

Assessing the specific sectoral and cross-sectoral green skills mismatch: evidence from North Macedonia*

Abstract

The ongoing energy crisis, along with accelerating climate change and the depletion of natural resources, has increased attention on how to respond to these challenges. The shift toward a greener economy and the integration of sustainable technologies will influence all sectors, making it necessary for individuals to develop new skills and update existing ones. The empirical analysis in this article is based on a survey carried out on a representative sample of 530 companies in North Macedonia during March-April 2025. The results demonstrate the existence of substantial green skills imbalances, affecting both sector-specific and cross-sectoral competencies. In this context, certain industries exhibit particularly high imbalances, reflecting the uneven pace of the transformation and underscoring the need for targeted policy responses. The results point to a systemic misalignment between the education and training system and the evolving needs of a green economy. Accordingly, a set of policy recommendations is proposed in educational reform, alongside incentives for private investment in the adoption of green practices.

Keywords: green transition, sustainable development, labour market, just transition, North Macedonia, green skills, skills mismatch

Introduction

The ongoing energy crisis, along with accelerating climate change and the depletion of natural resources, has increased attention on just how prepared economies are to respond to these challenges (EBRD 2020; ETF 2023). In this context, an increasing number of developed and developing countries are embracing ambitious climate targets accompanied by employment and skills policies to support the green transition (OECD 2025). In November 2020 North Macedonia, together with other western Balkan countries, signed the ‘Green agenda for the western Balkans, thus recognising the European Green Deal and its goals for an environmentally neutral

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and competitive economy that uses resources efficiently (European Commission 2020). Furthermore, the recently adopted National Development Strategy (NDS) 2024-2044 of North Macedonia covers, among other strategic issues, the areas of green transformation. More specifically, the ambition of the NDS is to position the country as a regional leader in sustainable development and in care for the environment, while implementing the transition to a low-carbon economy and ensuring growth. The fundamental goal of NDS a significant reduction in greenhouse gas emissions to enhance air quality and improve energy efficiency, thereby promoting a healthier living environment for citizens while integrating a gender perspective into environmental policies and programmes.

North Macedonia is currently navigating the challenges of transitioning toward a sustainable economy, though remaining in an early stage characterised by limited innovation and insufficient alignment between business practices and workforce skills (ETF 2019). Empirical analyses emphasise that the workforce needs new skills compatible with future technological changes while skills mismatches, together with a lack of green technologies, are acting as a key bottleneck in the expansion of green jobs (Nikoloski et al. 2026). The existing occupational structure and skill levels for developing an environmentally friendly economy are, in many respects, not aligned with the country's projected development goals. Namely, the content of vocational education and training (VET) curricula shows a rather low level of integration of green skills, sustainability and environmental content, which are present in only 26% of vocational subject areas (Nedanovski and Daniloska 2022). In addition, the process of identifying the required green skills and developing green curricula needs to involve all relevant stakeholders including the Ministry of Education, chambers of commerce and the academic community (OECD 2022).

The shift toward a greener economy and the integration of sustainable technologies will influence the workforce in all sectors, making it necessary for individuals to develop new skills and update existing ones in order to stay relevant in the labour market. As economic activities become more environmentally focused, the nature of many jobs and the skills they require will change. Therefore, a key concern is ensuring that workers possess the competencies needed to face these structural transformations, often described collectively as 'green skills'. To date, there is no unanimous understanding of the notion of 'green skills', since various organisations and governmental agencies are formulating and adopting their own definitions and approaches. According to the UN definition, green skills consist of the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society (Arthur 2021). In this context, there is particular ambiguity around whether the term 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.

As new occupations emerge and others evolve to satisfy the demands of the green transition, new skills will be required of the workers who occupy them. There are a number of stakeholders, such as government, the corporate sector, civil society etc, advocating sustainable development in which green skills will play a crucial role not only in workplaces but in social discourse and political debates. In addition, there

is little systematic empirical research to guide public intervention for meeting the demand for the skills needed to operate and develop green technologies. With respect to this, the design and the implementation of effective policy measures require a clear delineation between specific sectoral green skills and more general green skills that are applicable across multiple sectors (Janta et al. 2023).

