The Effects of the Energy Transition on Power Sector Employment in Latin America

Energy Division

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Abstract

The present study analyzes the relationship between energy transition and job creation potential in Latin America. It looks at companies' characteristics to infer potential hiring process drivers in forthcoming years. The analysis is based on an econometric model applied to cross-sectional data to explain the dependent variable "potential hiring rate" depending on the firm's size (based on the number of clients), area of activity or technology, employees' educational levels, and labor policies. The data came from 338 interviewed companies, including energy generation, transmission, distribution, and new energy services, oil and gas, and construction companies in six Latin American Countries (Bolivia, Chile, Costa Rica, Mexico, Panama, and Uruguay). The econometric study focused on 135 companies that declared they would be hiring new employees in the next year when they were interviewed.

The results show that the smaller energy companies with a larger participation of skilled workforce will tend to have a higher expected hiring rate in the forthcoming year, implying an inverse relationship between firm size and potential hiring rate. The model findings convey that the higher the number of skilled employees in the workforce, the greater the expected expansion of the company's labor force, particularly in renewable generation companies. Another aspect worth considering about the factors behind the company's potential hiring rate is the question of job quality. The results suggest that the firms hiring more are those with fewer policies. It can be explained by the fact that more traditional companies, such as hydrocarbon and utility companies, tend to have better-established policies but necessarily the highest potential job creation rates. This takeaway raises a discussion about whether a change in job quality is associated with the energy transition or merely with new entrants who will become traditional in the coming years. Moreover, it also helps to explain some of the political economies of the labor market that may play a role in the energy transition process. Therefore, one of the present study's main takeaways is the need to analyze more in-depth and promote job quality in smaller energy companies.

JEL Codes: L25, D25, M51, Q40, Q42

Keywords: FIRM'S JOB CREATION, ENERGY TRANSITION, POST-COVID ECONOMIC RECOVERY, LATIN AMERICA, INDUSTRIAL ORGANIZATION.

1. Introduction

More than 75% of global greenhouse emissions result from energy use (Energy Hub, 2022a). Consequently, the energy transition is central to achieving the Paris Agreement Goals. Moreover, in the COVID-19 green recovery, the energy transition has become a promise of investments and employment (IRENA, 2019). According to the International Labor Organization (ILO, 2018), the shift towards sustainable practices may create 18 million new jobs worldwide by 2030. WEF (2021) also suggests that renewable energy and energy efficiency jobs are geographically more diversified, gender diverse, and more likely to employ young people. In Latin America, the renewable energy sector already provided jobs (directly and indirectly) for at least 1.7 million people. This clean energy employment in the region is concentrated in liquid biofuels, hydropower, and solar and wind energy (IRENA, 2021).

The economic contraction caused by the COVID-19 pandemic was reflected in electricity demand and, consequently, in new investment decisions. In Latin America, the impact on the economy was even greater. According to the World Bank Group (2022), the Latin American gross domestic product (GDP) dropped by 6.7% in 2020, while the global GDP slowed by 3.3%. Despite increased threats to investment decisions, the International Energy Agency – IEA (2020a, 2021a) argued that investment levels in clean energy technologies remained resilient during COVID-19.

At the end of 2021, governments worldwide mobilized funds in rebates, grants, loans, and tax incentives/exemptions to mitigate the effects of the COVID-19 crisis. Governments have approved US $480 billion for clean energy investments between 2021-2023 (IEA, 2021b). Those investments include energy efficiency, public transport, clean transport, low carbon power, clean fuels, innovative technologies, grid extension and reinforcement, and storage. That is extremely important, especially because electricity demand is already upward (c et al., 2021).

Many studies have also highlighted that the energy transition can aid post-pandemic economic recovery (IEA, 2020b; Urdiales et al., 2021, Hallack et al., 2021). The broad vision of those studies defends the idea that post-COVID economic recovery plans must be consistent with countries' energy transition strategies because these investments have greater potential to reduce greenhouse gas emissions and create jobs and income. In its sustainable recovery plan for the health crisis, the International Energy Agency (IEA, 2020b) even proposes that this is a unique opportunity to reboot economies and open up many new employment opportunities while accelerating toward a more resilient and cleaner energy scenario.

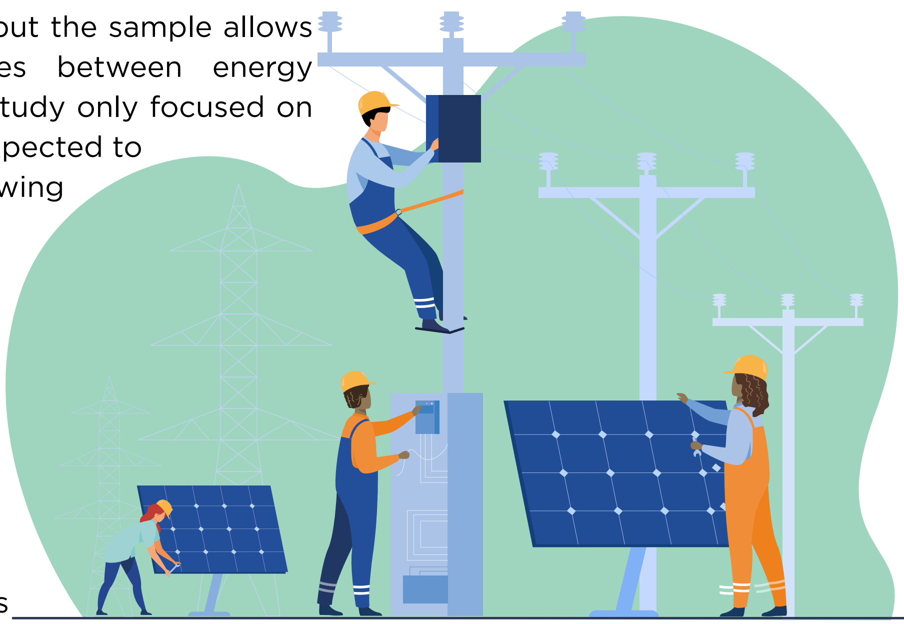
According to different studies, US $1 million invested by an energy transition firm can contribute, on average, to the creation of two to 45 direct jobs, depending on the technology, sector, and country (IEA, 2020b; ACEEE, 2011; Garrett-Peliter, 2017; Pollin & Garrett-Peltier, 2009; Janssen & Staniaszek, 2012). IADB then conducted firm-level surveys in three Latin American countries (Bolivia, Chile, and Uruguay) to understand the profile of companies with higher job creation potential (Ravillard et al., 2021).

As a result of the IADB study, Ravillard et al. (2021) conclude that investing US $1 million in new energy services companies (related to the energy transition, such as battery storage projects, distributed generation project design, and demand management options) can create 11 to 36 direct jobs while investing the same amount in the generation sector only creates 3 to 11 direct jobs. Moreover, companies that provide new energy services can create more gender-diverse jobs. However, the relationship between renewable energy generation companies and the higher participation of women in the workforce is not exactly straightforward. Ravillard et al. (2021) also highlighted the significant heterogeneity of results among the Latin American countries analyzed and reiterated the importance of conducting more in-depth studies using aggregated data.

