed as W^{pub} for public sector employees and as W^{pri} for private sector employees. Assuming that wages are a function of productivity, then:

$$\begin{aligned} \ln W^{pub} &= X_{pub} \beta_{pub} \\ \ln W^{pri} &= X_{pri} \beta_{pri} \end{aligned} \tag{2}$$

where X_{pub} and X_{pri} represent factors related to productivity conditions (determinant) of public sector and private sector employees, such as education level, working years, and working hours; β_{pub} and β_{pri} are wage return coefficients for public and private sector employees in the labor market, respectively; and, notably, $\ln W^{pub} - \ln W^{pri}$ cannot be directly understood as sectoral discrimination. The counterfactual group is constructed as “private-sector workers who are considered to work in the public sector” (C) in the labor market. The wage of this group is expressed as W^C , with the basic setting as their remuneration. Thus, the wage gaps between sectors can be decomposed as:

$$\begin{aligned} \ln W^{pub} - \ln W^{pri} &= (\ln W^{pub} - \ln W^C) + (\ln W^C - \ln W^{pri}) \\ &= \beta_{pub} (X_{pub} - X_{pri}) + (\beta_{pub} - \beta_{pri}) X_{pri} \end{aligned} \tag{3}$$

where the interpretable part (characteristic effects) is $\ln W^{pub} - \ln W^C = \beta_{pub} (X_{pub} - X_{pri})$, that is, the wage gaps generated under different productivity conditions (for example, $X_{pub} \neq X_{pri}$). The unexplainable part (price effects) is $\ln W^C - \ln W^{pri} = (\beta_{pub} - \beta_{pri}) X_{pri}$, that is, the wage gaps generated under different sectoral return coefficients (for example, $\beta_{pub} \neq \beta_{pri}$), which can be understood as sectoral discrimination.

3.2 Data

The microlevel data in the present study are obtained from the China Urban Household Survey (UHS) conducted by the Economic Survey Team of the National Bureau of Statistics of China. Public access is provided by the Tsinghua–China Data Center. The UHS is a comprehensive survey of urban and rural households in four provinces, namely, Shanghai, Liaoning, Sichuan, and Guangdong (Eastern, Northeast, Western, and Southern China, respectively). Three years (2004, 2008, and 2013) are selected as the sample period and over 40,000 pieces of detailed data are included. Besides monthly wage, the statistics also included age, experience, gender, education, occupation, family status, and ethnicity.

The industry classification of the UHS is based on the Chinese classification standard “Industrial classification and codes for

TABLE 6 | Quantile regression results by sector in 2004.

	10%		50%		90%	
	PUSs	PRsSs	PUSs	PRsSs	PUSs	PRsSs
Gender	-0.188 (0.15)	-0.682** (0.28)	-0.234*** (0.08)	-0.0244 (0.24)	-0.182*** (0.07)	-0.121 (0.13)
Marital status	0.137 (0.27)	0.0713 (0.50)	0.0841 (0.15)	0.794* (0.43)	0.135 (0.12)	0.950*** (0.23)
Ethnicity	-0.124 (0.31)	-0.386 (0.81)	0.112 (0.17)	0.627 (0.70)	0.0263 (0.14)	-0.453 (0.37)
Education	0.0423 (0.03)	0.302*** (0.06)	0.0502*** (0.02)	0.286*** (0.05)	0.0221 (0.01)	0.0669** (0.03)
Exp	0.0902** (0.04)	0.0253 (0.07)	0.0600*** (0.02)	-0.00571 (0.06)	0.0311** (0.02)	-0.0550* (0.03)
Exp2	-0.00192** (0.00)	-0.000567 (0.00)	-0.00119*** (0.00)	0.000464 (0.00)	-0.000753** (0.00)	0.00141* (0.00)
Occupation (technicians)						
Manager of enterprises	-0.0396 (0.37)	— —	0.171 (0.20)	— —	0.294* (0.16)	— —
Clerical staff	-0.129 (0.20)	-0.835* (0.49)	-0.0672 (0.11)	-0.365 (0.42)	-0.0161 (0.09)	-0.839*** (0.22)
Commerce staff	— —	0.968 (1.25)	— —	0.492 (1.08)	— —	-1.343** (0.57)
Service staff	-0.493 (0.32)	-0.278 (0.63)	-0.19 (0.18)	0.0498 (0.55)	-0.171 (0.14)	-1.146*** (0.29)
Production and transport	-0.421** (0.19)	-0.317 (0.47)	-0.179* (0.11)	0.253 (0.41)	-0.012 (0.09)	-0.769*** (0.22)
Others	-0.59 (0.59)	1.881 (1.18)	0.0409 (0.33)	1.148 (1.02)	-0.341 (0.26)	-0.761 (0.54)
Province (Liaoning)						
Shanghai	0.397 (0.28)	2.297** (1.09)	0.677*** (0.16)	0.987 (0.94)	0.733*** (0.12)	-0.281 (0.50)
Guangdong	0.183 (0.18)	1.221*** (0.34)	0.460*** (0.10)	0.661** (0.29)	0.798*** (0.08)	0.337** (0.16)
Sichuan	-0.15 (0.18)	0.848** (0.40)	0.0353 (0.10)	0.307 (0.34)	0.119 (0.08)	-0.582*** (0.18)
Constants	7.750*** (0.64)	5.232*** (1.46)	8.265*** (0.35)	4.274*** (1.26)	9.533*** (0.28)	10.10*** (0.67)

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

Source: China Urban Household Survey (2004).

national economic activities” (GB/T 4754-94). **Table 1** shows the specific classification of the energy industry; the sample includes more than 1,500 workers in the energy industry. As the table indicates, the energy industry can be divided into extraction and production-and-supply.

