THE IMPACT OF GREEN SKILLS MISMATCHES ON GREEN JOB CREATION: EVIDENCE FROM NORTH MACEDONIA

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Abstract

The green transition and the adoption of new green technologies impact all workers, necessitating upskilling and reskilling to remain relevant to the changing labour market. The dynamics of the green transition is determined by many factors including the required green skills and related skills mismatches. Hence, the aim of this paper is to assess the impact of green skills mismatches on green job creation in North Macedonia. The empirical analysis is based on a survey of a representative sample of 530 companies, randomly selected from all regions, economic activities and company sizes. The green job creation is assessed by estimating fractional logit regression. Besides the standard control variables, particular attention has been paid to the underskilling, overskilling, skills deficits, skills obsolescence and horizontal skills mismatches. The results reveal that the green jobs creation is considerably limited by the presence of underskilling and skills obsolescence, while horizontal skills mismatches are emphasized as a problem that weakens the short run planning of green jobs. Accordingly, we suggest policy measures in the fields of education and business cooperation aiming to overcome skill mismatches and accelerate the green transition.

Keywords: *Green transition, green jobs, green skills, skill mismatches.*

JEL classification: *O15, J24, C51*

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1. Introduction

The current energy crisis accompanied by rapid climate changes and resources depletion have imposed a growing interest about the readiness of society to address these challenges. Achieving sustainable development with respect to the key dimensions: environmental, social and economic, represents one of the most pressing issues in developed and developing countries. A green transition, from one hand imposes strict goals with specific environmental targets, but on the other hand, opens up a wide room for adoption of environmentally friendly practices leading to new business opportunities. In addition, a green transition and the adoption of green technologies will impact all workers, necessitating upskilling and reskilling to remain competent in the labour market. As new occupations emerge and others evolve to satisfy the demands of the green transition, new skills will be required from the workers who occupy them.

In November 2020, North Macedonia together with other Western Balkan countries signed the Declaration entitled the 'Green Agenda for the Western Balkans', thus recognizing the European Green Deal and its goals for an environmentally neutral and competitive economy that will use resources efficiently (European Commission 2020). One of the important elements of this Declaration relates to the Economic and Investment Plan, designed for long-term support towards a green and sustainable economy that would bring the Western Balkan region closer to the European market. Furthermore, North Macedonia adopted the National Development Strategy (NDS) 2024-2044 that among other strategic issues, covers the areas of green transformation[1]. In this context, the ambition is to position the country as a regional leader in sustainable development and care for the environment, while implementing the transition to a low-carbon economy and ensuring growth. The fundamental primary goal of NDS is to significantly reduce greenhouse gas emissions, enhance air quality and improve energy efficiency, thereby promoting a healthier living environment for its citizens.

The green transition entails a substantial job reallocation as new jobs are created in expanding low-emission activities, others are lost in shrinking emission-intensive industries, while many others are transformed as tasks and working methods become greener (OECD 2025). In this context, the current academic debate emphasises that skills dimension of the green transition within the national and sectoral strategies is often downplayed, thus reducing their effectiveness in driving transformative change (ETF 2023). Besides the proliferation of new occupations, the greening of the economy will inevitably change the skills required and the tasks involved in many of the existing occupations. Therefore the undergoing structural changes require qualified workforce equipped with technical expertise, transversal skills and sustainability mindset.

The existing occupational structure and skill levels for developing environmental friendly economy in North Macedonia with many respects are not in line with the projected development goals (Nedanovski and Daniloska 2021). In this context, Macedonian companies are facing a number of challenges to adequately transform in order to remain competitive in the process of a green transition. Although the green skills mismatch is a highly relevant issue down the road of green transition, it has still not been a subject of rigorous scientific research. Moreover, besides acknowledging the importance of the green skills and competences, there is a need of outlining appropriate measures in order to ensure that the green transition is feasible, cost-effective and socially accepted.

Having in mind the above considerations, we attempt to address the issue of green skills as a prerequisite for creating green jobs and to fill the identified gap in the research of green skills imbalances. More precisely, the aim of this paper is to assess the impact of various types of green skills mismatches on green job creation in North Macedonia in order to provide policymakers with the empirical evidence necessary for effective decision-making. Hence, the paper is structured as follows. In Section 2 the theoretical framework related to green jobs and green skills mismatches is outlined, followed by presentation of the research methodology in Section 3. The respective empirical analysis, including descriptive statistics and econometric modelling is provided in Section 4. Finally, Section 5 conveys the main concluding remarks and formulates appropriate policy recommendations.

2. Theoretical framework

2.1. Green transition and green jobs

The green transition is a process of transforming the system of production, distribution and consumption towards a development model that ensures environmentally sustainable and a fairer society (ETF 2022). In this context, the green transition brings structural shifts in employment and required skills composition. According to CEDEFOP (2021), the shift to the new development model, will inevitably result in expansion of the so-called 'green' sectors that will gain additional employment from sustainability and adoption

of green technologies, alongside a substantial contraction of other sectors. Namely, the green transition triggers a job reallocation from sectors, companies and occupations that do not comply with the green standards to those that are in line with the new policy priorities. In addition, the green transition affects different occupations with different outcomes. Some existing occupations are expected to be highly in demand due to the greening of the economy. Other occupations are expected to undergo significant changes in task content as a consequence of the greening of the economy. Finally, new occupations are emerging from the structural changes due to the green transition (Maclean et al. 2018). The result of the rapidly increasing pace of adoption of green technologies, is a new composition of skills required for the newly created jobs. In this context, many studies emphasize potential bottlenecks and labour market frictions that may arise, particularly in the 'green' sectors (Council of the European Union 2024; Keese and Marcolin 2023). Other studies point out to the opportunities that green jobs offer, particularly to young people who can find employment or become entrepreneurs in the green sectors (Sulich and Zema 2018).

Achieving sustainable development with respect to the key dimensions: environmental, social and economic, represents one of the most pressing issues in developed and developing countries as well. Having in mind the potential negative consequences of the job reallocation engendered by the green transition, a number of authors advocate delivering a 'just transition' by involving all social partners in making the skills transition fair, particularly for the population segments most at risk of being left behind (Balata et al. 2022). Namely, we are witnessing disproportional effects of the green transition that need to be taken into account in order to avoid the risk of increasing inequalities (ILO 2022; ILO 2024). In this context, companies as generators of the economic development have to adhere to the principles of a just transition without compromising their efficiency and business performance. The success of the green transition to a great extent depends on the ability of policy makers to address the social challenges it poses and to design policies in consultation with the key stakeholders involved (Council of the European Union 2024). In the case of developing countries, the shift toward a sustainable development model is even more difficult due to the size of the informal economy, which poses a further challenge for greening because it is unregulated (ILO 2019).

The progress of the green transition can be tracked by various indicators, among which the number of created green jobs can be considered as one of the most relevant. The scope of the green jobs is complex, since they include a wide range of activities related to environmental protection. Therefore, statistical indicators used to identify and measure the number of green jobs in a given economy are often inconsistent and contradictory (ILO 2025; CEDEFOP 2018). The green jobs can be defined as jobs that reduce the environmental impact of enterprises and economic sectors, ultimately to sustainable levels (ILO 2025; Gregg et al. 2015). In addition, these jobs are assumed to meet the criteria for decent work that encompass adequate wages, safe working conditions, workers' rights, social dialogue and social protection. Generally, there are two approaches to the identification of green jobs: (i) output approach – jobs that produce goods or provide services that benefit the environment or protect natural resources; and, (ii) process approach – jobs in which workers' duties involve making their establishment's production process more environmentally friendly or use fewer natural resources (Vona et al. 2015). The green jobs can be created from scratch as new jobs, or by greening of the traditional jobs as they become less polluting or more resource efficient (ETF 2022). In this context, a comprehensive assessment of various taxonomies regarding the green jobs has been conducted by Urban et al. (2023).