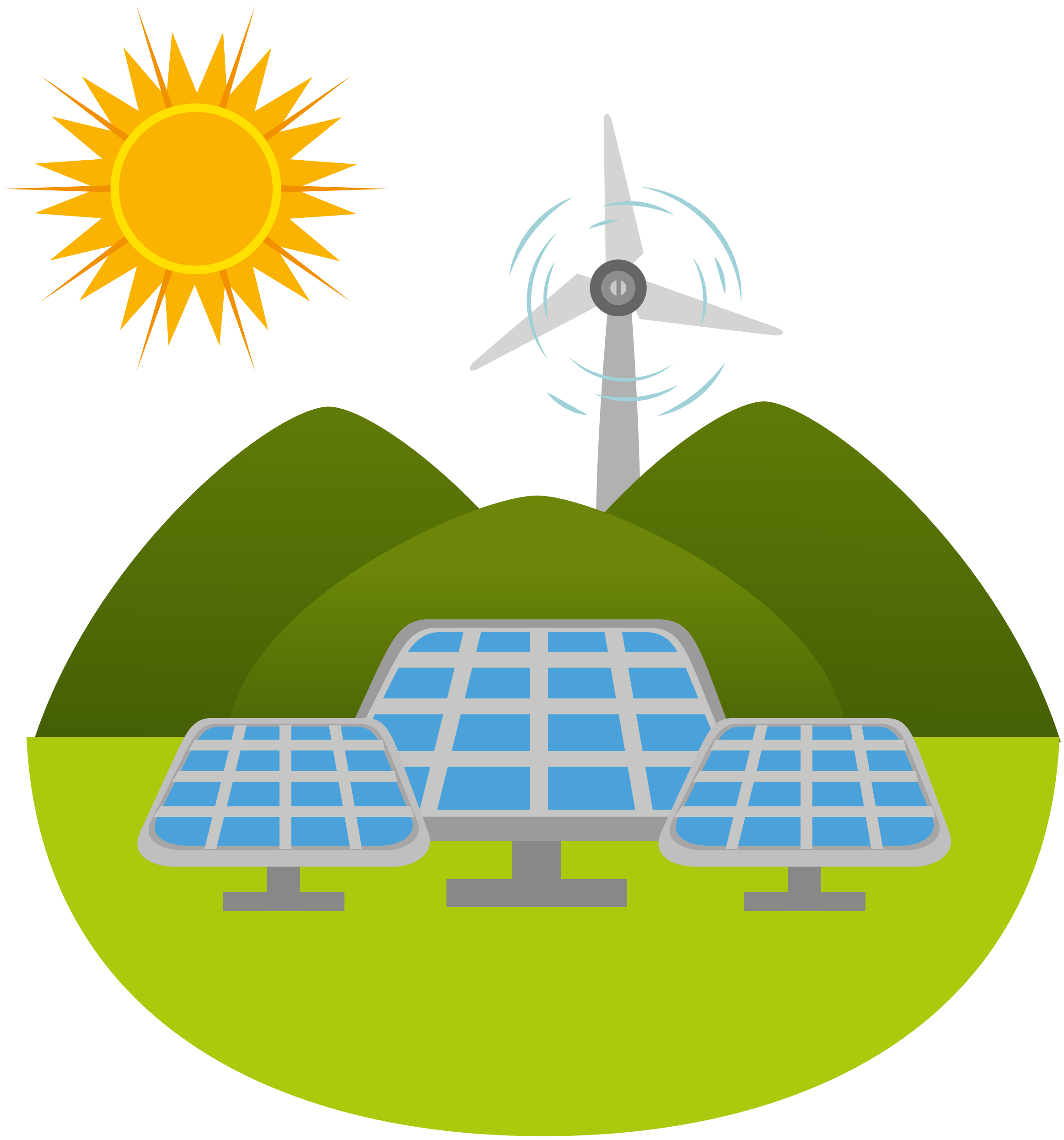
The present study complements Ravillard et al. (2021) by investigating further the relationship between energy transition and job creation potential over the post-COVID economic recovery in Latin America. In addition, this study focuses on companies' characteristics to infer potential drivers of the hiring process in forthcoming years. The study aims to analyze policy measures that can maximize net positive economic and employment benefits and get a deeper understanding of the potential opportunities and challenges for the power industry in Latin America, given the energy transition and its effect on employment. Finally, this study provides policy recommendations on how policymakers can create more inclusive jobs with good working conditions during the energy transition and post-COVID economic recovery.

To answer those research questions, the present study used an econometric model on cross-sectional data to explain the dependent variable "potential hiring rate" depending on the variables of firm size, area of activity or technology, employees' educational level, and corporate social responsibility policies, considering salary, social security, health, capacitation, gender and diversity policies. The data came from firm-level surveys in six Latin American countries - Bolivia, Chile, Costa Rica, Mexico, Panama, and Uruguay. Three hundred thirty-eight companies were interviewed, and the sample included energy generation, transmission, distribution, and new energy services, oil and gas, and construction companies. The study aims. to represent these countries, but the sample allows us to understand the differences between energy companies' jobs. The econometric study only focused on 135 companies that declared they expected to hire new employees in the year following the survey year.

In addition to this introduction section, the study is divided into six sections. The next section is dedicated to contextualizing post-COVID economic recovery and job creation through the energy transition in Latin America and the Caribbean (LAC). The third section is



dedicated to a literature review of the drivers of job creation in the energy sector, focusing on the energy transition process. That is followed by a section on the methodology and data. The fifth section presents the study results with a characterization of the companies that declared hiring expectations for the next year. Finally, the sixth section gives the main conclusions of the study and policy recommendations to promote a post-COVID economic recovery based on clean energy investments and inclusive job generation with good working conditions.



2. Post-COVID Economic Recovery and Job Creation through the Energy Transition in Latin America

The need for more and better jobs is a top sustainable development priority. According to the World Bank Group - WBG (2018), inclusive, sustainable, and higher-paying jobs can transform societies, boost economies, eradicate poverty, and enable shared prosperity, especially in developing countries. Seeking this objective, WBG (2018) highlights the importance of a deeper structural economic change and market integration as well as effective measures to correct market failures, supporting the countries'' jobs agendas by helping to provide job seekers with skills training, finance loans for micro and small enterprises, and leverage financing for private-sector employment growth. Economic transformation and inclusive, sustainable growth are the keys to delivering higher-paying jobs in developing countries.

According to the World Employment and Social Outlook of the International Labor Organization – ILO (2022), 214 million people worldwide were unemployed in 2021, most of them in developing countries.

> **WBG (2018) estimates that 600 million additional jobs will need to be created in developing countries by 2030 to attend the expected population growth.**

As expected, the job creation challenges faced by Latin American countries are considerable and have substantially increased with the pandemic. Latin America had the largest unemployment rate of all regions in 2021 (10%), meaning that around 32 million people were unemployed and looking for jobs. Employment is analyzed with a focus on age and gender inequalities. The situation in Latin America is even more challenging. The youth unemployment rate is still worrying, projected at 20.5 percent in 2022. Historically, young women's unemployment rates have always been higher than young men's, but the crisis has exacerbated this trend (ILO, 2022)

In the post-pandemic world, getting people back to their jobs or finding new jobs will be crucial for many governments. Achieving a better economic transformation that balances competing for economic, health, environmental and social demands will be one of the biggest challenges for governments worldwide. To a large extent, advancing towards a green economy can create employment at the global level. Transitioning to a low-carbon and resource-efficient economy involves changing production methods across several sectors. These changes require the development of new business models, the penetration of new technology, and increased investment in the energy sector (ILO, 2018), which will create opportunities for job creation. Many post-COVID economic recovery plans have highlighted the importance of the energy sector and the transition to green energy to drive clean energy investments and the creation of new inclusive jobs. An interesting example is the Inflation Reduction Act promoted by the US government in 2021.

According to IRENA (2021), the energy sector is expected to create 122 million jobs by 2050, including 43 million in renewable energies alone. That can be explained by the fact that the value chain of renewable energy is more labor-intensive than fossil fuels (Ram et al., 2022). As a result, the energy transition promises net employment gains (IRENA, 2019). Many countries have estimated positive GDP and employment growth impacts to overcome the downsides of a low-carbon economy (MIT, 2020; Czako, 2020). For example, the European Union has estimated an annual 1.1% GDP growth and 0.5% employment growth up to 2030 (Czako, 2020). Furthermore, evidence suggests that renewable energy and energy efficiency jobs are geographically more widespread, gender diverse, and likely to be filled by young people (WEF, 2021).