In this study, the dependent variable is the logarithmic monthly wage. There are four types of independent variables: personal characteristics, human capital characteristics, employment characteristics and regional characteristics. **Table 2** describes in detail the definitions and descriptions of the specific variable indicators for these four types of explanatory variables.

Figures 1–3 show the Kernel density distribution of the logarithm of month wage rates in 2004, 2007, and 2013. In general, the wages in both the public sector and private sector increased. The distribution of wages in each of these 3 years resembles normal distributions; arithmetic means of wages in the public sector remain higher than those in the private sector. Furthermore, two characteristics of change should be noticed. First, wage gaps between the sectors continued to

decrease during these 3 years. Second, although wage distributions in both the public and private sectors resembled normal distribution, the centrality and dispersion differ. For the wage distribution in the public sector, years 2004 and 2013 are more centralized, while 2008 is more dispersive. In the case of the private sector, wage distributions during the period maintain a trend of increasing centrality and decreasing dispersion.

Table 3 gives descriptive statistics for all variables in the public and private sectors for 2004, 2008, and 2013. There is a persistent wage advantage in the public sector. In terms of individual characteristics, women are consistently underrepresented in the energy industry, occupying just a quarter of the workforce, but are more represented in the private sector. Both marital status and Han ethnicity account for more than 90% of the variation, but there is little real difference between the two sectors. In terms of human capital characteristics, the level of education among public sector employees continued to rise, while education levels among private sector employees were more stable. Public sector employees had more work experience than private sector employees, suggesting

TABLE 7 | Quantile regression results by sector in 2008.

	10%		50%		90%	
	PUSs	PRsS	PUSs	PRsS	PUSs	PRsS
Gender	-0.294** (0.14)	-0.163 (0.14)	-0.0635 (0.08)	-0.279* (0.16)	0.0642 (0.09)	-0.419** (0.17)
Marital status	-0.066 (0.24)	0.748*** (0.24)	0.212 (0.13)	0.184 (0.28)	0.290* (0.16)	0.923*** (0.29)
Ethnicity	-0.159 (0.26)	-0.291 (0.35)	-0.137 (0.14)	0.0506 (0.41)	0.0165 (0.17)	-0.0152 (0.43)
Education	0.0591** (0.03)	0.118*** (0.03)	0.0450*** (0.02)	0.136*** (0.03)	0.0307* (0.02)	0.0765** (0.03)
Exp	0.0737*** (0.03)	-0.0224 (0.02)	0.0116 (0.02)	-0.0277 (0.03)	0.0036 (0.02)	0.0147 (0.03)
Exp2	-0.00155** (0.00)	0.000618 (0.00)	-0.0000993 (0.00)	0.000847 (0.00)	-0.00017 (0.00)	-0.000145 (0.00)
Occupation (technicians)						
Manager of enterprises	0.0765 (0.34)	0.790*** (0.24)	0.222 (0.19)	-0.149 (0.28)	0.288 (0.22)	-0.540* (0.29)
Clerical staff	0.14 (0.34)	0.849*** (0.25)	-0.0376 (0.19)	-0.256 (0.29)	0.128 (0.22)	-0.787** (0.30)
Commerce staff	-0.165 (0.47)	0.784*** (0.29)	-0.241 (0.26)	-0.371 (0.34)	-0.371 (0.34)	0.0812 (0.35)
Service staff		0.635 (0.69)		-1.249 (0.81)		-0.517*** (0.83)
Production and transport	0.172 (0.35)	0.411 (0.27)	0.0728 (0.19)	-0.471 (0.31)	0.222 (0.23)	-1.200*** (0.32)
Others	-0.411 (0.62)	0.740** (0.29)	-0.186 (0.34)	-0.185 (0.34)	0.456 (0.40)	-0.258 (0.35)
Province (Liaoning)						
Shanghai	0.00366 (0.64)	1.173** (0.48)	0.0815 (0.35)	0.743 (0.56)	0.199 (0.41)	0.635 (0.58)
Guangdong	-0.137 (0.17)	0.375** (0.17)	0.240** (0.09)	0.615*** (0.20)	0.278** (0.11)	0.755*** (0.20)
Sichuan	-0.133 (0.15)	0.133 (0.15)	-0.243*** (0.08)	-0.0057 (0.18)	-0.392*** (0.10)	0.0354 (0.19)
Constants	8.192*** (0.69)	6.793*** (0.61)	9.407*** (0.38)	8.445*** (0.71)	10.07*** (0.44)	9.162*** (0.73)

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

Source: China Urban Household Survey (2008).

that there was a higher hiring threshold in the public sector and that the private sector had a higher capacity to absorb labor. In other words, the public sector had a more pronounced human capital advantage. In terms of occupational characteristics, production and transport clerks and managers dominate, with the percentage of technicians continuing to decrease, and the two sectors were relatively similar. In terms of regional characteristics, the main sample was concentrated in Sichuan and Liaoning. Liaoning is located in northeast China and is traditionally a heavy industrial base; while Sichuan is located in southwest China and has more abundant water and solar energy.