Although the green jobs creation marks a continuously rising trend, there are various factors that limit its growth such as: cultural, economic, entrepreneurial, governance and organizational, social and behavioral, health-occupational etc. (Streimikis et al. 2024). In this context, the lack of necessary green skills and competences are stated as one of the main barriers to green employment (ETF 2023). Therefore, the availability of a skilled workforce, specialized training programmes and addressing labour market transitions are vital for filling green jobs.

2.2. Green skills and skills mismatches

The green skills are closely related to the green transition consisting of knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society (UNIDO 2021)[2]. A recent literature review emphasizes the increasing importance of the green skills in achieving environmental sustainability (Carminati et al. 2025). However, there has been identified an evident gap in the empirical literature related to the impact of green skills on the sustainability transition (Fuchs 2024). In addition, the scope of this term is ambiguous, since it is not clear-cut whether it should refer only to those skills explicitly related to narrow green processes or products, or whether it should embrace more general skills

that can be applied to green outcomes. In this context, some authors opt for the term 'skills for green jobs', which is the predominant paradigm that frames green skills as a set of specific skills and capacities needed to fill green jobs that drive the transition to a green economy (Kwauk and Casey 2022). This approach to identifying green skills, besides the core green skills, emphasizes the importance of more generic capacities like innovation, leadership, problem-solving, analytical thinking, communication skills and the ability to work in teams. In this context, Stroud et al. (2025) propose a macro-to-micro conceptual framework according to which, the worker's green skills at micro level can only be identified through their macro outcomes. In this context, the organizational arrangements are considered at mezzo-level as drivers in redefining the processes and job profiles and by adopting new technologies that contribute to green outcomes.

The empirical evidence shows that greening of the economy is associated with higher reliance on non-routine cognitive skills and higher dependence on formal education, work experience and particularly on-the-job training (Consoli et al. 2015). The recent studies corroborate the earlier findings in terms of existing systematic difference in the skills requirements between green and non-green jobs. Analyses based on job ads suggest that green vacancies are more skills intensive than generic job ads, leading to heterogeneous skill gaps and possible reskilling paths (Saussay et al. 2022). Some authors as a solution to this problem propose the usage of labour market intelligence that can provide real time information about the distribution of the required green skills with respect to occupation, industry, level of education, as well as the regional and time dimensions (Nikoloski et al. 2024). The empirical evidence shows that the education systems around the world are not well equipped to support the development of a broad range of green skills needed for the green transition (Sanchez and Yanez-Pagans 2024). Hence, the identified green skills gaps and hard-to-fill vacancies due to the green skills deficits can be used as signals for policy makers, particularly in the domain of education and active labour market policies. The countries' leadership across government, the corporate sector, and civil society need to initiate steps toward generic green skills not only through formal education and training but through a larger social interaction embedded in workplaces, social discourses, and political debates (Lamperti et al. 2019).

The green skills mismatch is a multidimensional phenomenon and challenging to measure since many types of mismatches can be simultaneously considered (McGuinness et al. 2017). With respect to this, the European Skills and Jobs Survey (ESJS) offers a conceptual framework for assessing the green skills mismatches by collecting information on the skill requirements and skill mismatches[3]. According to ESJS, a skill mismatch is defined as s situation where there is a discrepancy between the qualifications and skills that individuals currently possess and those needed by the labour market. It encompasses the micro aspect of the skill mismatch typically measured by comparing the skills or qualifications of an employed worker with the skills or qualifications required by his/her job. In the case where the worker possesses skills compatible with those required by the job, then the pair is a good match. Otherwise, the worker can be classified as underskilled or overskilled with reference to a specific position. Hence, the mismatch can be vertical or horizontal. A vertical mismatch is a situation in which the level of education or skills is less or more than the required level of education or skills. In contrast, the mismatch is considered as horizontal in the case in which the level of educations or skills matches job requirements, but the type of educations or skills is inappropriate for the current job (Říhová 2016).

Regarding the assessment of skills mismatches there are several approaches that can be classified in three broad categories: objective, subjective and empirical. The objective measure is obtained by systematic job evaluation used to determine the precise level of qualifications required to perform a particular job. The subjective measure is based on individual perception about the level of education required to perform a particular job. Hence, it is a self-reported estimation of potential skills mismatches either by the companies' employees or employers. Employees surveys are widely criticized because they tend to underestimate the skill mismatch compared to more objective statistical measures that compare individual skills with average skills in a given occupation. In contrast, employers and managers are likely to provide more accurate measure than employees about skills requirements (Brunello and Wruuck 2019). According to the empirical method, mismatch occurs when the level of education is more than one standard deviation above or below the mean for education within an occupation.

3. Data and methodology

The empirical analysis in this study is based on an employers' survey of a representative sample of companies in North Macedonia that was carried out in the period March/April 2025. The sample consists of 530 companies that responded to the questionnaire distributed through surveyors. The companies were randomly selected according to predefined quotas with respect to statistical regions (NUTS-3 level), economic

activities (NACE rev.2 classification) and company size (micro, small, medium and big). Hence, the representativeness of the sample has been achieved regarding these three attributes.

In the survey, we use a direct firm-based method for assessing the green jobs and associated green skills mismatches. The amount of green jobs in the company is expressed as a share of the total number of jobs. In addition, we assess the planned green job creation of the companies in the short run *i.e.* during the following 12 months, which is the amount of planned green jobs as a share of the total number of planned jobs. In this context, a job is identified as green if it involves application of one or more green practices. As possible green practices are distinguished the following: saving materials and minimising waste, using renewable sources of energy, achieving energy efficiency, selling waste to other companies, recycling by reusing the materials, producing eco-products, eco-design of products (easy for maintenance, use and repair) and other green practices.

Within the scope of the survey we pay attention to various dimensions of green skills mismatches already defined in ESJS such as: underskilling, overskilling, skill deficit, skill obsolescence and horizontal skill mismatch. This taxonomy has been adopted by many studies and applied in the skills mismatch analyses in different countries (ETF 2019). In particular, underskilling is defined as a situation in which an individual lacks the skills and abilities necessary to perform the current job adequately, while overskilling is a situation in which an individual is not able to utilize fully his or her skills and abilities in his/her current job. Furthermore, a skill deficit refers to a situation where the skills and abilities of individuals are lower than a given benchmark level of skills, while skill skills obsolescence is defined as a situation in which skills previously utilized in a job are no longer required or have diminished in importance. Last but not least, horizontal skill mismatch occurs when an individual's skills or field of education are inappropriate for the requirements of their job, even if the level of education corresponds to the position (McGuinness et al. 2017).

The questions on green skills mismatches are straightforward and are easy to interpret and analyse. In this context, the companies' managers were asked to separately answer whether the particular type of green skills mismatch poses problems for the company to implement green practices. The responses are measured on a five point Likert scale (strongly disagree, disagree, neutral, agree and strongly agree). The higher value of a certain skills mismatch dimension is associated with higher skills imbalance. Although this types of measurement are widely used in the empirical works, there remain concerns regarding the assumption of equal distances between the categories when transforming the ordinal into interval measures (Bishop and Herron 2015). In order to avoid misunderstandings with respondents regarding the interpretation of the constructs, appropriate examples of skill mismatches associated with each dimension where provided in addition to each question in the questionnaire.

Besides the green skills mismatches, we control for various company's characteristics such as: year of establishment, type of ownership, company size, presence of foreign direct investment (FDI), involvement in the global value chains through import/export, membership of an employers' association, certification related to international environmental standards and involvement in corporate social responsibility.

In Figure 1, panels a and b are presented the distributions of the shares of existing and planned green jobs, while in Table 1 are shown the corresponding descriptive statistics.