Accordingly, the aim of this article is to assess green skills imbalances in North Macedonia with respect to specific sectoral and cross-sectoral skills as a means of informing future policy interventions particularly in the domain of education reform. The article is structured as follows: the next section provides the theoretical framework for the analysis of the green transition and associated green skills imbalances, following which there is a presentation of the results of the empirical analysis and their interpretation. Finally, the article draws some conclusions and suggests several associated policy recommendations.

Theoretical background

The green transition is a process of transforming the system of production, distribution and consumption towards a development model that ensures an environmentally sustainable and a fairer society which brings structural shifts in employment and required skills composition (ETF 2022; Wilts 2022). According to CEDEFOP (2021), the shift to the new development model will inevitably result in the expansion of ‘green’ sectors that will gain employment from sustainability and the adoption of green technologies alongside a substantial contraction of other sectors. In particular, the green transition will trigger a reallocation of jobs from sectors, companies and occupations that do not comply with green standards to those that are in line with the new policy priorities.

In addition, however, the green transition affects different occupations with different outcomes. Some existing occupations are expected to be in high demand due to the greening of the economy; others are expected to undergo significant changes in task content as a consequence of the greening of the economy. Furthermore, new occupations are emerging from the structural changes due to the green transition (Vona et al. 2015; Maclean et al. 2018).

The result of the rapidly increasing pace of the adoption of green technologies is a new composition of the skills required by the newly created jobs. In this context, many studies emphasise the potential bottlenecks and labour market frictions that may arise, particularly in green sectors (Council of the European Union 2024; Keese and Marcolin 2023). Other studies point to the opportunities that green jobs offer, particularly to young people who can find employment or become entrepreneurs in green sectors (Sulich and Zema 2018).

Achieving sustainable development with respect to the key environmental, social and economic dimensions represents one of the most pressing issues in developed and developing countries alike (IOE 2023). Keeping in mind the potential negative consequences of 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 those population segments most at risk of being left behind (Balata et al. 2022). In this respect, the concern is to avoid

the disproportionate effects of the transition in order to avoid the risk of increasing inequalities (ILO 2022; ILO 2024). In this context, companies as generators of economic development have to adhere to the principles of a just transition without compromising their efficiency and business performance. Even so, the success of the transition depends, to a great extent, on the ability of policymakers 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; IOE 2023).

A recent literature review emphasises the increasing centrality of green skills in achieving environmental sustainability in the context of the green transition (ETF 2023; Carminati et al. 2025). However, the empirical literature also identifies an evident gap related to the precise impact of green skills on the sustainability of the transition (Fuchs 2024): that played by the role of countries' VET systems. In addition, the scope of the term is itself not clear-cut: whether it refers only to technical skills explicitly related to narrow green processes or products, or whether it encompasses transferable soft skills that can be applied to green outcomes. In this regard, some authors opt for alternative terms such as 'skills for green jobs' or 'skills for the green transition' that frame green skills as the set of specific skills and capacities needed to fill the green jobs that are driving the transition to a green economy (Kwauk and Casey 2022; Janta et al. 2023). This approach to identifying green skills, besides core green skills, highlights 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 a worker's green skills at micro level can only be identified through their macro outcomes. Organisational arrangements are considered at mezzo-level as drivers in redefining processes and job profiles and by the adoption of new technologies that contribute to green outcomes.

The empirical evidence shows that the greening of the economy is associated with a higher reliance on non-routine cognitive skills and a higher dependence on formal education, work experience and, in particular, on-the-job training (Consoli et al. 2015). Recent studies corroborate the earlier findings in terms of the existing systematic difference in skills requirements between green and non-green jobs. Analyses based on job advertisements suggest that green vacancies are more skills intensive than generic jobs, leading to a heterogeneity in skill gaps and in the possible reskilling paths (Saussay et al. 2022). As a solution to this problem, some authors propose the use of labour market intelligence that can provide real-time information about the distribution of required green skills with respect to occupation, industry and level of education, as well as regional and time dimensions (Nikoloski et al. 2024; CEDEFOP 2025). The empirical evidence shows that education systems around the world are not well equipped to support the development of the broad range of green skills needed for the green transition (Sanchez and Yanez-Pagans 2024). Hence, the identified green skills gaps, and the hard-to-fill vacancies which

arise due to workers' green skills deficits, can be used as signals for policymakers, particularly in the domain of education and active labour market policies. Countries' leaderships across government, the corporate sector and civil society need to initiate steps toward the establishment of generic green skills not only through formal education and training but through wider social interaction embedded in workplaces, social discourse and political debates (Lamperti et al. 2019).