4 EMPIRICAL RESULTS

4.1 Ordinary Least Squares Model

The estimated results of wage functions based on variable means in 2004, 2008 and 2013 are reported in **Table 4**. Columns (1), (4), (7) take only sector as the independent variable; columns (2), (5), (8) add individual characteristics, human capital characteristics and employment characteristics as control variables; columns (3),

(6), (9) further add regional characteristics. The main conclusions are as follows.

Considering sectors only, the wage gap between sectors declined rapidly between 2004 and 2008 before eventually stabilizing. Specifically, employees in the public sector earned nearly 30% more than employees in the private sector in 2004, compared to 19% and 17.8% in 2008 and 2013 respectively. The regression coefficients are all significant.

Second, gender played a key role in wage gaps. In all 3 years, women in the energy industry earned more than ten percent less than men. Education and work experience were also important factors affecting earnings. For each additional year of education and work experience, earnings increased by about 5%–7% and 2%–6%. Most regression coefficients of wage on occupation were not significant, indicating that positions do not have a real impact on wages in the energy industry. In addition, marriage and ethnicity had no significant effect on wages of energy industry workers.

In terms of regional characteristics, the regression coefficients were positive and mostly significant for Guangdong and Shanghai, as economically developed provinces and

TABLE 8 | Quantile regression results by sector in 2013.

	10%		50%		90%	
	PUSs	PRsS	PUSs	PRsS	PUSs	PRsS
Gender	-0.235 (0.18)	-0.363* (0.19)	-0.150* (0.08)	-0.0506 (0.26)	-0.363* (0.19)	-0.00276 (0.29)
Marital status	0.26 (0.28)	0.455 (0.34)	-0.0599 (0.13)	0.686 (0.46)	0.455 (0.34)	0.303 (0.52)
Ethnicity	-0.033 (0.31)	-0.356 (0.60)	-0.0611 (0.14)	-0.0722 (0.80)	-0.356 (0.60)	-0.102 (0.91)
Education	0.0315 (0.04)	0.0606 (0.04)	0.0472*** (0.02)	0.114** (0.05)	0.0606 (0.04)	0.147** (0.06)
Exp	-0.00323 (0.03)	-0.0231 (0.03)	0.0521*** (0.01)	0.0131 (0.03)	-0.0231 (0.03)	0.0536 (0.04)
Exp2	0.0000556 (0.00)	0.000435 (0.00)	-0.000927*** (0.00)	-0.000278 (0.00)	0.000435 (0.00)	-0.000889 (0.00)
Occupation (technicians)						
Manager of enterprises	1.113** (0.50)	-1.443** (0.63)	0.2 (0.23)	-0.422 (0.84)	0.135 (0.20)	-0.427 (0.95)
Clerical staff	1.165** (0.50)	-0.947 (0.62)	-0.156 (0.23)	-0.797 (0.83)	0.0682 (0.20)	-0.0491 (0.95)
Commerce staff	1.181 (0.98)	-1.330** (0.67)	-0.463 (0.44)	-1.267 (0.89)	-0.682* (0.40)	-0.952 (1.01)
Service staff	0.0869 (1.55)	-1.755* (1.04)	-1.169* (0.70)	-2.069 (1.39)	-1.624*** (0.63)	-2.46 (1.58)
Production and transport	0.893* (0.51)	-0.932 (0.62)	-0.157 (0.23)	-0.463 (0.82)	-0.125 (0.21)	-0.304 (0.94)
Others	1.043 (0.73)	-1.467** (0.65)	-0.442 (0.33)	-0.824 (0.87)	-0.158 (0.30)	-0.408 (0.99)
Province (Liaoning)						
Shanghai	0.537 (0.40)	-0.476 (0.47)	0.487*** (0.18)	0.0043 (0.63)	0.258 (0.16)	0.141 (0.71)
Guangdong	-0.966*** (0.25)	-1.340*** (0.22)	-0.217* (0.11)	-0.15 (0.30)	0.0456 (0.10)	1.276*** (0.34)
Sichuan	0.123 (0.18)	-0.0621 (0.21)	-0.211** (0.08)	-0.0593 (0.28)	-0.380*** (0.07)	0.276 (0.32)
Constants	8.221*** (0.83)	10.30*** (1.05)	9.638*** (0.37)	8.821*** (1.40)	10.31*** (0.34)	8.573*** (1.60)

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

Source: China Urban Household Survey (2013).

municipalities with scarce energy compared to Liaoning, which has sufficient oil reserves. Because Sichuan has abundant hydro energy, coupled with an abundant labor force and relatively low economic level, the regression results for it are significant negative, at about 15%.