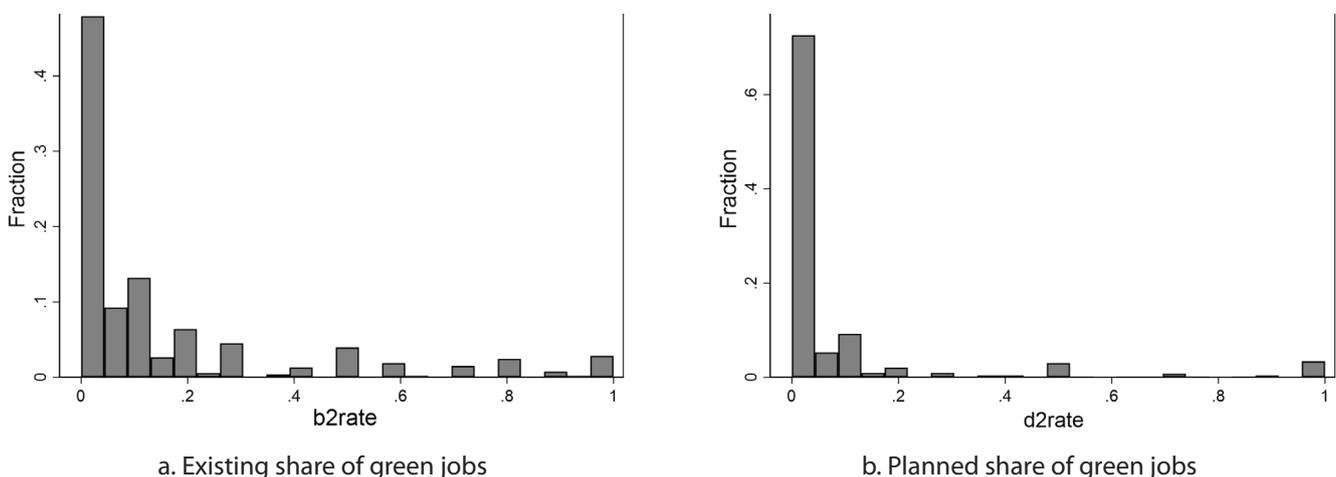**Figure 1. Distributions of the shares of green jobs**

a. Existing share of green jobs

b. Planned share of green jobs

Table 1. Descriptive statistics of existing and planned shares of green jobs

Variable	Mean	St. deviation	Skewness	Kurtosis
Existing share of green jobs	0.1591	0.2517	1.9865	6.08
Planned share of green jobs	0.0875	0.2199	3.1728	12.39

Source: Authors' calculations

Having in mind that the dependent variables are the shares of existing and planned green jobs, the possible modelling approach would take into consideration models with fractional outcomes. More precisely, we use fractional logit model, where the dependent variable is a fraction in the unit interval (between 0 and 1, inclusive). The specification of the model is provided by Papke and Wooldridge (1996) as follows:

$$E(y|\mathbf{X}) = \frac{\exp(\mathbf{X\beta} + \varepsilon)}{1 + \exp(\mathbf{X\beta} + \varepsilon)}$$

where, y is dependent variable (share of green jobs), $\mathbf{X}$ is a vector of control variables, $\mathbf{\beta}$ is the vector of coefficients to be estimated, while ε is the error term. The coefficients in this model show how and independent variable changes the log-odds, while the marginal effects (elasticities) offer clearer interpretation.

4. Empirical analysis

4.1. Descriptive analysis

According to the obtained results from the survey, about 60 percent of the companies have implemented one or more green practices, while the remaining 40 percent declare that do not have any type of green practices. The majority of the companies with green jobs, have applied just one green practice (27.2%), followed by companies with two green practices (13.2%) and three green practices (9.8%). The companies with four and five green practices represent 4.7% and 4.9% respectively of the total number of surveyed companies. Having in mind that more than two thirds of the surveyed companies have one or no implemented green practices, we can conclude that the green transition in North Macedonia has still not gained momentum. The distribution of green practices in Macedonian companies is presented in Figure 2.

According to Figure 2, among the green practices, the most common is saving materials and minimising waste (22.5%), followed by using renewable sources of energy (19.5%) and energy efficiency (17.9%). Selling waste to other companies and recycling by reusing the materials account for 15.9% and 15.8% respectively. The least represented are producing eco-products (5.2%), eco-design of products (2.4%) and other green practices (0.9%). Accordingly, the green engagement of the companies in North Macedonia is mostly a passive rather than active contribution with green products. Namely, saving materials, using
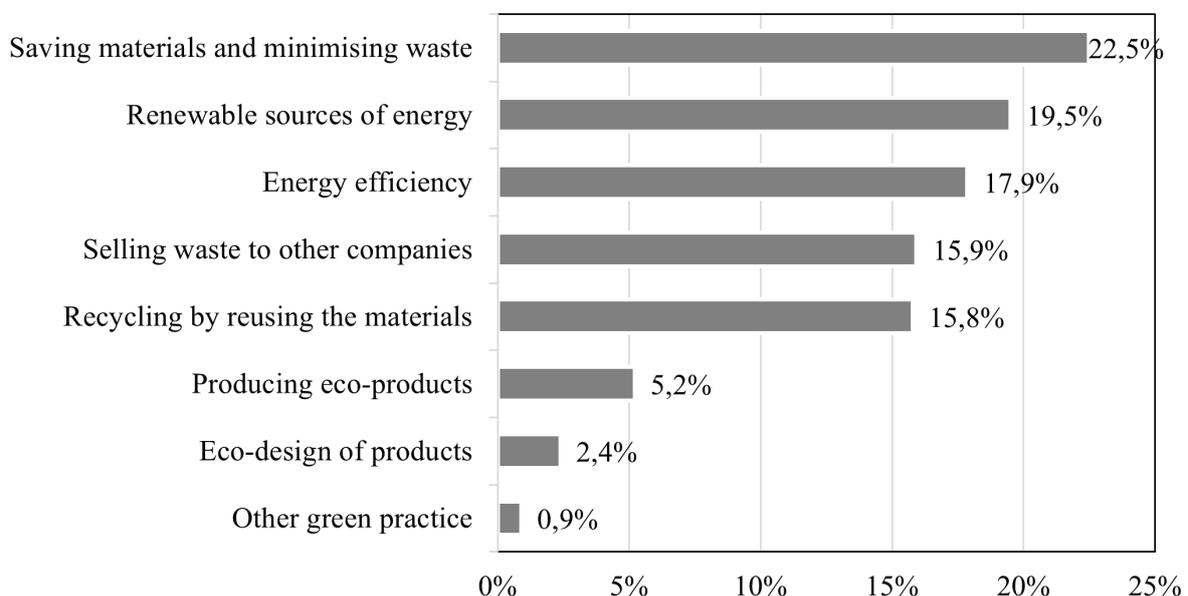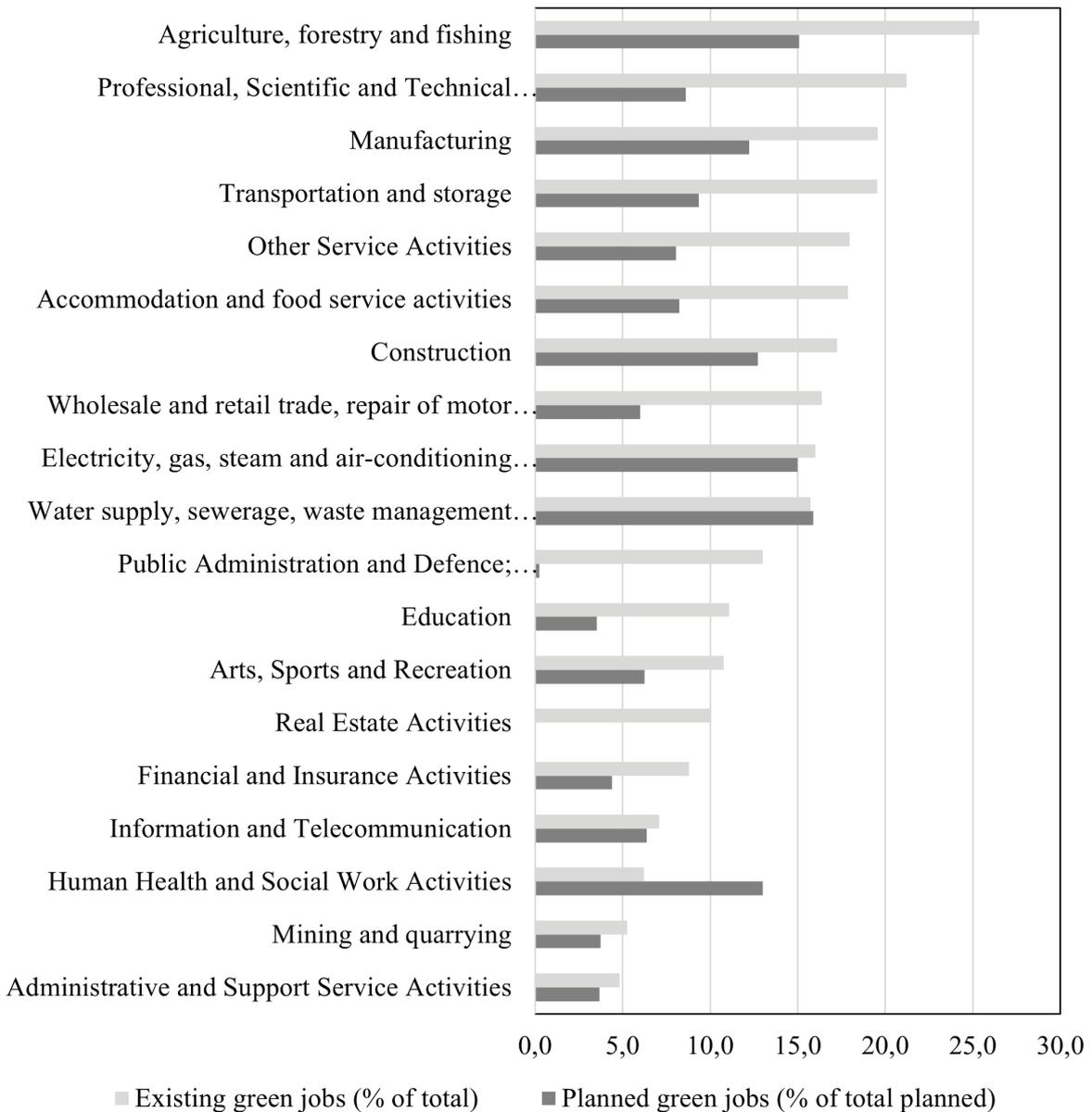
Figure 2. Distribution of the green practices