Specific sectoral green skills are related to the use of green technologies or methods that improve the environmental outcomes of a particular activity. These are related to the use of green technologies or methods required to perform specific green jobs or tasks within one industrial sector. Examples of specific sectoral skills include solar panel installation or wind turbine maintenance within the renewable energy sector. In contrast, cross-sectoral green skills are necessary to carry out environmentally friendly processes and functions that are similar across multiple sectors of the economy. These amount to the green skills which are relevant to a broad range of occupations and sectors with a focus on broad sustainability principles, environmental awareness and the soft skills needed to adapt to changing environmental demands (Economist Impact 2024).

The micro-perspective rationale for an analysis of the dichotomy between specific sectoral and cross-sectoral green skills arises from differences in their transferability. Namely, specific sectoral skills are tailored to meet the demands of a particular work environment and, therefore, are less transferable. These skills are essential because they require a deep understanding of the peculiar practices and challenges of a given industry. Furthermore, developing such skills often involves a combination of formal education, on-the-job training and hands-on experience. On the other hand, cross-sectoral skills are transferable across various sectors and, generally, they are acquired during the process of formal and/or informal education and are less associated with actual experience on the job. Companies value both specific and transferable human capital but have different incentives to invest. While specific human capital is unique to a single employer or a sector, creating a strong incentive for that employer to invest, general human capital is widely applicable across many firms, making it more attractive for individual employees to invest in themselves.

The current policy debate brings to the fore the advantages and disadvantages of focusing on the green transition in terms of its sectoral or its more general aspects (Gregg et al. 2015). The sectoral approach has many benefits, such as the relative ease of stakeholder coordination and the identification of specific skills needs. However, this is not sufficient for ensuring comprehensive skills development for the green transition since not only the priority sectors, but all sectors, have the potential for greening. A cross-sectoral perspective instead allows stakeholders to identify the skills needs arising out of both direct and indirect job creation along supply chains and, in turn, to the design and implementation of training programmes for a wide range of sectors and jobs at all skill levels.

In practice, the implementation of an economy-wide approach is more complex than a sectoral approach. With respect to this, a good understanding of what is required for successful cross-sectoral coordination represents a challenging task. The high level of public acceptance of environmental sustainability goals may well have

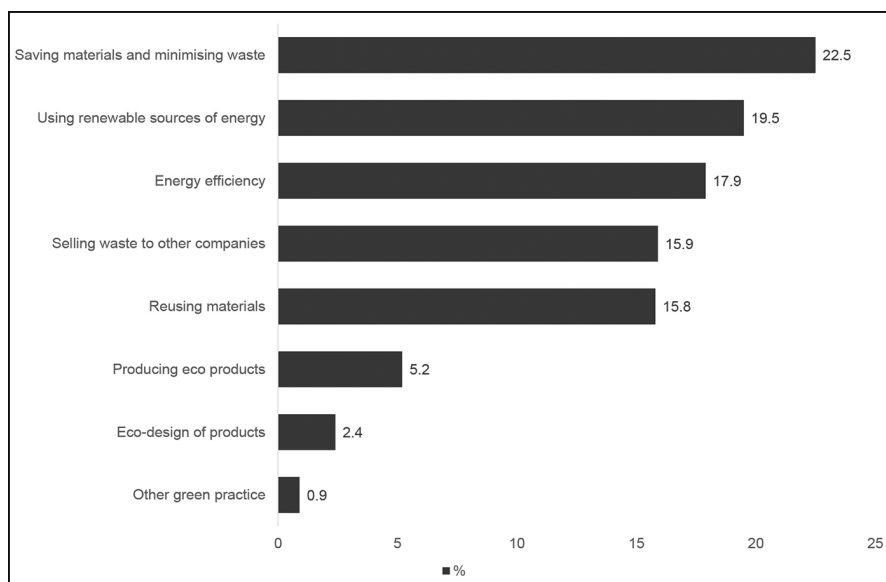
facilitated cross-sectoral coordination and consensus building with an economy-wide perspective. Thus, raising awareness of environmental issues is a powerful tool for the development of skills for the greening of the economy as a whole, not only in the priority sectors. In this context, a country's leaders, alongside its corporate sector and civil society, need to initiate steps toward a growth of generic green skills and by taking advantage of a variety of formal and informal places for this.