4.2 Blinder–Oaxaca Decomposition

In keeping with the purpose of this study, the dependent variable is whether or not respondents are willing to have a second child. Specifically, the questionnaire asks, “How many children would you like to have if there are no policy restrictions?” If the answer is fewer than two (in other words, the respondent does not want to give birth to more than one child), we assign the value “0;” for those who are willing to have two or more children, we assign the value “1.” The independent variables include basic individual characteristics, family characteristics, and social characteristics. Individual characteristics include age, ethnicity, health, and education level. Family characteristics include the respondent’s marital status, family economic level, and the number of people living together in the family. Social

characteristics include the respondent’s geographic location, hukou, religious beliefs, and decision about participating in medical treatment insurance. The specific variable descriptions are shown in **Table 2**.

The decomposition results using the Blinder–Oaxaca decomposition model are summarized in **Table 5**.

Overall, wage gaps between sectors decreased from 0.316 in 2004 to 0.213 in 2008 and then widened to 0.326 in 2013. In 2004, the characteristic effect (explainable part) can explain only 6.74% of the gap and the price effect (unexplainable part) accounted for up to 93.26%. In 2008 and 2013, the data are 24.47%, 75.53%, and 20.92% and 79.08%, respectively. The characteristic effect represents wages that can be explained by the market mechanism, while the price effect can be explained by discrimination. The results suggest that at the beginning of the twenty-first century, the public/private sector wage gap in China is still mainly due to discrimination through non-market mechanisms, with market mechanisms explaining only about one-fifth of the gap.

In 2004, gender (91.08%), occupation (51.40%), and experience (23.58%) were the most robust factors in

TABLE 9 | Estimated result of wage function by industry type in 2004.

	Extractive			Production and supply		
	(1)	(2)	(3)	(4)	(5)	(6)
Sector	0.657*** (0.15)	0.590*** (0.15)	0.589*** (0.15)	0.0892 (0.10)	0.164* (0.10)	0.165* (0.09)
Gender		-0.0782 (0.16)	-0.0835 (0.16)		-0.301*** (0.07)	-0.282*** (0.07)
Marital status		0.419* (0.25)	0.412 (0.26)		-0.0237 (0.14)	0.0984 (0.13)
Ethnicity		-0.152 (0.30)	-0.141 (0.30)		0.283* (0.16)	0.147 (0.15)
Education		0.00275 (0.03)	0.00487 (0.03)		0.0851*** (0.02)	0.0859*** (0.02)
Exp		0.0352 (0.03)	0.0362 (0.03)		0.0766*** (0.02)	0.0691*** (0.02)
Exp2		-0.000981 (0.00)	-0.000994 (0.00)		-0.00144*** (0.00)	-0.00134*** (0.00)
Occupation(technicians)						
Manager of enterprises		-0.155 (0.49)	-0.171 (0.50)		-0.0289 (0.19)	0.126 (0.18)
Clerical staff		-0.261 (0.24)	-0.221 (0.24)		-0.0171 (0.10)	0.00856 (0.09)
Commerce staff		0.0131 (0.74)	0.0121 (0.75)		—	—
Service staff		-0.378 (0.35)	-0.364 (0.35)		-0.251 (0.15)	-0.156 (0.14)
Production and transport		-0.783*** (0.22)	-0.787*** (0.23)		0.00875 (0.09)	0.0607 (0.09)
Others		-0.906* (0.50)	-0.909* (0.51)		0.166 (0.32)	0.101 (0.29)
Province(Liaoning)						
Shanghai			-0.456 (0.48)			0.495*** (0.08)
Guangdong			-0.0439 (0.18)			-0.0496 (0.08)
Sichuan						0.492*** (0.08)
Constants	8.748*** (0.13)	8.919*** (0.64)	8.887*** (0.65)	9.579*** (0.10)	7.512*** (0.35)	7.450*** (0.33)

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

Source: China Urban Household Survey (2004).

characteristics effects; marital status (14.08%), and gender (6.17%) were the most robust contributors to price effects. In 2008, province (55.06%), experience (26.67%), and occupation (12.04%) were the greatest factors in characteristics effects; occupations (25.46%) and gender (12.13%) had the greatest price effects. In 2013, education (51.15%), province (23.13%), and occupation (20.91%) were the most influential factors in characteristics effects; for price effects, the most influential factors were experience (32.41%) and gender (28.91%).

These results reveal that education, experience, gender, and occupation are the primary determinants of wage gaps between private and public sector energy firms in China.

4.3 Quantile Regression

Table 6, Table 7, and Table 8 provides the estimated results from the quantile regression model. The wage structures by wage percentiles become apparent as follows.

In terms of personal characteristics, females earn less than males in both sectors; in general, the wage gaps are more pronounced in the lower wage percentile and the gender wage gaps are larger in the private sector. Marital status is significant only in the 90th percentile of employees in the private sector and has a positive effect on earnings but has no significant effect on other percentiles or employees in the public sector.

As for human capital characteristics, education and work experience play a pivotal role. From 2004 to 2013, the regression coefficients for education were mostly significant and increased in importance. Meanwhile, the regression coefficient of education is the largest in the 50th percentile, because the jobs in 10th percentile are mostly manual laborers, while the high-wage group in the 90th percentile is attributable more to non-educational factors such as social networks. In addition, the regression coefficients are generally higher in the public sector than in the private sector, which also corresponds to the fact that highly educated workers are more likely to join the public sector. Except for 2004, the regression results for

TABLE 10 | Estimated result of wage function by industry type in 2008.