Figure 3. Percent of green jobs according to industry

Existing green jobs (% of total)   Planned green jobs (% of total planned)

renewable sources of energy, being energy efficient or applying appropriate waste management are examples of passive ways to implement green practices, which account for three quarters of the total number of applied green practices. In contrast, the recycling, producing eco-products or using eco-design that are innovative by their nature account for just one quarter of the total number of green practices. The shares of existing and planned green jobs according to industry are presented in Figure 3.

The highest percentage share of existing green jobs is observed in Agriculture, forestry and fishing (25.4%), followed by Professional, Scientific and Technical Activities (21.2%) and Other service activities (18%). The highest potential for opening new green jobs in the following 12 months have the following sectors: Water supply, sewerage, waste management and remediation (15.9%), Agriculture, forestry and fishing (15.1%) and Electricity, gas, steam and air-conditioning supply (15%). In addition, a significant number of green jobs are expected to be created in the healthcare sector, manufacturing and construction. These findings are in line with the global trends where increasing importance in the future development have jobs in the areas of renewable energy, recycling, civil engineering, urban farming etc.

We further consider the distribution of green skills mismatches along the following dimensions: underskilling, overskilling, horizontal mismatch, skills deficit and skills obsolescence. The distributions of

Figure 4. Distribution of answers for green skills mismatshes
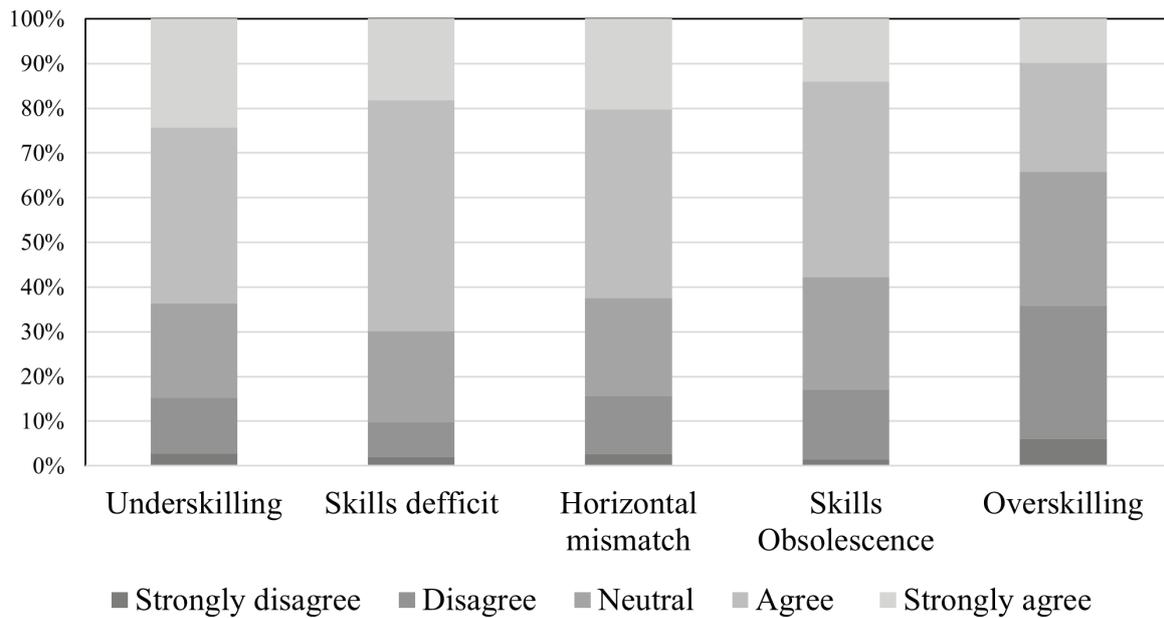
respondents' answers regarding the degree of gravity of these green skills mismatches are presented on Figure 4.

From Figure 4 we can notice that underskilling and skills deficit represent the biggest challenge for companies in providing the necessary green skills. The horizontal skills mismatch and skills obsolescence also pose significant problems, while the least important for companies' performance is the overskilling.

4.2. Econometric analysis

As elaborated in the methodological section, the factors that influence the existing and planned shares of green jobs are assessed by fractional logit regression. We estimate two different models, where dependent variables are respectively the existing share of green jobs and the planned share of green jobs in the short run as a percentage of total number of planned jobs. The explanatory variables in both models are the following:

Year – the number of years since the establishment of the company

Public – 1 if the company is in public ownership, 0 otherwise

Micro – 1 if the company is a micro enterprise (1-10 employees), 0 otherwise

FDI – 1 if the company has foreign capital (at least 10%), 0 otherwise

Import – 1 if the company imports raw materials or semi-products, 0 otherwise

Export – 1 if the company exports (fully or partly) their products

Chamber – 1 if the company is a member of an employers' association, 0 otherwise

Standard – 1 if the company is certified in environment protection standards, 0 otherwise

CSR – 1 if the company is engaged in corporate social responsibility activities 0 otherwise

Underskilling – measured on the Likert scale (from 1 lowest, to 5 highest mismatch)

Overskilling – measured on the Likert scale (from 1 lowest, to 5 highest mismatch)

Horizontal mismatch – measured on the Likert scale (from 1 lowest, to 5 highest mismatch)

Skill deficit – measured on the Likert scale (from 1 lowest, to 5 highest mismatch)

Skill obsolescence – measured on the Likert scale (from 1 lowest, to 5 highest mismatch)

The results from the estimated models are presented in Table 2. Besides presenting the estimated coefficients and associated *p*-values, we report the marginal effects of the factors as estimated semi-elasticities (percentage change in y as a result of a unit increase in x).