Empirical analysis

The empirical analysis in this study is based on a survey of a representative sample of companies in North Macedonia, carried out in March-April 2025. The sample consisted of 530 companies that responded to a questionnaire distributed via the project team. 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 large) with the aim of achieving representativity in these variables. In addition, various company characteristics were controlled for such as year of establishment, type of ownership, company size, presence of foreign direct investment (FDI), involvement in global value chains through import/export, membership of an employer association, certification related to international environmental standards, and involvement in corporate social responsibility (CSR).

Green engagement

The results identify that about 60% of companies have implemented one or more green practice with the remaining 40% declaring that they have not engaged in any such thing. The majority of companies that have engaged have done so in just one area (27.2% of all companies), followed by those with two green practices (13.2%) and then three (9.8%). Companies with four and five green practices represent 4.7% and 4.9% respectively of the total number. Bearing in mind that more than two-thirds of companies have implemented no green practices or only the one, we can conclude that the green transition in North Macedonia is still to gain momentum. The distribution of green practices is presented in Figure 1.

Figure 1 – Distribution of green practices

As Figure 1 reports, the green engagement of companies in North Macedonia is mostly a passive exercise rather than reflecting an active contribution. Namely, saving materials, using renewable sources of energy, being energy efficient or applying appropriate waste management policies are the most frequently mentioned examples, accounting for three-quarters of the total number of applied green practices, yet all are passive. In contrast, recycling materials by reusing them, producing eco products or using eco design principles, which are innovative by their nature, account for just one-quarter of the total number of green practices.

Green skills mismatches

The survey questions on green skills mismatches are straightforward and easy to interpret and analyse. Company managers were asked to answer whether the particular category of green skills (specific sectoral or cross-sectoral ones) are in accordance with the company's needs when it comes to the implementation of green practices. It can be assumed that the responses provided closely reflect the actual conditions since employers and managers are likely to have more accurate information than employees about skill requirements (Brunello and Wruuck 2019).

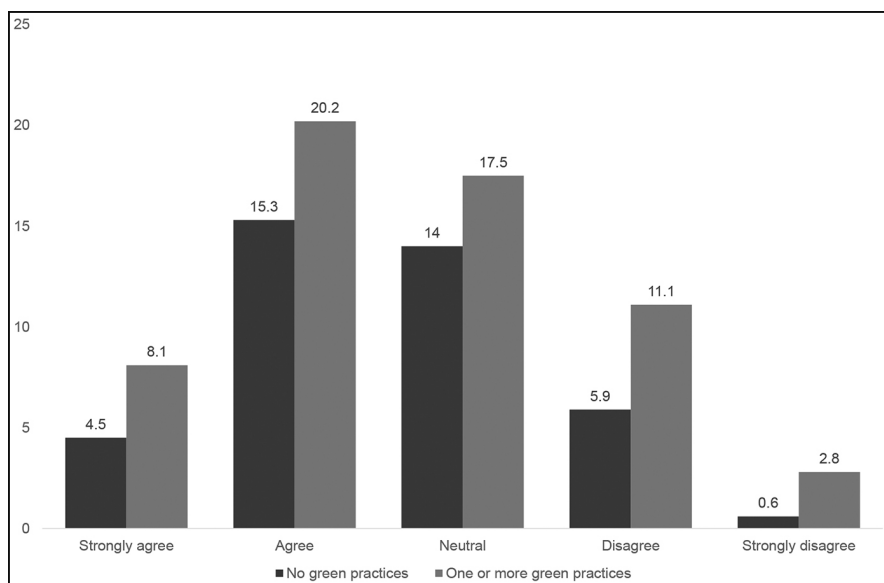
In order to avoid misunderstandings regarding the interpretation of the constructs, appropriate examples of skill mismatches associated with each dimension were provided alongside each question on the questionnaire. The responses were measured on a five-point Likert scale (strongly agree, agree, neutral, disagree and strongly disagree); hence, higher values for a particular dimension of a skills mismatch is associated with a higher skills imbalance. The distribution of responses with respect

to specific sectoral and cross-sectoral green skills mismatches are presented in Figure 2.