	Extractive			Production and supply		
	(1)	(2)	(3)	(4)	(5)	(6)
Sector	0.355*** (0.13)	0.260** (0.13)	0.263** (0.13)	0.135 (0.09)	0.114 (0.09)	0.126 (0.08)
Gender		-0.0471 (0.10)	-0.0461 (0.10)		-0.172** (0.08)	-0.183** (0.07)
Marital status		0.312 (0.19)	0.323* (0.19)		0.196 (0.13)	0.177 (0.12)
Ethnicity		0.0509 (0.22)	0.0485 (0.22)		-0.0956 (0.14)	-0.154 (0.14)
Education		0.0188 (0.02)	0.0171 (0.02)		0.0855*** (0.02)	0.0774*** (0.01)
Exp		0.0410** (0.02)	0.0461** (0.02)		-0.0000778 (0.01)	-0.00198 (0.01)
Exp2		-0.000694 (0.00)	-0.000867* (0.00)		0.00018 (0.00)	0.0002 (0.00)
Occupation(technicians)						
Manager of enterprises		0.118 (0.28)	0.0764 (0.28)		-0.0431 (0.15)	-0.0396 (0.15)
Clerical staff		-0.0686 (0.28)	-0.108 (0.28)		-0.126 (0.16)	-0.154 (0.15)
Commerce staff		-0.0869 (0.50)	-0.275 (0.50)		-0.171 (0.19)	-0.243 (0.19)
Service staff		— —	— —		-0.629 (0.67)	-0.908 (0.65)
Production and transport		-0.263 (0.29)	-0.317 (0.29)		-0.0671 (0.16)	-0.0214 (0.16)
Others		-0.135 (0.40)	-0.0645 (0.40)		-0.117 (0.24)	-0.11 (0.23)
Province(Liaoning)						
Shanghai			0.167 (0.16)			0.360*** (0.08)
Guangdong			-0.244** (0.11)			-0.109 (0.08)
Sichuan			— —			0.363 -0.248
Constants	9.869*** (0.12)	8.994*** (0.54)	9.067*** (0.53)	9.978*** (0.08)	8.897*** (0.35)	9.025*** (0.34)

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

Source: China Urban Household Survey (2008).

work experience were not particularly significant, and only in the 10th and 50th percentile sectors are the results more significant. This could be due to both the human society mentioned above and the fact that the energy industry does not require particularly long work experience. In other words, work experience plays a role only in the early and mid-career in the energy industry as a whole.

With respect to employment characteristics, the regression results are mostly more significant in both sectors at the 10th percentile and in the private sector at the 90th percentile, while the effect of career choice is not significant for the middle-wage group. Among them, the private sector is a better choice for the low-wage group if they work as clerks, tradespeople, etc.; the public sector is a better choice for the high-wage group if they are in managerial positions.

In terms of regional characteristics, from 2004 to 2013, the regression coefficients of Guangdong and Shanghai, two economically developed regions, become smaller and some

less significant, indicating that wages in the energy industry are more balanced in different regions and receive fewer regional shocks, especially for the middle- and high-wage groups.

4.4 Heterogeneity Analysis

Based on the analysis in Table 1, the energy industry is further divided into extraction and production-and-supply. The regression results of wages by category from 2004 to 2013 are shown in Table 9, Table 10, and Table 11.

The regression results are significant in both industries. In extraction, a worker in the public sector earns much more than a worker in the private sector, although the gap narrowed over time. In 2004, a worker in the public sector earned about 58.9% more than the same worker in the private sector; in 2008 and 2013, the gap was 26.3% and 22.6% respectively. In production and supply, on the other hand, the gap between public and private

TABLE 11 | Estimated result of wage function by industry type in 2013.

	Extractive			Production and supply		
	(1)	(2)	(3)	(4)	(5)	(6)
Sector	0.391*** (0.13)	0.234* (0.13)	0.226* (0.13)	0.257*** (0.09)	0.172* (0.09)	0.115 (0.09)
Gender		0.034 (0.12)	0.0443 (0.12)		-0.134 (0.09)	-0.187** (0.09)
Marital status		-0.0595 (0.17)	-0.0384 (0.17)		0.242 (0.16)	0.195 (0.16)
Ethnicity		-0.134 (0.19)	-0.109 (0.19)		0.00195 (0.19)	0.0528 (0.19)
Education		0.0354 (0.02)	0.0355 (0.02)		0.0905*** (0.02)	0.0902*** (0.02)
Exp		0.0243 (0.02)	0.0279 (0.02)		0.0309* (0.02)	0.0381** (0.02)
Exp2		-0.000347 (0.00)	-0.000458 (0.00)		-0.000484 (0.00)	-0.000682** (0.00)
Occupation(technicians)						
Manager of enterprises		0.0693 (0.24)	0.0247 (0.24)		0.712* (0.41)	0.564 (0.40)
Clerical staff		0.0373 (0.25)	0.0466 (0.25)		0.547 (0.41)	0.356 (0.41)
Commerce staff		-0.831 (0.53)	-0.945* (0.52)		0.398 (0.47)	0.159 (0.47)
Service staff		— —	— —		-0.508 (0.65)	-0.73 (0.64)
Production and transport		-0.311 (0.24)	-0.365 (0.24)		0.708* (0.41)	0.451 (0.41)
Others		-0.539 (0.37)	-0.582 (0.36)		0.752 (0.46)	0.56 (0.46)
Province(Liaoning)						
Shanghai			-0.341 (0.22)			-0.350*** (0.11)
Guangdong			-0.260** (0.12)			-0.0327 (0.10)
Sichuan			— —			0.413** (0.17)
	10.25*** (0.12)	9.929*** (0.44)	9.975*** (0.45)	10.16*** (0.08)	7.863*** (0.57)	8.116*** (0.56)

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

Source: China Urban Household Survey (2013).

sector wages narrowed a little, from 16.5% to 11.5%, remaining relatively stable.