Table 2. Estimation results of the fractional logit regression

Variable	Existing share of green jobs		Planned share of green jobs	
	Coefficient	Margin ey/dx	Coefficient	Margin ey/dx
Year	−0.01320***	−0.01108***	−0.01802***	−0.01636***
	(0.000)	(0.000)	(0.000)	(0.000)
Public	−0.07399	−0.06208	0.07514	0.06823
	(0.700)	(0.700)	(0.797)	(0.797)
Micro	0.07118	0.05973	0.25328	0.23001
	(0.684)	(0.684)	(0.280)	(0.280)
FDI	−0.25009**	−0.20987**	0.02126	0.01931
	(0.037)	(0.037)	(0.899)	(0.899)
Import	−0.49874***	−0.41851***	−0.54929***	−0.49883***
	(0.000)	(0.000)	(0.007)	(0.007)
Export	0.55289***	0.46396***	0.36619*	0.33254*
	(0.000)	(0.000)	(0.078)	(0.078)
Chamber	−0.10121	−0.08493	0.28807	0.26159
	(0.475)	(0.475)	(0.120)	(0.120)
Standard	0.69096***	0.57982***	0.85516***	0.77659***
	(0.000)	(0.000)	(0.000)	(0.000)
CSR	0.84623***	0.71011***	1.00233***	0.91023***
	(0.000)	(0.000)	(0.003)	(0.003)
Underskilling	−0.16776***	−0.14078***	−0.14207	−0.12901
	(0.008)	(0.008)	(0.175)	(0.175)
Overskilling	0.26211***	0.21995***	0.16759**	0.15219**
	(0.000)	(0.000)	(0.028)	(0.028)
Horizontal mismatch	0.00169	0.00142	−0.11119	−0.10098
	(0.980)	(0.980)	(0.181)	(0.181)
Skill deficit	0.14436**	0.12114**	0.04659	0.04231
	(0.042)	(0.042)	(0.646)	(0.646)
Skill obsolescence	−0.37631***	−0.3157743***	−0.14127	−0.12829
	(0.000)	(0.000)	(0.104)	(0.104)
Constant	−2.18864***		−3.24279***	
	(0.000)		(0.000)	
No. observ.	530	530	530	530
Prob > chi2	0.0000	0.0000	0.0000	0.0000

Note: *, ** and *** is statistical significance at the 10%, 5% and 1%;

Source: Authors' calculations

In Table 2 the estimated coefficients and marginal effects are presented for both fractional logit models (the existing and planned shares of green jobs). The estimated coefficients and respective marginal effects are interpreted as follows. An additional year since the company's establishment is associated with 1.3 and 1.8 percent decrease in the shares of existing and planned green jobs respectively. The type of ownership and company size do not exert statistically significant effects on both the existing and planned shares of green jobs. The presence of foreign direct investment decreases the probability of the existing shares

of green jobs by about 21 percent, while it does not exert an influence on the planned share of green jobs. This finding corroborates the previous evidence that FDI exert negative impact on environmental efficiency due to their focus on short-term gains, rapid expansion, and a globally oriented supply chains that favor cost efficiency at the expense of sustainability (Uddin et al. 2024).

The involvement of a company in the global supply chains via import or export has mixed results. Companies that import raw materials or semi-products have about 42 and 50 percent lower shares of

existing and planned green jobs respectively. In contrast, the export of final products is associated with an increase of 46 and 33 percent in the shares of existing and planned green jobs respectively. The company's membership of an employers' associations does not have statistically significant impact on both the existing and planned shares of green jobs. The possession of certificates in the domain of environment protection standards is associated with substantially higher shares of existing and planned green jobs (58 and 78 percent respectively). Similarly, being socially responsible would result with an increase in both share by 71 and 91 percent respectively.

With respect to the impact of green skills mismatches we can make the following inference. The presence of underskilling and skill obsolescence have a negative impact on the existing share of green jobs, since an increase on the Likert scale by 1 point, reduces it by 14 and 32 percent respectively. In contrast, overskilling and skill deficit are associated with higher share of existing jobs, since an increase on the Likert scale by 1 point, increases it by 22 and 17 percent respectively. The horizontal skills mismatch does not exert a statistically significant impact on the existing share of green jobs. Regarding the planned share of green jobs, we only find positive impact of overskilling, where an increase on the Likert scale by 1 point causes an increase of 15 percent. The other dimensions of green skills imbalances do not cause statistically significant impact on the planned share of green jobs, which can be attributed to the uncertainty involved in planning the job creation.

The simultaneous inclusion of five mismatch indicators (underskilling, overskilling, horizontal mismatch, skill deficit, skill obsolescence) raises concerns about multicollinearity due to conceptual overlap. Hence, a post-estimation analysis is performed by calculating the variance-covariance matrix of the estimators. The results for the existing and planned shares of green jobs are presented in Table 3a and Table 3b respectively.

From Tables 3a and 3b we can notice that covariances between the different dimensions of green skills mismatch are rather small, which leads to conclusion that multicollinearity does not represent a potential problem in the estimated models. In addition, we calculate the predicted shares of green jobs at each levels of green skills mismatches. The incidence rates of existing and planned shares of green job are presented with the margin plots in Figure 5.

Table 3a. Variance-covariance matrices of the estimators for existing share of green jobs

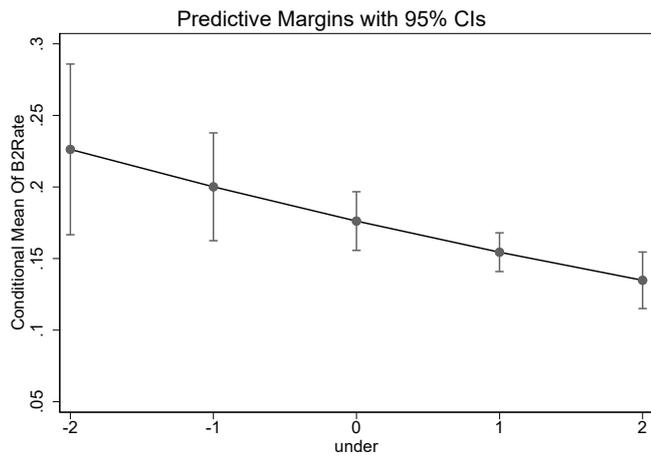|	Underskilling	Overskilling	Horizontal	Skill deficit	Skill obsol.
Underskilling	0.00399059				
Overskilling	−0.00106119	0.00299647			
Horizontal	−0.00092525	−0.00070149	0.00432179		
Skill deficit	−0.00074235	0.00004578	−0.00086161	0.005018	
Skill obsol.	−0.00036091	−0.00040429	−0.0009213	−0.00115152	0.00394166

Source: Authors' calculations

**Table 3b. Variance-covariance matrices of the estimators for planned share of green jobs**

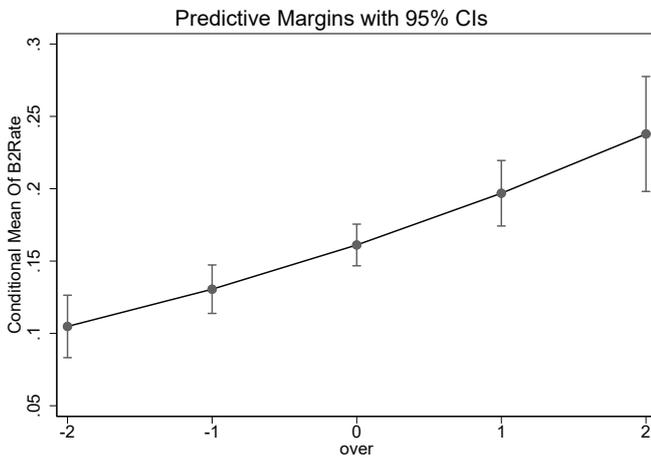|	Underskilling	Overskilling	Horizontal	Skill deficit	Skill obsol.
Underskilling	0.01095825				
Overskilling	−0.00215811	0.00578373			
Horizontal	−0.00017574	−0.00209952	0.00690915		
Skill deficit	−0.00335668	−0.00180673	0.00002054	0.01029531	
Skill obsol.	−0.00341243	0.00080508	−0.00162008	−0.00132297	0.00754276