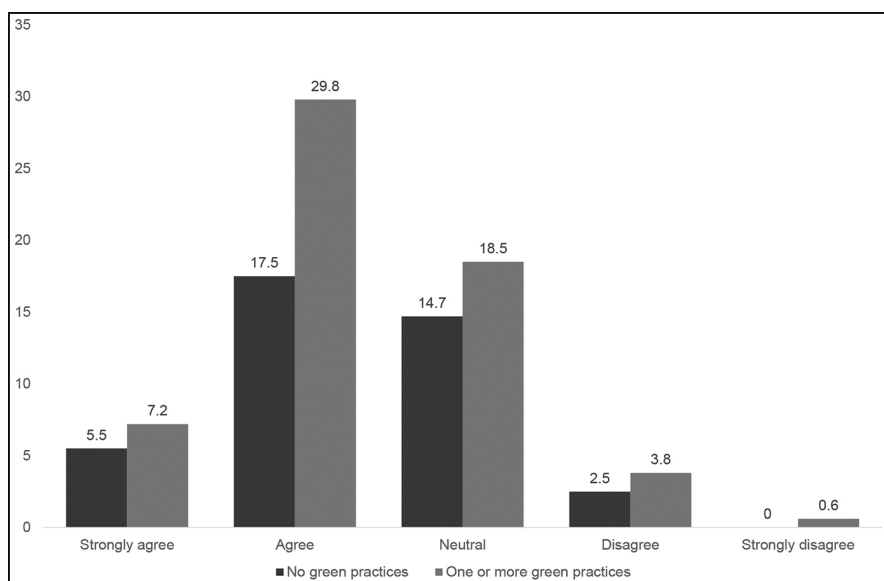
It is noticeable that the distribution of responses regarding specific sectoral green skills imbalances is more symmetric (panel a) compared to the distribution of cross-sectoral green skills imbalances, which is more skewed to the left (panel b). Hence, in the latter case, the relative share of companies with implemented green practices that agree on the question of green skills mismatches is disproportionately higher compared to the relative share of those that disagree. In contrast, regarding specific sectoral green skills imbalances, the relative share of companies that have implemented green practices which disagree is considerably higher. This means that specific sectoral green skills mismatches represent a more severe problem than cross-sectoral mismatches for those companies which have implemented at least one green practice.

Figure 2 – Distribution of responses with respect to green skills mismatches

Panel (a): specific sectoral green skills correspond to the company's needs



Panel (b): cross-sectoral green skills correspond to the company's needs



Assessing the determinants of green skills mismatches was achieved via the estimation of two ordinal logistic models in which the dependent variables are specific sectoral and cross-sectoral green skills mismatches. The dependent variable in each model specification takes values 1-5 corresponding to the five modalities of the Likert scale. Although these types of measurement are widely used in empirical work, there remain concerns regarding the assumption of equal distances between the categories when transforming the ordinal into interval measures (Bishop and Herron 2015).

The following variables were used as explanatory variables:

Year – number of years since the establishment of the company

Public – takes value 1 if the company is public; 0 otherwise

SME – takes value 1 if the company is a small or medium enterprise; 0 otherwise

FDI – takes value 1 if the company has at least 10% foreign capital; 0 otherwise

Import – takes value 1 if the company imports materials; 0 otherwise

Export – takes value 1 if the company exports products; 0 otherwise

Chamber – takes value 1 if the company is a member of a chamber of commerce; 0 otherwise

Standard – takes value 1 if the company applies international environmental standards

CSR – takes value 1 if the company identifies as socially responsible; 0 otherwise

Green practice – takes value 1 if the company declares that it applies at least one green practice

The results of the estimated coefficients and odd-ratios are presented in Table 1.