Personal characteristics were not significant in the extractive industry but could have a significant impact in the production and supply industry. For each additional year of education, wages in the production and supply industry increased by 9%. The regression results were similar in all 3 years. A similar effect can be found for work experience. Combined with the regression results in **Tables 6, 7, 8**, most workers at the beginning and middle of their careers are working in the extractive industry, where human capital characteristics do not significantly boost earnings. The regression results for occupation choice were insignificant, regardless of the industry, which is the same as found in **Table 4**. In terms of regional characteristics, the regression results for production and supply were more significant because supply tends to be more associated with consumers, which implies a stronger relationship with local levels of economic development.

5 CONCLUSION

Using data from the China Urban Household Survey (UHS) for 2004, 2008, and 2013, this paper focused on wage gaps between companies in the public and private sectors in the energy industry, which have received little attention in the literature.

The research considered four groups of worker characteristics (personal characteristics, human capital characteristics, employment characteristics, and regional characteristics) to analyze and answer the four specific research questions posed in the Introduction. The results of the research determined that energy workers in the public sector have continued to earn more than those in the private sector, but the wage gap decreased from 30% to 18% between 2004 and 2013. To answer the second question, using Blinder-Oaxaca decomposition we found that although education, gender, and work experience were the main factors influencing the wage gap, those factors explained only a small portion of the wage gap. For the third question, the paper used quantile regression to find that education and work

experience did not significantly affect the high-wage group in the public sector, but had a positive effect on wages among the low- and middle-wage groups. In addition, the regression coefficients showed that women earned less than men in both sectors across all 3 years studied, especially in the low-wage group. Finally, heterogeneity analysis was used to compare two sub-industries, extraction on one hand and production and supply on the other. The results revealed that earnings in the public sector were much higher than in the private sector in both the extractive industry and production and supply industry, but the difference was much larger in the extractive industry.

5.1 Discussion of the Results

Our findings have diverse implications for labor, the energy industry, and government.

For workers in the energy industry, the results of the study demonstrate that choosing to work for state-owned enterprises is a rational choice because of the significant wage premium paid in the public sector. For workers who are already in the private sector, more education and work experience are effective means to reduce the wage gap.

The status of workers in the energy industry—a representative monopoly—is an under-researched issue, especially in terms of workers' wages. This study aimed to provide a preliminary exploratory analysis of the factors that contribute to the wages of employees in this industry and is the first systematic study of the differences in worker earnings due to sectoral differences in the energy industry. At the same time, the study of variation within the energy industry could be a potential topic for future research. As the world's largest developing economy, with historical and institutional factors, the results of this study of the energy industry in China may be a starting point for future research, using this study as a model, into the relative status of workers in other countries.

From the perspective of the market-oriented reforms currently underway in China, although wage gaps between the public and private sectors have declined slightly in the energy industry, there is still a wage premium in the public sector due to the different wage determination mechanisms. This is strongly supported by results showing that price effects, i.e., non-explained and discriminatory factors, determine wage gaps. This suggests that the market economy in China is still influenced by serious non-market factors that prevent private sector firms from competing fairly with state-owned enterprises in the energy industry, and that there is an urgent need for more radical measures to level the playing field.

REFERENCES

- Aderemi, T., and Alley, I. (2019). Gender Pay Gap in the Workplace: the Case of Public and Private Sectors in Nigeria. *J. Soc. Econ. Dev.* 21 (2), 370–391. doi:10.1007/s40847-019-00079-9
- Bailey, W. R. (1977). Pay Differentials between Federal Government and Private Sector Workers: Comment. *Industrial Labor Relat. Rev.* 31, 78–81. doi:10.2307/2522512
- Becker, G. S. (2009). *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. University of Chicago press. University of Chicago
- Bliner, A. S. (1973). Wage Discrimination: Reduced Form and Structural Estimates. *J. Hum. Resour.* 8, 436–455. doi:10.2307/144855
- Botchway, E., and Asiedu, K. F. (2020). Ownership Type and Earnings Gap Decomposition: Evidence from the Ghanaian Labor Market. *Afr. Dev. Rev.* 32 (4), 619–631. doi:10.1111/1467-8268.12465
- Castagnetti, C., and Giorgetti, M. L. (2019). Understanding the Gender Wage-Gap Differential between the Public and Private Sectors in Italy: A Quantile Approach. *Econ. Model.* 78, 240–261. doi:10.1016/j.econmod.2018.09.025
- Clark, R. L., Ogawa, N., Mansor, N., Abe, S., and Mahidin, M. U. (2021). Wage Differentials in Malaysia: Public Employment, Gender, and Ethnicity. *Asian Econ. Pap.* 20 (3), 16–34. doi:10.1162/asep_a_00840

5.2 Policy Recommendations

Based on the above results and discussion, this paper makes three recommendations. First, the market-oriented reforms previously begun need to be expanded. The government must reduce the effects of monopoly in the public sector and lower the barriers to entry that to date have prevented private sector companies from entering the energy industry, especially the extraction industry. Wages in the public sector must be made subject to market influences, rather than being determined solely by the central government.