Source: Authors' calculations

Figure 5. Margin plots for incidence rates of green jobs at different levels of skills mismatches
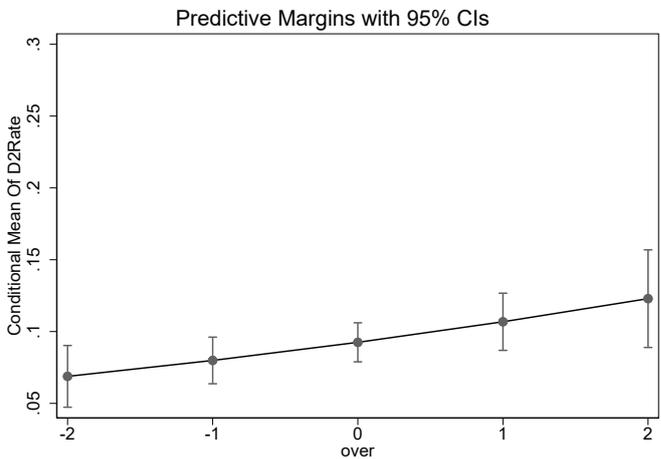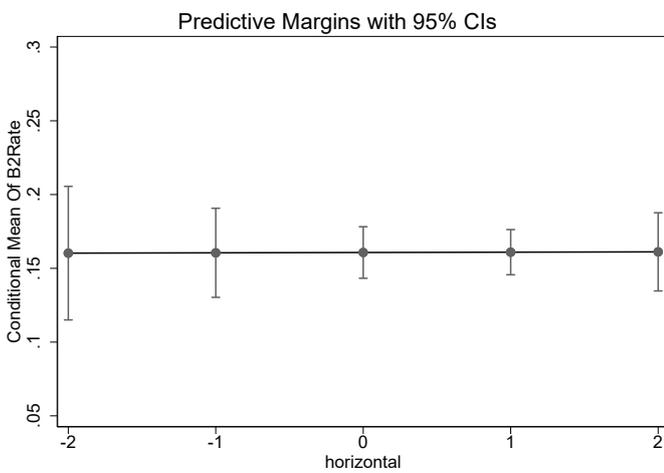
a1. Existing share, underskilling
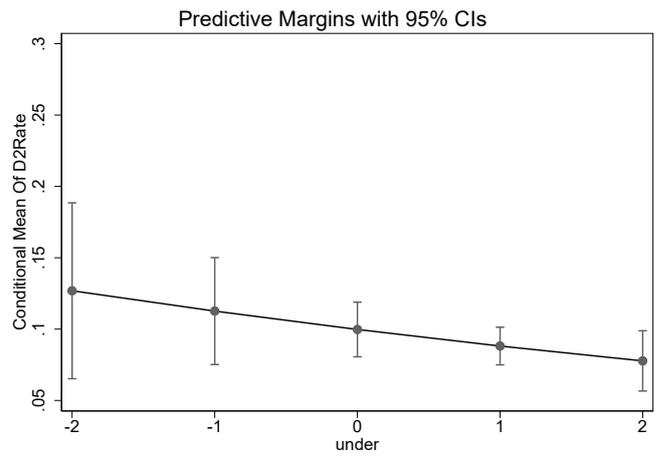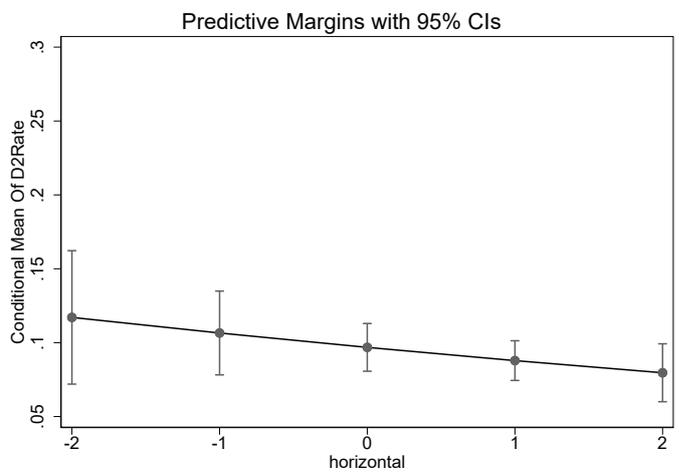
b1. Planned share, underskilling

a2. Existing share, overskilling
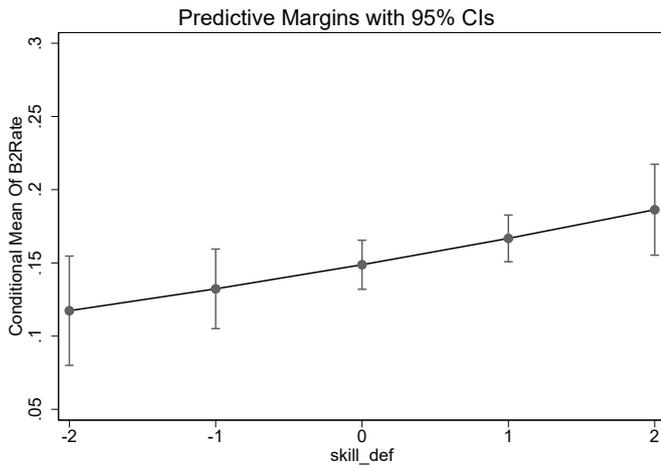
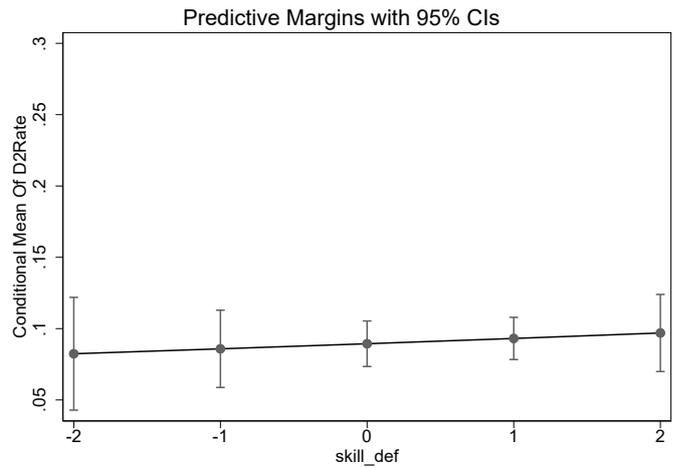b2. Planned share, overskilling

a3. Existing share, horizontal mismatch
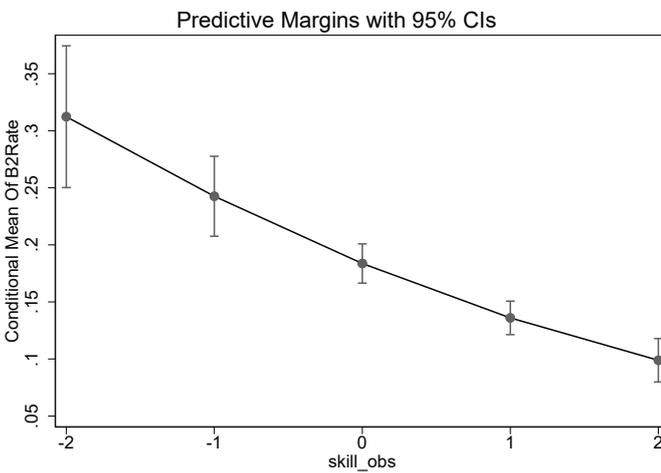
b3. Planned share, horizontal mismatch
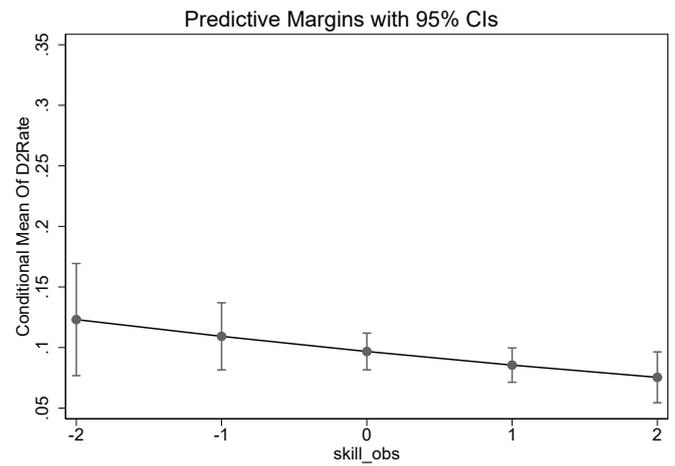
Figure 5. *Continued*