Table 1 – Ordinal logit models for green skills mismatch

Variable	Specific sectoral green skills mismatch		Cross-sectoral green skills mismatch	
	Coefficient	Odd-ratio	Coefficient	Odd-ratio
<i>Year</i>	−0.00221 (0.149)	0.99778 (0.149)	0.00578*** (0.000)	1.00580*** (0.000)
<i>Public</i>	0.32201*** (0.000)	1.37991*** (0.000)	−0.10716 (0.238)	0.89838 (0.238)
<i>SME</i>	0.02095 (0.746)	1.02117 (0.746)	−0.18943*** (0.004)	0.82743*** (0.004)
<i>FDI</i>	0.00476 (0.948)	1.00478 (0.948)	0.47136*** (0.000)	1.60217*** (0.000)
<i>Import</i>	0.14907** (0.022)	1.16076** (0.022)	−0.32134*** (0.000)	0.72517*** (0.000)
<i>Export</i>	0.07957 (0.270)	1.08228 (0.270)	−0.46728*** (0.000)	0.62670*** (0.000)
<i>Chamber</i>	0.06823 (0.200)	1.07875 (0.200)	−0.18647*** (0.001)	0.82988*** (0.001)
<i>Standard</i>	−0.17819*** (0.004)	0.83678*** (0.004)	−0.64309*** (0.000)	0.52567*** (0.000)
<i>CSR</i>	−0.51194*** (0.000)	0.59933*** (0.000)	−0.81526*** (0.000)	0.44252*** (0.000)
<i>Green practice</i>	0.31148*** (0.000)	1.36544*** (0.000)	0.47733*** (0.000)	1.61177*** (0.000)

Note: p-values in parentheses; */**/** indicate significance respectively at 10/5/1 percentage levels.

Source: authors' own calculations.

The estimated ordinal logit models provide useful information about the factors that are influencing green skill mismatches. The number of years since the establishment of the company increases the cross-sectoral mismatch, but has no effect on specific sectoral green skills mismatches. Furthermore, public companies experience

higher specific green skills mismatches, while small and medium-sized enterprises face lower cross-sectional green skills mismatches. Integration in global value chains provides mixed results: the presence of FDI increases the cross-sectoral green skills mismatch; the importing of materials has a negative impact on specific sectoral green skills mismatches but a positive impact on cross-sectoral ones; and exporting products has a positive impact only on cross-sectoral green skills mismatches. Association in chambers of commerce decreases the cross-sectoral green skills mismatch, while the certification of international environmental standards and the practising of CSR decrease both the specific sectoral and cross-sectoral green skills mismatches. Finally, companies who implement green practices have statistically significant higher levels of both specific sectoral and cross-sectoral green skills mismatches, which is particularly relevant for potential policy interventions. Namely, doing so increases the probability of being rated higher on the Likert scale by about 36.5% for specific sectoral, and 61.2% for cross-sectoral, green skills mismatches.

In order to account for the sectoral effects of green practices on skills mismatches, dummy variables were then included. Potential multicollinearity is avoided by replacing the aggregate green practice variable with disaggregated sectoral effects. Here, the survey used the NACE Rev.2 classification, which consists of 21 sectoral classes. However, some sectors have only a small number of observations so, instead of operating with 21 dummy variables, a high-level aggregation was applied into ten categories, as suggested by Eurostat (2008), and as presented in Table 2.

Table 2 – 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 communications
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)

The number of companies in the real estate sector was only 2, so this dummy was omitted with the other nine dummy variables included as follows: agriculture, manufacturing, construction, trade, information and communications (ICT), finance, professional, administration and other services. The results from the estimated ordered logit models with these sectoral dummy variables are presented in Table 3.

The estimated coefficients in the upper panel of Table 3 are similar in magnitude and statistical significance as in the initial model in Table 1, confirming the robustness of the specified ordered logistic model.

Agricultural companies with implemented green practices experience neither sectoral specific nor cross-sectoral green skills mismatches that are statistically significant. The implementation of green practices in manufacturing companies causes a 38.4% higher probability of being rated higher on the Likert scale, while it does not exert a statistically significant impact on specific sectoral imbalances. Green practices in the construction sector are associated with a 48.6% and a 78.4% higher probability of specific sectoral and cross-sectoral green skills mismatches, respectively. Companies in the trade sector and those engaged in professional services experience a higher probability of having specific sectoral than cross-sectoral green skills mismatches as a result of the implementation of green practices. In contrast, the implementation of green practices in IT companies and those operating in the financial sector exert a higher probability of cross-sectoral green skills imbalances, but not specific sectoral ones. Finally, the implementation of green practices in the administrative sector is associated with a higher probability of cross-sectoral green skills mismatches; while other services experience both types of green skills imbalances.