Second, gender discrimination in energy companies must be taken seriously in both the public and private sector. Legislation must be passed to guarantee that the employment and promotion opportunities available to men are also available to women.

Third, the government needs to encourage firms in the private sector to improve education and vocational training for their employees, and to introduce corresponding policies to encourage high-level talent to enter the private sector.

5.3 Future Improvement

Although this study is the first to analyze wage gaps in the energy industry in China, there are still potential directions for future research. First, this paper focuses on the traditional energy industry, leaving the study of wage gaps in the new energy industry to future research. The impact of new and traditional energies on wages may differ significantly. Second, wage gaps in the energy industry lack global comparisons. The energy industry is inherently monopolistic in nature, but the attribution to the private or public sector, as well as the characteristics of other workers, still merit further investigation with a global perspective.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

ML designed the study, processed the data, and drafted the original manuscript. FZ and CT provided the data and revised the manuscript. All authors critically reviewed and approved the final manuscript.

- Démurger, S., Li, S., and Yang, J. (2012). Earnings Differentials between the Public and Private Sectors in China: Exploring Changes for Urban Local Residents in the 2000s. *China Econ. Rev.* 23 (1), 138–153.
- Doeringer, P. B., and Piore, M. J. (2020). *Internal Labor Markets and Manpower Analysis: With a New Introduction*. Routledge. Milton Park, Abingdon-on-Thames, Oxfordshire, England, UK.
- El-Haddad, A., and Gadallah, M. M. (2021). The Informalization of the Egyptian Economy (1998–2012): a Driver of Growing Wage Inequality. *Appl. Econ.* 53 (1), 115–144. doi:10.1080/00036846.2020.1796917
- Gimpelson, V., Lukiyanova, A., and Sharunina, A. (2019). *Economics and Politics of the Public-Private Wage Gap (The Case of Russia)*. Bonn: Institute for the Study of Labor (IZA), Research Paper Series.
- Gindling, T. H., Hasnain, Z., Newhouse, D., and Shi, R. (2020). Are Public Sector Workers in Developing Countries Overpaid? Evidence from a New Global Dataset. *World Dev.* 126, 104737. doi:10.1016/j.worlddev.2019.104737
- Gunderson, M. (1979). Earnings Differentials between the Public and Private Sectors. *Can. J. Econ.* 12, 228–242. doi:10.2307/134598
- Gustafsson, B., and Wan, H. (2020). Wage Growth and Inequality in Urban China: 1988–2013. *China Econ. Rev.* 62, 101462. doi:10.1016/j.chieco.2020.101462
- Hakro, A. N., Ghulam, Y., Jaffry, S., and Shah, V. (2021). Employment Choices and Wage Differentials: Evidence on Labor Force Data Sets from Pakistan. *Ind. J. Labour Econ.* 64 (1), 199–216. doi:10.1007/s41027-021-00306-0
- Hospido, L., and Moral-Benito, E. (2016). The Public Sector Wage Premium in Spain: Evidence from Longitudinal Administrative Data. *Labour Econ.* 42, 101–122. doi:10.1016/j.labeco.2016.08.001
- Hyder, A., and Reilly, B. (2005). The Public and Private Sector Pay Gap in Pakistan: A Quantile Regression Analysis. *Pak. Dev. Rev.* 44, 271–306. doi:10.30541/v44i3pp.271-306
- Kerrissey, J., and Meyers, N. (2021). *Public-Sector Unions as Equalizing Institutions: Race, Gender, and Earnings*. Newbury Park: SAGE Publishing. doi:10.1177/00197939211056914
- Koenker, R., and Bassett, G. (1978). Regression Quantiles. *Econometrica* 46 (1), 33–50. <Go to ISI>://WOS:A1978EK96200003. doi:10.2307/1913643
- Krueger, A. B. (1988). Are Public Sector Workers Paid More Than Their Alternative Wage? Evidence from Longitudinal Data and Job Queues. *When public Sect. Work. unionize* 1, 217–242. doi:10.3386/w2500
- Kwenda, P., and Ntuli, M. (2018). A Detailed Decomposition Analysis of the Public-Private Sector Wage Gap in South Africa. *Dev. South. Afr.* 35 (6), 815–838. doi:10.1080/0376835x.2018.1499501
- Li G, G., Zhang, R., Feng, S., and Wang, Y. (2022). Digital Finance and Sustainable Development: Evidence from Environmental Inequality in China. *Bus. Strategy Environ.* doi:10.1002/bse.3105
- Li K, K., Ma, M., Xiang, X., Feng, W., Ma, Z., Cai, W., et al. (2022). Carbon Reduction in Commercial Building Operations: A Provincial Retrospection in China. *Appl. Energy* 306, 118098. doi:10.1016/j.apenergy.2021.118098