Latin America and the Caribbean have advantages in entering this market because their electricity matrices are either relatively clean or in the process of being decarbonized. These advantages give rise to other opportunities (CEPAL, 2021). For example, decarbonization could create 15 million new jobs in Latin America and the Caribbean by 2030 (Ravillard, 2021). According to IRENA (2021), the renewable energy sector already provided jobs (directly and indirectly) for an estimated 12 million people worldwide in 2020 and at least 1.7 million in LAC countries **(Table 1)**.

Table 1. Renewable Energy Employment* in LAC Countries and the World, by Technology in 2020 (thousands)

Country	Hydropower		Liquid Biofuels		Solar PV+other solar		Wind Energy		Others		All techs
	Workers	%	Workers	%	Workers	%	Workers	%	Workers	%	
Argentina	23.48	80%	-		2.19	7%	1.68	6%	2.06	7%	29.41
Brazil	175.82	15%	871.00	72%	115.20	10%	40.20	3%	-		1,202.22
Chile	10.30	38%			8.89	32%	7.50	27%	0.73	3%	27.42
Colombia	51.30	19%	193.93	73%	0.36	0%	2.10	1%		7%	266.31
Costa Rica	0.89	66%			0.05	3%	0.30	22%		8%	1.34
Dom Republic					-		0.30	100%	-		0.30
Ecuador	10.55	99%		0.2%	0.02	0.2%	0.02	0.2%	0.06	1%	10.66
El Salvador					-				0.16	100%	0.16
México	17.33	16%			39.15	35%	26.00	23%	28.79	26%	111.27
Nicaragua	1.20	17%			0.20	3%	1.95	27%	3.90	54%	7.25
Pánama					-		0.20	100%	-		0.20
Paraguay	13.98	100%			-				-		13.98
Perú	11.55	94%			0.38	3%	0.30	2%	0.05	0%	12.28
Uruguay	0.50	5%	5.45	52%	0.87	8%	1.00	10%	2.57	25%	
Venezuela		100%			-				-		15.06
Aggregated											
LAC	331.9	19.4%	1,070.4	62.7%	167.3	9.8%	81.5	4.8%	57.1	3.3%	1,708.2
World	2,181.6	18.2%	2,410.9	20.1%	4,826.4	40.2%	1,254.2	10.4%	1,345.0	11.2%	12,018.0

Source: Authors' elaboration based on IRENA (2021).

**Direct and indirect jobs*

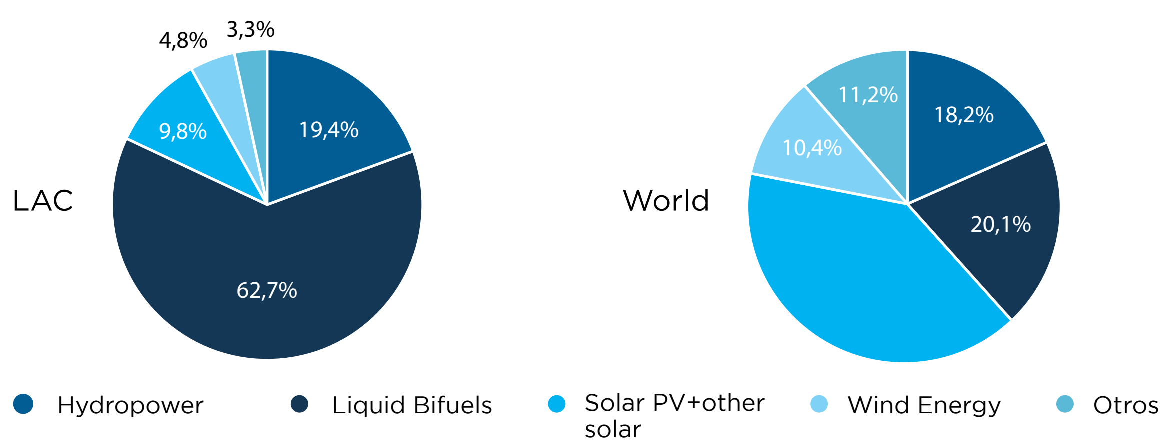
Note. Thousands of workers. Percentages correspond to all renewable employment in each country, and bars indicate country comparisons among each technology. Others include biogas, geothermal, waste, solid biomass, and ocean energy.

As presented in Figure 1 below, renewable energy employment in LAC is concentrated in liquid biofuels (62.7%), followed by hydropower (19.4%), solar PV + other solar technologies (9.8%) and wind energy (4.8%). At the same time, this distribution is quite different globally, where solar energy is the most prominent for generating jobs (40.2%). Thus, the importance of biofuels differentiates LAC from other regions. That is because the productive chains of bioethanol and biodiesel rely on other activities such as agriculture and agroindustry (mostly sugar cane and soy) that are relevant components of trade performance and labor in many countries. Additionally, biofuels supply energy to the power and transportation and manufacturing sectors. That explains the importance of considering biofuels in the political economy of the energy transition in LAC.

It is worth mentioning that the liquid biofuel sector as an employment driver is most concentrated in Brazil, Colombia, and Uruguay, which have higher participation of biomass in their renewable energy matrix. Moreover, the hydropower sector is the leading renewable energy generator and employs workers across more LAC countries. Compared to the rest of the world, the importance of solar and wind are relatively less important, accounting for just under 15% of total jobs in renewable energy generation (compared to more than 50 % in the rest of the world). Nevertheless, wind and solar energy generation has increased participation in the energy matrix and is consequently expected to increase participation in job creation. It is estimated that solar and wind generation will have the highest growth in the generation matrix in LAC. Their participation in the energy mix is expected to increase by 10.4% and 9.1%, respectively (LOPÉZ et al., 2022) and increase job creation. Compared to the current number of workers per megawatt (MW), other variables remaining the same, these sectors could provide at least 650,000 new jobs by 2030, or 2.6 times more than in 2020.

The dynamics of current employment distribution within each country could be of interest for policymakers to understand and support adequate regulation and policies. Some countries in the region rely more on one or two technologies (Dominican Republic, El Salvador, and Paraguay), while others are more diversified (Chile, Mexico) **(Table 1).**

Figure 1. Renewable Energy Employment in LAC* and the World, 2020



3. Drivers of Job Creation in an Energy Sector in Transition to a Sustainable Future

The literature suggests that the relationship between job creation and energy transition is more complex and could be affected and changed by different factors such as emerging firms, electricity demand growth projections, energy market diversification impacting technology costs (operational and capital costs), adequate labor supply with the necessary skills avoiding misalignments with demand, and availability of national and local policies addressing the changes of a decarbonized economy (Czako, 2020; ILO, 2018).

The following section discusses preliminary evidence for some of the determinants that, in theory, can affect potential job creation and hiring. Although there is a wide range of studies in industrial organizations that explore the interaction of these variables, we will focus on the information available in firm surveys in Latin America. A more detailed discussion of the methodology, data sources, and econometric analysis will be given in Section 4.

3.1 Firm Size and Potential Hiring

The relationship between company size and employment generation is a common theme for all sectors, and the energy sector is no exception. Today the energy sector comprises a wide range of actors, not only large, well-established companies such as regulated utilities and traditional engineering firms but also new independent power producers and startups of various sizes (IRENA, 2019). So, could a firm's size be a determinant for potential hiring in the energy sector?