a4. Existing share, skill deficit

b4. Planned share, skill deficit

a5. Existing share, skill obsolescence

b5. Planned share, skill obsolescence

From Figure 5 it can be confirmed the negative implication of underskilling and skill obsolescence on the green job creation regarding the existing shares (panels a1 and a5) and planned shares (panels b1 and b5). Namely, both graphs show declining trends on the Likert scale as the skill mismatch increases. In contrast, the overskilling and skill deficit show positive association with the green job creation (panels a2 and a4 for the existing shares; panel b2 and b4 for the planned shares). Finally, the horizontal skill mismatch seems that does not exert an impact on the existing share of green jobs, but has moderate negative impact on the planned shares of green jobs (panel a3 for the existing shares; panel b3 for the planned shares).

In order to account for the sectoral effects of green skills mismatches on green job creation, a sector dummy variables are included for each dimension of green skills imbalance. The potential multicollinearity is avoided by replacing the aggregate skills mismatch variable with disaggregated sectoral effects. As mentioned in the methodological section, in the survey is used NACE Rev.2 classification that consists of 21 sectoral classes. However, because some sectors have small number of observations, instead of operating with 21 dummy variables, we apply a high-level aggregation into 10 categories as suggested by Eurostat (2008). The aggregated classes are presented in Table 4.

Table 4. A high-level aggregation of economic activities

No.	NACE Rev.2 sections	Description
1	A	Agriculture, forestry and fishing
2	B, C, D and E	Manufacturing, mining and quarrying and other industry
3	F	Construction
4	G, H and I	Wholesale and retail trade, transportation and storage, accommodation and food service activities
5	J	Information and communication
6	K	Financial and insurance activities
7	L	Real estate activities
8	M and N	Professional, scientific, technical, administration and support service activities
9	O, P and Q	Public administration, defence, education, human health and social work activities
10	R, S, T and U	Other services

Source: Eurostat (2008)

In addition, because in the sample there are only have 2 observations in the Real estate activates, we omit this dummy and use 9 instead of original 10 dummy variables. Accordingly, both fractional logit models (for existing and planned shares of green jobs) are estimated again and the estimated marginal effects are reported respectively in Tables 5a and 5b. In the upper panels of Tables 5a and 5b are estimated the base specifications of the fractional logit models for the existing and planned shares of green jobs, while in the lower panels are the estimated sectoral fixed effects for each dimension of green skills mismatch.

The estimated marginal effects in the upper panels of Tables 5a and 5b are close to those estimated in the base specifications (Table 2), which confirms the robustness of the estimated fractional logit models of the existing and planned shares of green jobs.

From Table 5a is noticeable that underskilling is particular problem for construction companies and other service activities, as well as for those who employ professional administrative workers. The overskilling seems to be beneficial for the job creation in manufacturing, construction, trade, IT and finance. In addition, skill deficit is a substantial problem for companies who hire professional, scientific, technical and support service workers. Similarly, these companies encounter the biggest problem of skills obsolescence followed by companies in agriculture and other service activities, while to lesser extent the skill obsolescence is a problem in finance, trade and manufacturing.

From Table 5b it can be observed that underskilling represents a potential barrier for the green job creation in finance and public administration. In addition, the overskilling exerts positive effect in manufacturing and construction companies, while it has negative effect on the planned green job creation in public administration. The horizontal mismatch is expected to encounter companies who hire professional, scientific, technical and support service workers, as well as those in the public administration, defence, education, human health and social work activities. Finally, the green skills obsolescence will negatively impact the planned green jobs in finance, public administration and other service activities. The obtained results from this analyses can be further used to formulate policy recommendations that aims at reducing the identified green skills imbalances and increasing the number of created green jobs.

Table 5a .Marginal effects on existing share of green jobs with sectoral control variables

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Year	−0.01162***	−0.01192***	−.01129***	−0.00953***	−0.01126***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Public	−0.07842	−0.05719	−0.04644	−0.09943	−0.10841
	(0.632)	(0.730)	(0.779)	(0.540)	(0.507)
Micro	0.10176	0.05243	0.08398	0.07661	0.06959
	(0.493)	(0.723)	(0.564)	(0.601)	(0.637)
FDI	−0.19890*	−0.24577**	−0.16761	−0.18063*	−0.20005*
	(0.059)	(0.018)	(0.120)	(0.071)	(0.058)
Import	−0.44328***	−0.40907***	−0.44709***	−0.47113***	−0.46118***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Export	0.42235***	0.45811***	0.45334***	0.42717***	0.48241***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Chamber	−0.12077	−0.08416	−0.10072	−0.10435	−0.11888
	(0.327)	(0.476)	(0.404)	(0.392)	(0.332)
Standard	0.63183***	0.58873***	0.61308***	0.58232***	0.59378***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CSR	0.71419***	0.75821***	0.71119***	0.72329***	0.71295***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Underskilling		−0.13559**	−0.14143***	−0.13651**	−0.11717**
		(0.014)	(0.009)	(0.010)	(0.032)
Overskilling	0.23283***		0.22523***	0.22158***	0.21041***
	(0.000)		(0.000)	(0.000)	(0.000)
Horizontal	−0.01388	−0.01261		−0.00809	−0.00779
	(0.794)	(0.823)		(0.880)	(0.889)
Skill deficit	0.12812	0.13917**	0.12872** (0.029)		0.11548*
	(0.030)	(0.023)			(0.051)
Skill obsol.	−0.31693***	−0.31435***	−0.31629***	−0.33247***	
	(0.000)	(0.000)	(0.000)	(0.000)	

	Underskilling dummies	Overskilling dummies	Horizontal dummies	Skill deficit dummies	Skill obsol. dummies
Agriculture	−0.08679	−0.12029	−0.04071	0.23259	−0.43348***
	(0.497)	(0.575)	(0.824)	(0.133)	(0.008)
Manufacturing	0.12735	0.33151***	0.14229* (0.098)	0.33828***	−0.17390*
	(0.135)	(0.000)		(0.000)	(0.100)
Construction	−0.31955**	0.20689*	−0.06418	0.05773	−0.09764
	(0.015)	(0.098)	(0.601)	(0.720)	(0.451)
Trade	−0.11404	0.30052***	0.04516	0.22809***	−0.31010***
	(0.188)	(0.001)	(0.570)	(0.005)	(0.000)
Information	−0.04996	0.55681*	0.30779	−0.00791	−0.25289
	(0.807)	(0.066)	(0.263)	(0.970)	(0.195)
Finance	−0.03723	0.70554***	−0.06501	−0.09367	−0.32073**
	(0.723)	(0.000)	(0.665)	(0.479)	(0.014)
Professional	−0.38707***	0.01786	−0.18500	−0.37569*	−0.50115***
	(0.002)	(0.887)	(0.215)	(0.063)	(0.002)
Administration	−0.18548*	0.07682	−0.04046	0.05001	−0.11475
	(0.079)	(0.581)	(0.758)	(0.713)	(0.496)
Other services	−0.29752***	0.08748	−0.13346	0.07067	−0.43847***
	(0.002)	(0.384)	(0.190)	(0.533)	(0.000)
No. observ.	530	530	530	530	530
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000