- Li, X., Liu, X., and Wang, Y. (2015). A Model of China's State Capitalism. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2061521 (Accessed December 29, 2020). Available at SSRN 2061521.
- Lin, J. Y., Cai, F., and Li, Z. (1998). Competition, Policy Burdens, and State-Owned Enterprise Reform. *Am. Econ. Rev.* 88 (2), 422–427.
- Lin, J. Y. (2021). State-owned Enterprise Reform in China: the New Structural Economics Perspective. *Struct. Change Econ. Dyn.* 58, 106–111. doi:10.1016/j.strueco.2021.05.001
- Liu, Y., Xu, W., Shen, J., and Wang, G. (2017). Market Expansion, State Intervention and Wage Differentials between Economic Sectors in Urban China: A Multilevel Analysis. *Urban Stud.* 54 (11), 2631–2651. doi:10.1177/0042098016650421
- Melly, B. (2005). Public-private Sector Wage Differentials in Germany: Evidence from Quantile Regression. *Empir. Econ.* 30 (2), 505–520. doi:10.1007/s00181-005-0251-y
- Mueller, R. E. (2022). Gender Pay Gap in the Public Sector: Evidence from the Canadian Labour Force Survey. *LABOUR* 36 (1), 29–70. doi:10.1111/labr.12214
- Mueller, R. E. (1998). Public-private Sector Wage Differentials in Canada: Evidence from Quantile Regressions. *Econ. Lett.* 60 (2), 229–235. doi:10.1016/s0165-1765(98)00110-4
- Nawakitphaitoon, K., Chen, X., and Ge, Y. (2016). State and Non-state Earnings Differentials over Time in China's Urban Labor Market: Evidence from the Urban Household Survey (1994–2007). *J. Labor Res.* 37 (3), 287–316. doi:10.1007/s12122-016-9227-2
- Oaxaca, R. (1973). Male-female Wage Differentials in Urban Labor Markets. *Int. Econ. Rev.* 14, 693–709. doi:10.2307/2525981
- Shahen, M. E., Kotani, K., Kakinaka, M., and Managi, S. (2020). Wage and Labor Mobility between Public, Formal Private and Informal Private Sectors in a Developing Country. *Econ. Analysis Policy* 68, 101–113. doi:10.1016/j.eap.2020.09.006
- Singleton, C. (2019). The Public-Private Sector Wage Differential in the UK: Evidence from Longitudinal Employer-Employee Data. *Econ. Lett.* 174, 109–113. doi:10.1016/j.econlet.2018.11.005
- Smith, A. (2010). *The Wealth of Nations: An Inquiry into the Nature and Causes of the Wealth of Nations*. Petersfield: Harriman House Limited.
- Song, Y. (2016). Hukou-based Labour Market Discrimination and Ownership Structure in Urban China. *Urban Stud.* 53 (8), 1657–1673. doi:10.1177/0042098015576861
- Sun, Z., Ma, Z., Ma, M., Cai, W., Xiang, X., Zhang, S., et al. (2022). Carbon Peak and Carbon Neutrality in the Building Sector: A Bibliometric Review. *Buildings* 12 (2), 128. doi:10.3390/buildings12020128
- Wang, J., and Xie, Y. (2015). Feeling Good about the Iron Rice Bowl: Economic Sector and Happiness in Post-reform Urban China. *Soc. Sci. Res.* 53, 203–217. doi:10.1016/j.ssresearch.2015.05.008
- Whalley, J., and Xing, C. (2016). Ownership Restructuring and Wage Inequality in Urban China. *Int. Labour Rev.* 155 (1), 57–72. doi:10.1111/ilr.12005
- Willis, R. J. (1986). Wage Determinants: A Survey and Reinterpretation of Human Capital Earnings Functions. *Handb. labor Econ.* 1, 525–602. doi:10.1016/s1573-4463(86)01013-1
- Xiang, X., Ma, X., Ma, Z., Ma, M., and Cai, W. (2022a). Python-LMDI: A Tool for Index Decomposition Analysis of Building Carbon Emissions. *Buildings* 12 (1), 83. doi:10.3390/buildings12010083
- Xiang, X., Ma, X., Ma, Z., and Ma, M. (2022b). Operational Carbon Change in Commercial Buildings under the Carbon Neutral Goal: A LASSO-WOA Approach. *Buildings* 12 (1), 54. doi:10.3390/buildings12010054
- Xiao, D., Yu, F., and Yang, H. (2022). The Impact of Urban-Rural Income Inequality on Environmental Quality in China. *Complexity* 2022, 1–14. doi:10.1155/2022/4604467
- Xu, C. (2011). The Fundamental Institutions of China's Reforms and Development. *J. Econ. literature* 49 (4), 1076–1151. doi:10.1257/jel.49.4.1076
- Zhang, S., Ma, M., Li, K., Ma, Z., Feng, W., and Cai, W. (2022). Historical Carbon Abatement in the Commercial Building Operation: China versus the US. *Energy Econ.* 105, 105712. doi:10.1016/j.eneco.2021.105712
- Zhao, G., Zhou, P., and Wen, W. (2022). What Cause Regional Inequality of Technology Innovation in Renewable Energy? Evidence from China. *Appl. Energy* 310, 118464. doi:10.1016/j.apenergy.2021.118464

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