Previous conventional studies on firm dynamics, productivity growth, and job creation in developing countries exclude many micro- and small enterprises, many of which are informal. However, the typically excluded firms may be associated with a large share of total employment in developing countries. Li, Y., & Rama, M. (2015) found that micro- and small enterprises account for a greater share of gross job creation. Their study also reveals a greater dispersion of firm productivity, a weaker correlation between firm productivity and firm size, and a smaller contribution of within-firm productivity gains to aggregate productivity growth. In addition, Dogan et al. (2017) found that smaller firms contribute to job creation. These findings pointed to new directions in the data and research efforts needed to understand the role of micro- and small enterprises and to identify policies with the potential to foster job creation and the sustainability of these jobs over time in developing countries.

The study of Malik et al. (2021) sheds some additional light on this estimator. At a global level, this study found that solar-rooftop installations, small hydro, and microgrids are likely to employ many more workers per MW than large solar utility and hydropower projects. This conclusion suggests that firm size plays a role in potential hiring practices in the energy sector. Additional evidence from ILO (2018) found that decoupling a firm's economic growth from greenhouse gas (GHG) emissions does not limit the ability of enterprises to grow and generate employment, emphasizing that the results remain largely unchanged after considering the age and size of enterprises.

3.2 Firm Technology or Activity Area

Energy transition involves different employment factors across economic activities and technologies. For instance, several studies in OECD (Organisation for Economic Co-operation and Development) countries found that the employment factors for renewable energy technologies lead to higher employment than those of fossil fuel-based technologies (Malik et al., 2021; del Río and Burguillo, 2008; Wei et al., 2010).

Employment factors in solar PV installation and manufacturing components lead to higher employment than in other renewable energies (Malik et al., 2021; Cameron and van der Zwaan, 2015). Studies also find large variations in employment factors across different technologies such as wind, geothermal and hydro (Breitschopf et al., 2012; Cameron and van der Zwaan, 2015), while the type of the activity also differs (resource extraction vs. manufacturing and services) (Wei et al., 2009). Unclear boundaries between direct and indirect jobs, including several activities in the supply chain (local, imports, and exports) and country contexts with different job components, explain the large variety of employment factors within technologies (Cameron and van der Zwaan, 2015; IRENA, 2019; Malik et al., 2021).

For instance, a key factor when estimating energy-related jobs is the supply chain costs of technology and activity. Therefore, technology differentiations are good determinants for estimating potential hiring because the more expensive variations have employment factors that tend to create more jobs (Malik et al., 2021). Despite the exponential growth of employment, it is important to highlight that the jobs created by renewable energy generation are accompanied by decreasing marginal increments due to improvements in labor productivity and lower capital costs (Wei et al., 2009).

3.3 Employee Educational Level

A decade ago, ILO (2010) presented a G20 training strategy, "A skilled workforce for strong, sustainable and balanced growth," in which it mentioned that establishing solid bridges between vocational education, training and skills development, and the world of work makes it more likely that workers will learn the "right" skills, namely those required by the evolving demands of labor markets, enterprises, and workplaces in different economic sectors and industries. Education and skills policies are more effective when well-coordinated with employment, social protection, and industrial and investment policies.

The energy transition will demand investments in traditional utilities and new small energy producers in digitalization, demand management, manufacturing components of renewable technologies, and all new infrastructures for generation, storage, transportation, and distribution. Development of these investments will require increasing inflows of new workers with specific professional skill sets and different educational levels and delivering specific workforce training for workers without such skills, who would be most directly impacted (Foster et al., 2020). Thus, the educational and qualification level of the labor force will be a key factor in potential employment outcomes for the energy transition in the next few years (Czaco, 2020; ILO, 2018, Malik et al., 2021).

In the case of the European Union, it is expected that jobs created by the transition will be filled by low- to medium-educated employees, even for the less advanced tasks (Czaco, 2020). Evidence from Czaco (2020) also suggests that higher-skilled roles are initially preferred, but demand will also increase for lower-skilled workers during the energy transition. That is the case in the renewable energy sector, where job demand is geared toward medium- and high-skilled workers in connection with technological advancements. Czaco (2020) concludes that skills mismatches will be a key factor inhibiting the green energy transition in Europe and globally.

Recent studies have highlighted educational and training gaps in the renewable energy labor supply and the fact that this phenomenon is more acute in developing countries (Lucas et al., 2018). In India, for example (ILO, 2018), the potential for employment creation is conditioned to the domestic capacity of technology manufacturing and the establishment of vocational training programs and certification schemes.

The ILO (2018) has identified skill development regulations and policies in the labor market as key elements for a successful green energy transition. Indeed, early applications of such policies in Denmark, Estonia, France, and Germany suggest the rising demand for skilled workers in different green economy sectors. As a policy recommendation, the European Union report (Czako, 2020) suggests that employers improve and adapt STEM education profiles, improve visibility and wider perception, and incentivize STEM education for both men and women, creating opportunities in the green transition to build gender equity in the male-dominated energy sector. This policy recommendation echoes actions by companies operating in the sector that has also been implementing their corporate policies (usually referred to as corporate social responsibility), adapting their businesses to government policies and even looking at improving their social and environmental engagement within the organization and society (Sighn et al., 2020; Pfajfar et al., 2022; Mbanyele et al., 2022).

3.4 Corporate Social Responsibility (CSR) Policies

Associated with business ethics, corporate social responsibility (CSR) policies are shared value mechanisms companies use to help enhance society and the environment instead of contributing negatively. CSR policies can benefit the firm's employees, the community, and the environment.

Singh & Misra (2021) separate CSR policies into three public dimensions: employees, customers, and the community. CSR policies for employees include all of the company's socially responsible activities and spending for the well-being of employees, such as health insurance, retirement plans, internal training courses and inclusive gender and diversity policies. CSR policies for customers consist of the promotion of high-quality services by the company, as well as the provision to customers of all necessary information, quick resolution of complaints, and actions to improve customer satisfaction. Finally, community-oriented CSR policies can involve giving charity to communities, improving quality of life, providing the community with financial support (for the arts, culture, education, and health), and implementing sustainability policies for environmental conservation.

Evidence of CSR as a driver of green investments and, thus, more jobs is limited, and further research is needed (Mbanyele et al., 2022; Singh & Misra, 2021). While some studies reveal that credible CSR policies may draw highly skilled employees and low-cost funding, which stimulates firms to allocate more resources towards green technologies (Freeman, 1984; Dhaliwal et al., 2012; Lins et al., 2017; and as cited in Mbanyele et al., 2022), other studies have suggested that it may not affect the firms'' green innovation they allocate CSR actions to other areas such as employee protection, philanthropy and public relations (Masulis et al., 2015; as cited in Singh & Misra, 2021). Omitted variables may bias the correlation between CSR policies and green innovation actions. For example, green innovation could reduce a firm's spending on other CSR initiatives; therefore, the correlation can also be biased by this reverse causality.

In conclusion, CSR commitments should not be treated as a mandatory determinant of a firm's good performance. However, mandatory CSR rules (issued by government bodies or regulators) can effectively alter company behavior and performance (Mbanyele et al., 2022).

Based on the literature review on how a firm's size, technology or area of activity, employee education, and corporate social responsibility policies impact the potential hiring rate of energy sector companies, the next sections introduce the methodology and data used to understand the determinants that could affect employment and potential hiring in the energy sector in upcoming years.

4. Data and Methodology

This section presents the data and methodology used to study job creation potential in electricity markets with a sample of Latin American countries. Company-level surveys conducted in six Latin American countries were the main data source for energy employment variables. The survey looks at each company's employment structure, worker profiles, the number of stated corporate social responsibility policies, new investments, and employment projections. Surveyed companies belonged to the broad spectrum of the energy sector and were classified into the following five categories:

- Renewable generators
- Non-renewable generators
- Energy service companies
- Network companies (which includes transmission and distribution)
- Oil companies
- Others, particularly including construction companies

That has made for a unique database and a useful instrument to explore potential variables explaining job creation in the energy sector. The section presents energy employment variables and their statistical description, followed by the econometric methodology and estimation procedure used to address a company's potential hiring.