Note: *, ** and *** is statistical significance at the 10%, 5% and 1%

Source: Authors' calculations

Table 5b. Marginal effects on planned share of green jobs with sectoral control variables

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Year	−0.01349***	−0.01705***	−0.01659***	−0.01524***	−0.01432***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Public	−0.02759	0.02323	0.20861	−0.02147	0.12777
	(0.916)	(0.932)	(0.459)	(0.938)	(0.653)
Micro	0.22332	0.21437	0.27085	0.29019	0.29402
	(0.307)	(0.323)	(0.189)	(0.169)	(0.163)
FDI	0.04077	−0.01259	0.04772	0.05288	0.05158
	(0.792)	(0.936)	(0.762)	(0.719)	(0.747)
Import	−0.71086***	−0.56148***	−0.64811***	−0.59078***	−0.51094***
	(0.000)	(0.002)	(0.000)	(0.002)	(0.007)
Export	0.32143*	0.36087**	0.46665***	0.34694*	0.34285*
	(0.079)	(0.054)	(0.005)	(0.068)	(0.073)
Chamber	0.22665	0.24535	0.21648	0.24306	0.26332
	(0.194)	(0.154)	(0.216)	(0.159)	(0.147)
Standard	0.77147***	0.80436***	0.75983***	0.79676***	0.77333***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CSR	0.86061***	0.91425*** (0.003)	0.88709***	0.89579***	0.87801***
	(0.005)		(0.004)	(0.004)	(0.005)
Underskilling		−0.13866	−0.13083	−0.12654	−0.15294
		(0.150)	(0.163)	(0.177)	(0.123)
Overskilling	0.16369**		0.11852*	0.17275**	0.17156**
	(0.023)		(0.086)	(0.012)	(0.015)
Horizontal	−0.13338*	−0.13158		−0.10071	−0.11124
	(0.077)	(0.104)		(0.182)	(0.145)
Skill deficit	−0.04449	0.05342	0.02669		0.08879
	(0.640)	(0.573)	(0.784)		(0.367)
Skill obsol.	−0.15150*	−0.13341*	−0.14844*	−0.15012*	
	(0.080)	(0.099)	(0.056)	(0.067)	
	Underskilling dummies	Overskilling dummies	Horizontal dummies	Skill deficit dummies	Skill obsol. dummies
Agriculture	0.43275**	0.40376	0.27571	0.23152	−0.15753
	(0.012)	(0.169)	(0.187)	(0.169)	(0.511)
Manufacturing	0.37069***	0.36693**	0.15665	0.30905	−0.01161
	(0.008)	(0.027)	(0.326)	(0.114)	(0.953)
Construction	0.13685	0.26568*	0.25214	0.16002	−0.02921
	(0.414)	(0.099)	(0.181)	(0.491)	(0.902)
Trade	−0.23334	0.14675	0.08705	0.11786	0.04395
	(0.196)	(0.333)	(0.389)	(0.404)	(0.682)
Information	0.09914	0.77452	0.682418*	0.02263	0.22881
	(0.703)	(0.103)	(0.092)	(0.923)	(0.322)
Finance	−0.37841*	0.05434	−0.45263	0.03981	−0.50696***
	(0.099)	(0.740)	(0.187)	(0.852)	(0.002)
Professional	−0.17921	0.06967	−0.94652***	−0.02665	0.15609
	(0.380)	(0.707)	(0.005)	(0.902)	(0.510)
Administration	−1.23215***	−0.68661**	−1.28547***	0.05706	−1.18534***
	(0.000)	(0.021)	(0.000)	(0.817)	(0.000)
Other services	−0.14151	0.11767	−0.18495	−0.21531	−0.31149**
	(0.304)	(0.320)	(0.199)	(0.210)	(0.038)
No. observ.	530	530	530	530	530
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000

*Note: *, ** and *** is statistical significance at the 10%, 5% and 1%*

Source: Authors' calculations

5. Conclusion and policy recommendations

Green jobs play an increasingly important role in the transition toward sustainable and just economies. The adopted national strategic documents and ratified regional initiatives demonstrate the commitment of the Macedonian Government to the goals of the green transition. The study explores how green skills mismatches affect green job creation in North Macedonia, a country currently navigating the challenges of transitioning toward a sustainable economy. The findings suggest that the green transition in North Macedonia remains in an early stage, characterized by limited innovation and insufficient alignment between business practices and labour market skills. The results emphasize that skills mismatches, besides the lack of green technologies, are a key bottleneck in green job expansion.

According to our analysis, the majority of the existing green jobs are concentrated in the low productivity industries such as agriculture, manufacturing, transport and construction, while trend of increased job creation in the short run is expected in Water supply, sewerage, waste management and remediation, Electricity, gas, steam and air-conditioning supply; and Human Health and Social Work Activities. Most firms pursue passive environmental actions (e.g., saving materials, improving energy efficiency, using renewables) rather than active green innovations such as eco-product design or recycling-based production. In addition, various factors such as the low capacity of businesses to integrate with the current global value chains particularly via export hinder the economy to speed up the process of green transition. Furthermore, the analysis reveals that the existing level of green skills and competences of the North Macedonian workforce represents a challenge, since the green jobs creation is considerably limited, particularly by the presence of underskilling and skills obsolescence. In addition, horizontal skills mismatches are emphasized as a problem that weakens the short run planning of green jobs.

In essence, successful green job creation depends not only on environmental regulation or investment but on a workforce equipped with the right mix of technical and transversal green skills. Overcoming underskilling, preventing skills obsolescence, and fostering lifelong learning will be central to ensuring that North Macedonia's green transition is both inclusive and sustainable. In addition, the implementation of future reforms requires coordinated action among education system, labour market institutions, and the private sector to anticipate future skill needs. Future work on this subject should take into consideration multiple data sources and methods for green job assessment such as: job posting datasets, Input-Output analyses, Social Account Matrices, macroeconomic modelling etc.

According to the above results, we formulate two strands of policy recommendations, the first being with respect to education and formation of green skills, while the second group of recommendations is in the field of business cooperation and institutional support. In the context of education and skills development, the companies who need specific sectoral/occupational skills should increase their training capacities by implementing on-the-job training, training centers, academia etc. Particularly important is a fast green skills upgrade of workers in traditional sectors such as manufacturing, construction and trade. For providing the necessary workforce in specific emerging occupations new study programmes should be established in the vocational education and training and in the higher education. The most concerned with this respect are the professionals, technical occupations, administration and support service activities, public administration, defence, education, human health and social work activities. The educational reforms need to be accompanied by appropriate active labour market measures such as training for known employers in order to reskill or upskill the unemployed workers who look for jobs in the new green sectors. In order to satisfy the needs for transferable i.e. cross-sectoral green skills, we recommend reforms (greening) of the existing curricula by adding new subjects and/or implementing generic green doctrines. Again, specific active labour market measures such as training for in-demand occupations can be applied according to the Public Employment Service Survey in occupations and skills in demand.

With respect to business cooperation, the companies who need specific sectoral skills may engage with specialized sub-contractors for specific operations that require expertise or certification. Furthermore, sector skills bodies can be established in order to understand and systematically anticipate the future green skill needs of a given sector. In addition, we encourage increased commitment of companies in participating in sectoral events such as fairs, hackathons etc. that promote the emerging green technologies and bring collaborative efforts to solve problems and create innovative solutions. The companies that need cross-sectoral green skills can opt for establishing public-private partnerships, cooperation with other domestic and/or foreign companies, and cooperation

with academic/research institutions. Finally, we recommend greater corporate social responsibility engagement and environmental certification, which are empirically associated with more green jobs.

Endnotes

1   https://www.nrs.mk/

2   https://www.unido.org/stories/what-are-green-skills.

3   https://www.cedefop.europa.eu/en/projects/european-skills-and-jobs-survey-esjs

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