4.1 Energy Employment Variables

The survey made it possible to explore the different electricity markets in greater detail. Information was collected between 2020 and 2021 from 338 companies and distributed as follows. In 2020, Bolivia, Chile, and Uruguay contributed with 26, 82 and 83 companies, respectively. In 2021, 74 companies responded to the questionnaire in Costa Rica, 42 companies responded in Mexico, and 31 companies responded in Panama. The survey instrument collected the same information on the number of employees, employees' sociodemographic data, the firm's costs and investments, and capital estimate forecasts. We used only those questionary questions that enabled us to construct the variables that, according to the literature review, could help us study job creation in the electricity sector. Table 2 below presents these variables and their descriptions. The main study variable, the potential job creation rate, measures the ratio of the total number of employees expected to to be hired for the coming year and the total number of currently employed employees. The employment survey was applied once in each of the selected countries, so this rate is not meant to be a growth rate, per se, but rather a potential creation rate according to the firm's investment outlook.

Three hundred thirty-eight (338) companies were surveyed in two different years. Nevertheless, the model adjustment was conducted with a sample of one hundred thirty-five (135) companies due to outliers and missing data. These companies' commonality is that they all declared their intentions to hire employees in the upcoming years. Table 3 shows the descriptive statistics for the main sample of companies.

Table 2. Variable Type and Description

Variable Name	Description	Type	Range
Potential Job Creation Rate	The main study variable, represented by the ratio of the total number of employees expected to be hired in the next year and the total number of employees in the current year in company i	Dependent Variable	(1, ∞+)
Employees	Total number of employees in the company i	Explanatory Variable	(0, ∞+)
Education (%)	The proportion of employees in company i with at least a technical or university education. Proxy for the skilled labor force.	Explanatory Variable	[0, 1]
Renewable Generation	Dummy variable that assumes value 1 when the company is a renewable energy generator, and 0, otherwise.	Explanatory Variable	[0, 1]
Female Labor Participation Rate	The proportion of female labor force in company i	Explanatory Variable	[0, 1]
CSR Policies	Number of corporate social responsibility policies company i said it had	Explanatory Variable	[0, ∞+)

Source: Authors' elaboration based on IDB's employment survey data.

Table 3. Descriptive Statistics

Variable	N	Mean	Std. Dev.	Min	Max
Potential Job Creation Rate		5.81	14.01	1.00	137.67
Employees	135.00	183.64	850.10	1.00	7,000.00
Education (%)	132.00	0.64	0.37	0.00	1.00
Renewable Generation	135.00	0.28	0.45	0.00	1.00
Female Labor Participation Rate	135.00	0.25	0.20	0.00	1.00
CSR Policies	135.00	1.10	0.99	0.00	5.00

Source: Authors' own elaboration based on the IDB's employment survey data.

4.2 Model and Estimation Methodology

The following multiple linear regression model is proposed to evaluate the impacts of the energy transition on the job creation potential in the post-COVID-19 economic recovery of the Latin American electricity sector. The specification was found using forward stepwise regression with the variables indicated by the literature review presented above as the initial explanatory variables.

$$Log\,(potential\ job\ creation\ rate_i) \sim b_0 + b_1\,Pol_i + b_2\,log(employees_i) + b_3\,education_i + b_4\,education_i{*}renewable_i + \varepsilon_i$$

Where $job\ creation\ potential_i$ is the ratio between the expected total number of employees in the next year and the total number of employees in the current year in company i. Pol_i is the number of corporate social responsibility policies adopted in company i. The variable $employees_i$ stands for the total number of employees in company i. $Education_i$ is the proportion of employees in company i with university or technical educational levels. The dummy variable $renewable_i$ is equal to 1 if company i adopts renewable generation technologies, or 0, if otherwise. The ε_i is the random term typically present in linear regression models.

One of the advantages and challenges of this study was counting the number of large traditional energy companies or generators and obtaining a representation of new businesses emerging from the energy transition. However, from the statistical point of view, the heterogeneity of firm sizes could bring some heteroscedasticity to the econometric analysis (Greene, 1999; Wooldridge, 2003). Therefore, besides their classification, these companies are also clustered into ten groups according to size, as measured by the number of employees (see Appendix 1 for more information on the explanatory statistical analysis and clustering exercise). Also, a check on the residuals resulting from the adjustment by ordinary least squares showed that the assumption of homoscedastic errors was not met. The logarithm of the explained variable was taken to overcome the problems arising from error heteroscedasticity. A logarithmic transformation on the number of employees variable was used to mitigate its distribution asymmetry.

The clustered standard error estimator (Wooldridge, 2003) was used because it assumed a heteroscedasticity pattern in which the error variance is a function of the number of company employees, a variable associated with the company size. One of the energy transition characteristics is the adoption of renewable generation. The renewable generation dummy variable was included to assess the energy transition's impact on employment in the electricity sector. In this case, we considered an interaction between the renewable and education variables, given that the novelty of renewable generation technologies demands qualified professionals.

5. Results and Discussion

The paper developed a multiple linear regression model to understand the characteristics of the companies that expect to have a higher hiring rate in the upcoming years. The analysis focuses on the firm's size, area of activity, employees' level of education and number of corporate social policies. Table 4 below shows the results of the econometric regression to explain the potential job creation rate in upcoming years. Three key results are important to our discussion:

1. The smaller the energy company, the larger the potential job creation rate.

2. Firms with larger skilled workforce participation, especially those in the renewable energy generation sector, will be expected to have a speedier hiring rate in the upcoming year.

3. Firms with a higher number of corporate social responsibility policies will tend to hire slower.

Table 4. . Regression Results with Clustered Standard Errors

Dependent Variable: Log(Potential Job Creation Rate)	
Log (Employees)	-0.274*** (0.053)
Education (%)	0.301* (0.168)
Education*Ren. Gen	0.618* (0.363)
CSR Policies	-0.167*** (0.040)
Intercept	1.65*** (0.251)
R2	0.413
Obs.	135

Source: Authors' elaboration based on the regression model and IDB's employment survey data.

In the upcoming year, the greater foreseen hiring rate of smaller companies in the energy sector highlights the importance of small and medium (S&M) companies for the transition. This result aligns with new energy services' intuitively increased importance and potential for new entrants in the energy transition. Moreover, it also aligns with the conclusion of Malik et al. (2021) that, globally, solar rooftop installations, small hydro and microgrids are likely to employ more people per MW than large utilities. Policies to support S&M companies in the energy sector can therefore be a good way to encourage job creation during the energy transition. It is worth mentioning that smaller companies may be younger companies, still in the growth phase, so a higher growth rate is to be expected.

Historically, large utilities and oil companies have been at the center of energy sector activity. The energy transition poses new questions about the role of new entrants, the changes the transition brings to the sector's political economy, and the best way to support S&M companies as a way to accelerate the economic benefits from this transition.

Education is another key element in characterizing companies with higher job creation expectations. The results show that companies based on more recent technologies and whose workforce has a larger participation of skilled employees expect to have a higher hiring rate. That is particularly relevant to renewable energy generators. Workforce training programs can boost the energy transition, especially in developing countries. This kind of training (skilling and re-skilling) is even more important with the increasing participation of S&M companies. In larger companies, internal training is more frequent. However, in small companies, a skilled workforce is more important. These findings agree with the evidence found by Czaco (2020) that suggests that higher-skilled roles are initially preferred, but demand will also increase for lower-skilled workers during the transition. That is the case of the renewable energy sector, where job demand is geared toward medium- and high-skilled workers in connection with technological advancements.

Moreover, more traditional, established companies with more corporate social policies expect to hire proportionately fewer people. Box 1 shows in more detail that although new energy technology companies have a lower number of corporate social policies, some already are taking actions to promote a more inclusive workplace, implementing gender equality, ethnic and disability minority inclusion, skill-based incentive, wage parity, and social security policies. That, however, highlights the importance of analyzing not only numbers but also the quality of the jobs created during the energy transition since deteriorating job quality standards can impact the political economy of the energy transition. Not having workers and workers' unions on board in the energy transition could create a barrier in upcoming years.

An important highlight is that employment for the green energy transition must be committed to gender equity and inclusion of ethnic and disabled minorities. According to Box 1, some energy transition companies, in both renewable generation and new energy service provision, are notably already aware of the importance of having corporate social responsibility policies focused on gender equity and inclusion of ethnic and disabled minorities in place for a more inclusive workplace.

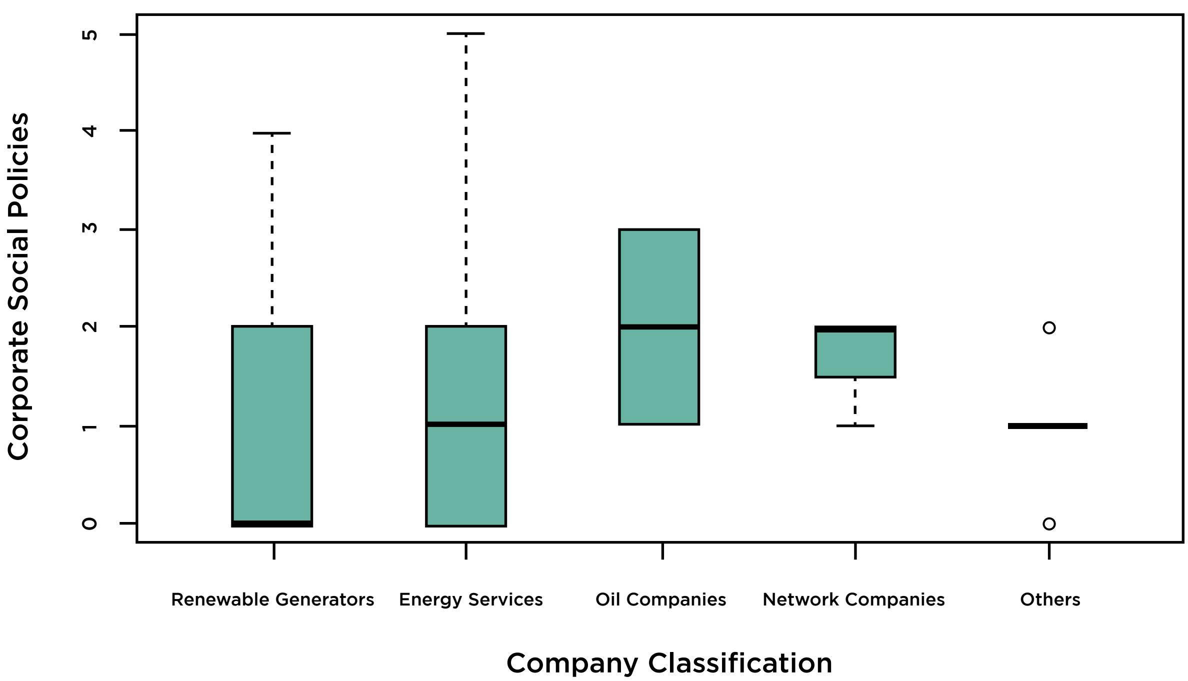
However, ARIAS et al. (2022) showed that gender gaps still exist in the Latin American energy sector and that a technology change alone does not generate qualitative changes in the labor market from a gender perspective. The percentage of women employed in science, technology, engineering, and mathematics (STEM) was lower and increased as the education level decreased. These conclusions highlight and present an opportunity for further discussion on the role of gender inequity in potential job creation rates for the Latin American energy sector since training and qualification policies focusing on the demands of the productive sector can have a positive impact on them. Finally, regarding the quality of the results, the regression's residual analysis using a chi-square test showed that the assumption of error normality is satisfied (p-value = 0.08057). Furthermore, the analysis of bootstrap confidence intervals showed that all explanatory variables are significant at the 90% confidence level. In other words, no interval covers zero at a 90% confidence level. Appendix 1 gives an exploratory statistical analysis of the residuals from the regression.

Box 1. Discussion of Corporate Social Policies

This paper's results suggest that companies with a higher expected hiring rate tend to have fewer corporate social responsibility (CSR) policies. Corporate social policies are understood to be salary, social security, health, capacitation, and gender, disabled and ethnic minority inclusion policies. However, it is important to note that better CSR policies can determine the consolidation of emerging companies in future years. A more detailed analysis of the CSR policies adopted by energy companies shows that most of the more traditional companies tend to have more corporate social policies already in place but that some new energy technology companies are obviously promoting a more inclusive workforce with social security and wage parity.

Figure 2 shows the number of corporate social policies in each type of energy company. According to Figure 2, some 50% of the renewable generators had no CSR policy, and 50% of the energy transition service companies had at least one CSR policy. However, it is important to notice that some renewable generation and new energy services companies have declared to present four or more CSR policies. With oil companies and power grid companies, 50% of the companies had at least two corporate social policies.

Figure 2. Number of Corporate Social Responsibility Policies Declared by Companies



Source: Authors´ elaboration based on employment survey data.

Box 1. Discussion of Corporate Social Policies

In contrast, **Table 5** shows that renewable generation and energy transition service companies have policies for increasing the participation of women and disabled employees in their workforce more frequently than other companies; less than 10% of the other companies implemented such policies. The most common policies adopted in renewable generation and energy transition service companies concerned salary, social security, and training. The same was declared by the oil and network companies, except that no salary policies were declared by the interviewed network companies. Inclusion policies for ethnic minorities, interestingly enough, are implemented in renewable generation, new energy services, and oil companies.

Policy	Company Category				
	Renewable Energy Generation	Energy Transition Services	Oil	Network	Others
Salary and Career Plan Policies	20.0%	30.8%	50.0%	0.0%	16.2%
Gender Equity Policies	12.0%	5.9%	0.0%	0.0%	8.1%
Social Security Policies	28.0%	32.3%	50.0%	100.0%	21.6%
Disability Inclusion Policies	4.0%	7.4%	0.0%	0.0%	0.0%
Ethnic Minorities Inclusion Policies	8.0%	10.2%	50.0%	0.0%	2.7%
Capacity building and training policies	24.0%	23.5%	50.0%	66.7%	62.0%

Source: Authors' elaboration based on IDB's employment survey data.

Conclusion

The energy transition process is expected to create new net employment gains worldwide (IRENA, 2019, ILO, 2018). Unlike in other sectors, investments in renewable energy power plants have not been impacted by the COVID-19 pandemic.

Actually, according to IEA (2020a, 2021a), clean energy power technologies presented resilient investment levels during the pandemic. National government support for energy transition policies was crucial for maintaining investments; as much as US $480 billion were expected to be spent on clean energy for 2021-2023 (IEA, 2021b). Maintenance of the investment level was extremely important for meeting electricity demand that has already rebounded to a steady upward trend, even in Latin America (Úbeda et al., 2021).

This paper details the job creation drivers and characteristics of firms that expect to hire new employees in upcoming years during the post-COVID economic recovery in Latin America. The study aims to analyze policy measures that can boost net positive economic and employment benefits and overcome the challenges of energy transition in the power industry in Latin America.

The study thus used an econometric model on cross-sectional data to explain the dependent variable of "potential job creation rate" of energy sector companies in future years in Latin America. Based on a bibliographic review and available data, the model has the following independent variables: firm size, area of activity or technology, employees' level of education, and social inclusion and social security policies.

The data were collected through firm-level surveys coordinated by the Inter-American Development Bank in six Latin American Countries: Bolivia, Chile, Costa Rica, Mexico, Panama, and Uruguay. The total sample included approximately 338 companies of different areas of activity in the power sector: generation, transmission, distribution, new energy services, oil and gas, and construction. The econometric study only considered 135 companies expecting to hire new employees. It is worth noting that the sample is not representative of these Latin American countries. Still, it gives us some evidence of the heterogeneity of the companies in this process and the variables that will impact job creation in the coming years.

The results show, for instance, that the smaller energy companies with a larger participation of skilled workforce tend to have a higher expected hiring rate in the upcoming year. That underlines the increasing importance of S&M companies in the energy transition labor market. It implies that policies supporting S&M companies in the energy sector can create jobs while accelerating the energy transition.

The model findings convey that the more skilled employees there are in the workforce, the more a company's labor force will expand. That is particularly significant in renewable generation companies. Adequate skilling and re-skilling programs can help job creation in the energy transition. Qualification, training, and education-related policies have been common in several developed countries to adapt their workforce to the energy transition.

Moreover, companies expecting to hire more are usually smaller companies with more recent technologies, mostly associated with energy transition. However, these new entrants tend to have fewer established policies. That could lead to a change in the characteristics of the energy job market. It is important to understand job quality in the transformation of companies in the energy transition. The tendency should first be considered to guarantee the quality (health, wage, and gender policies) of the jobs created. Secondly, differences in job quality can play a role in the energy transition, acting as either a barrier or an accelerator of the transition.

Although the limited number of corporate policies associated with new energy transition companies may seem a warning, it should be highlighted that this might be intrinsically related to the profile of companies with a higher expected potential job creation rate. Corporate social responsibility (CSR) policies can be less frequent for non-consolidated companies such as startups, even with higher education levels. It is not a coincidence that large, more traditional companies such as oil and power grid companies have, on average, more corporate social policies. Notably, some renewable generators and new energy services companies have four or five corporate social policies in place. In addition, those companies were the only ones with policies to increase the participation of women and disabled employees in their workforce.

Moreover, the present study seeks to provide policy recommendations for creating more inclusive jobs with good working conditions during the energy transition and post-COVID economic recovery. One of the main recommendations is to support smaller companies, energy transition service companies, and renewable power generators in incorporating more corporate social policies. Since these companies have the highest hiring potential, there should be a guarantee that new job positions will be inclusive and comply with quality work standards. In addition, it is essential to ensure that there will be qualified professionals to meet these new demands. In this respect, it is essential to reinforce qualification and training policies closely connected with the diagnoses and needs of this productive sector.

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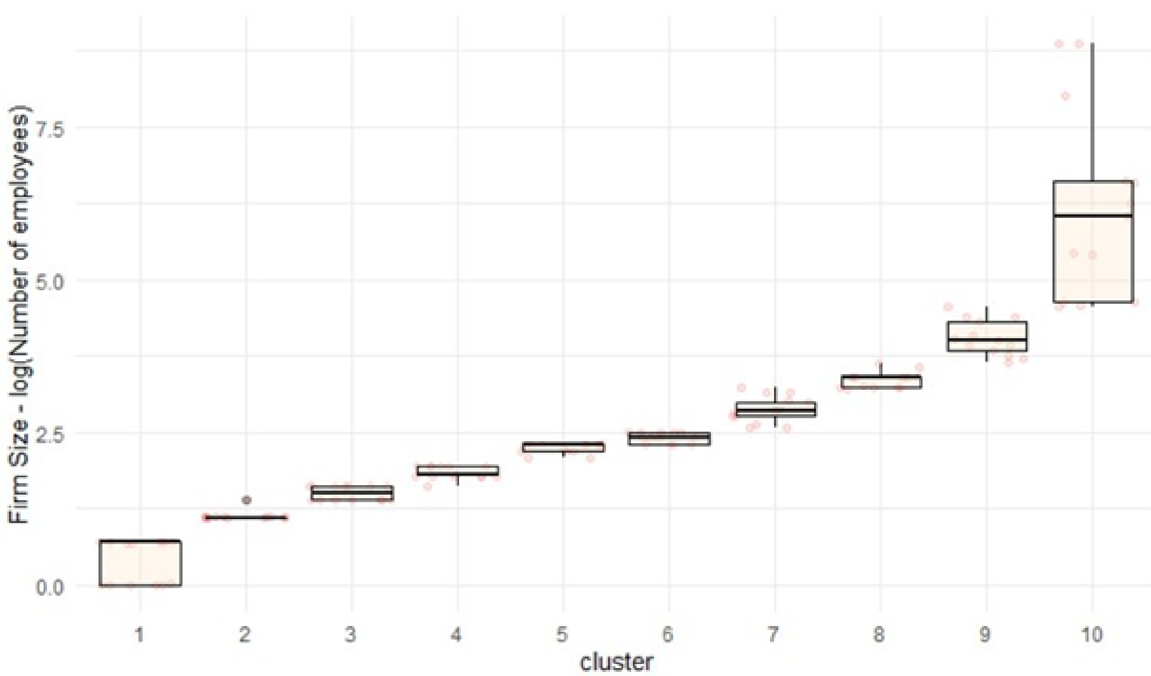
Appendix 1. Exploratory Statistical Analysis of the Error Components after the Clustering Exercise

Figure A1 shows a clustering exercise. In the graph, the vertical axis depicts firm size as the logarithm of the number of current employees, and the horizontal axis shows ten clusters that group the same number of firms as much as possible. This visualization by clusters allows us to see the great heterogeneity of the companies. While in the first decile, we have small companies with at most two employees, in the tenth decile, we have companies with between 95 and 7,000 employees. That disparity within clusters is also one of the reasons why we project the logarithm and not the absolute values of current employees. Some 80% of companies are small to medium companies (between 3 and 95 employees).

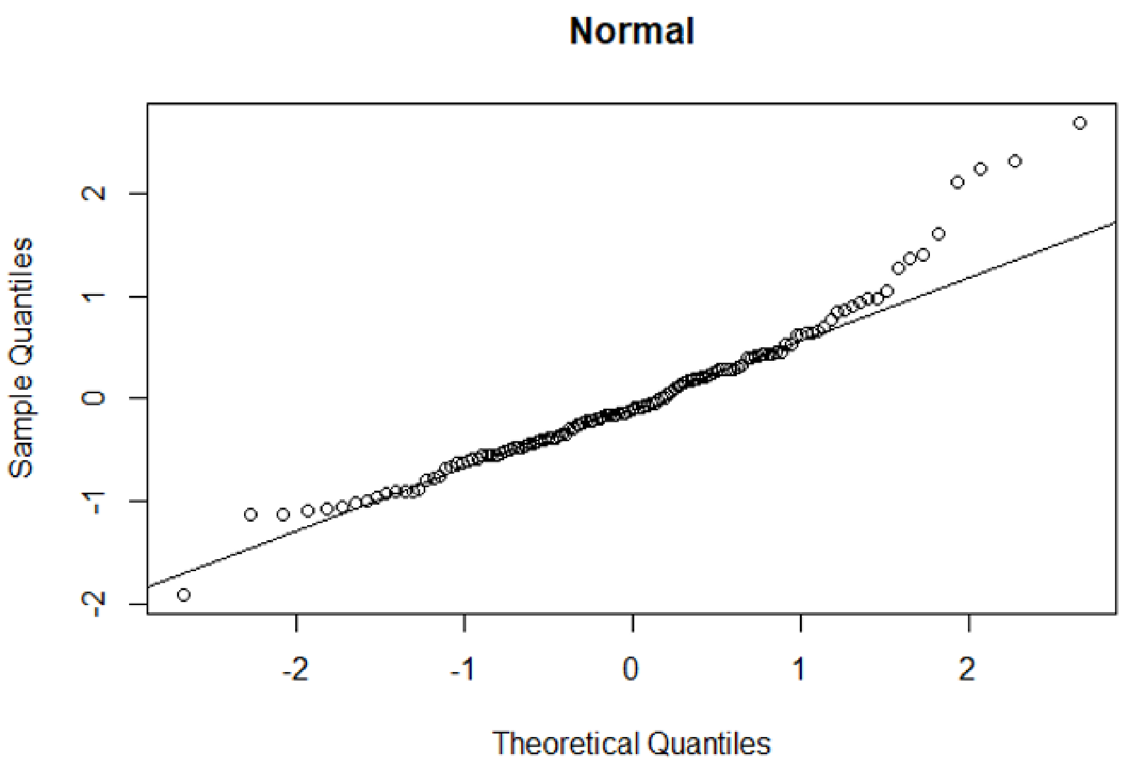
Figure A1. Firm Size by Cluster



Source: Authors' Elaboration.

Figure A2 compares theoretical error quantiles and the estimated residual quantiles. The diagonal line represents the theoretical residual's Gaussian (normal) distribution. If the residuals of a linear regression model represented in the graphic by the points lie approximately on the line, the residuals are Gaussian. Figure A2, therefore, suggests that the normality assumption for the error component of the regression model is reasonable.

Figure A2. QQ Plot of Standardized Residuals from Regression



Source: Authors' Elaboration.

Appendix 2. Robustness Check for Cross-Section Employment Data

The data used constitute a cross-sectional database of energy firms where we observed many subjects at one point or period. For this purpose, our analysis might also have no regard for time differences, and it was impossible to apply panel regression methods—fixed effects included. However, we ran a model with dummies for countries as a proxy. The results are presented below in Table A1.

Table A1. Alternative Model Results

R^2= 0.57683				
	Estimate	**Std. Error**	**t value**	**Pr (>|t|)**
(Intercept)	2.45642077	0.31653924	7.7602410	8.476813e-15
x_pol	-0.01935982	0.05463491	-0.3543488	7.230775e-01
log(trabajadores_t)	-0.24256776	0.05050587	-4.8027637	1.564905e-06
x_educacion	0.36808194	0.16766590	2.1953298	2.813995e-02
id_countryCRI	-1.20137634	0.27325223	-4.3965839	1.099679e-05
id_countryMEX	-1.50241061	0.39113095	-3.8411959	1.224363e-04
id_countryPAN	-1.11945363	0.38642789	-2.8969277	3.768366e-03
id_countryURY	-1.17885018	0.28721811	-4.1043728	4.054133e-05
x_educacion:x_gen_ren	0.10012130	0.36610741	0.2734752	7.844880e-01

Country coefficients are negative and significant, indicating that all countries tend to hire less than Chile (the reference category). The following two tables (Table A2 and Table A3) highlight the correlation of countries to the number of policies and the number of renewable generation firms. We are convinced that these correlations directed the dummy variables' sign and captured the effects of the number of policies variable and the interaction of education x_Ren .gen.

Table A2. Contingency Number of Policies (x_pol) and Country

	x_pol					
	0	**1**	**2**	**3**	**4**	**5**
CHL	19	3	0	0	0	0
CRI	15	13	9	5	0	0
MEX	5	1	3	0	0	0
PAN	0	5	3	2	2	1
URY	1	33	15	0	0	0

Chi sq. test=103.85 (p-value = 2.557e-13)

Table A3. Contingency Number of Renewable Generation Firms (x_gen_ren) and Country

	x_gen_ren	
	0	**1**
CHL	8	14
CRI	37	5
MEX	9	0
PAN	9	4
URY	33	16

Chi sq. test=22.844 (p-value = 0.000136)

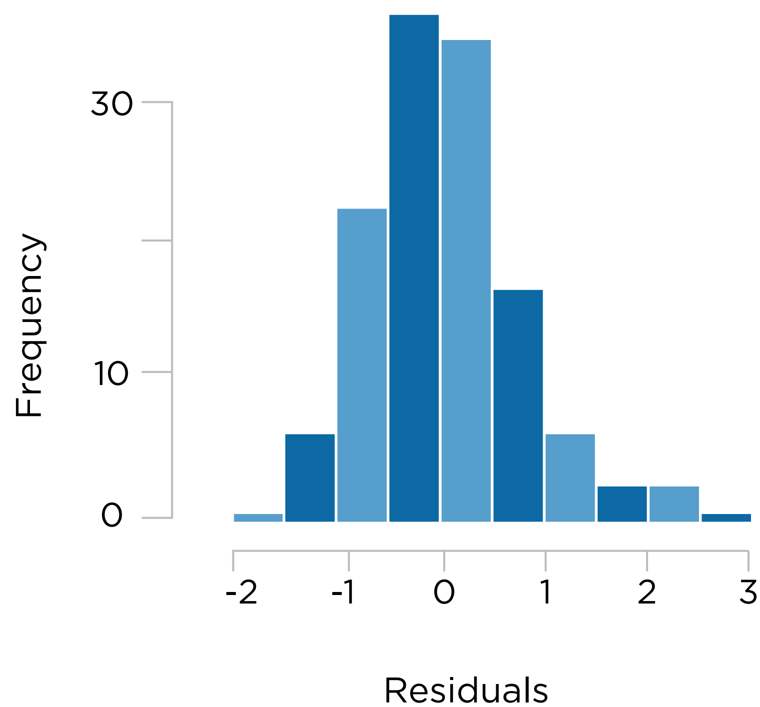
Table A4 and Figure A2 below present the model without the interaction term and its normality test (p-value 0,592).

Table A4. Alternative Model Results

R^2= 0.41103

	Estimate	Std. Error	t value	Pr (>|t|)
(Intercept)	1.4849729	0.22679004	6.547787	5.839586e-11
x_pol	-0.1628634	0.02968631	-5.486143	4.108053e-08
log(trabajadores_t)	-0.2768385	0.05446357	-5.083003	3.715130e-07
x_educacion	0.5289158	0.15293421	3.458453	5.432866e-04
x_gen_ren	0.4336245	0.20740828	2.090681	3.655669e-02

Figure A2. Residual Histograms



This alternative model has good properties, and it is worth noting that the regression coefficients are of the same order of magnitude as the regression coefficients of the proposed model in the paper. However, the model described in the article (model with interaction) has a slightly higher R2.

Next, we apply wild bootstrap to the proposed and alternative models to evaluate the robustness of the result. The estimates obtained by the wild bootstrap below corroborate the estimates presented in the work (Table A5 and Table A6).

Table A5. Wild Bootstrap Results

*Log(potential job creation rate) = b0 + b1Pol + b2log(employees) + b3education + b4education*renewable + error*

	B_hat	Standard_Error	p-value
Intercept	1.655	0.202	2.523e-16
Number of policies	-0.169	0.066	1.061e-02
log(number of employees)	-0.275	0.043	1.719e-10
Education	0.299	0.180	9.698e-02
Education * Ren.Gen	0.615	0.269	2.226e-02

Log(potential job creation rate) = b0 + b1Pol + b2log(employees) + b3education + b4renewable + error

	B_hat	Standard_Error	p-value
Intercept	1.490	0.183	3.889e-16
Number of policies	-0.163	0.063	9.673e-03
log(number of employees)	-0.277	0.042	4.246e-11
Education	0.525	0.172	2.271e-03
Education * Ren.Gen	0.432	0.164	8.435e-03

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