Table 3 – Ordinal logit models for green skills mismatch with sectoral dummy variables

Variable	Specific sectoral green skills mismatch		Cross-sectoral green skills mismatch	
	Coefficient	Odd-ratio	Coefficient	Odd-ratio
<i>Year</i>	-0.00213 (0.172)	0.99787 (0.172)	0.00615*** (0.000)	1.00617*** (0.000)
<i>Public</i>	0.37739*** (0.000)	1.45847*** (0.000)	-0.12922 (0.172)	0.87877 (0.172)
<i>SME</i>	0.02246 (0.731)	1.02272 (0.731)	-0.21035*** (0.002)	0.81029 *** (0.002)
<i>FDI</i>	-0.03334 (0.663)	0.96721 (0.663)	0.42211*** (0.000)	1.52518*** (0.000)
<i>Import</i>	0.19134*** (0.004)	1.21087*** (0.004)	-0.27892*** (0.000)	0.75659*** (0.000)

<i>Export</i>	0.09295 (0.204)	1.09741 (0.204)	-0.44261*** (0.000)	0.64236*** (0.000)
<i>Chamber</i>	0.05558 (0.303)	1.05715 (0.303)	-0.19451*** (0.000)	0.82323*** (0.000)
<i>Standard</i>	-0.19795*** (0.001)	0.82041*** (0.001)	-0.67616*** (0.000)	0.50856*** (0.000)
<i>CSR</i>	-0.51254*** (0.000)	0.59897*** (0.000)	-0.82831*** (0.000)	0.43678*** (0.000)
Green practice industry dummy variables				
<i>Agriculture</i>	-0.26393 (0.482)	0.76803 (0.482)	0.05267 (0.891)	1.05408 (0.891)
<i>Manufacturing</i>	-0.12314 (0.360)	0.88414 (0.360)	0.32504*** (0.016)	1.38409*** (0.016)
<i>Construction</i>	0.39621*** (0.001)	1.48618*** (0.001)	0.57862*** (0.000)	1.78357*** (0.000)
<i>Trade</i>	0.33632*** (0.000)	1.39978*** (0.000)	0.19779*** (0.048)	1.21871*** (0.048)
<i>Information</i>	0.79613*** (0.000)	2.21694*** (0.000)	0.90898*** (0.000)	2.48181*** (0.000)
<i>Finance</i>	0.43172** (0.013)	1.53991** (0.013)	0.59875*** (0.001)	1.81983*** (0.001)
<i>Professional</i>	0.47688*** (0.001)	1.61105*** (0.001)	0.38833*** (0.005)	1.47451*** (0.005)
<i>Administration</i>	0.20035 (0.112)	1.22182 (0.112)	0.53597*** (0.000)	1.70911*** (0.000)
<i>Other services</i>	0.38559*** (0.000)	1.47049*** (0.000)	0.59648*** (0.000)	1.81572*** (0.000)

Note: p-values in parentheses, */**/** indicate significance at 10/5/1 percent level, respectively.

Source: Authors' own calculations.

Conclusion and policy recommendations

This article provides important empirical evidence on green skills mismatches in North Macedonia, with a specific focus on the distinction between specific sectoral and cross-sectoral green skills. The findings confirm that the green transition in North Macedonia is still at an early stage. A significant share of companies are either not yet implementing green practices or are relying mainly on low-complexity passive measures such as energy efficiency and waste reduction, while more innovative and value-adding green activities, such as eco-design principles and the production of eco products, remain underdeveloped. The analysis demonstrates the existence of substantial green skills mismatches, affecting both sector-specific and cross-sectoral competencies. Importantly, companies that are already implementing green practices report higher levels of skills shortages, suggesting that demand for green skills is outpacing supply. This indicates that skills gaps are not only a barrier to the adoption of green practices but also intensify as firms move further into the green transition.

The determinants of skills mismatches differ across the two categories of skills. Cross-sectoral mismatches are more strongly influenced by factors such as firm age, foreign ownership and participation in global value chains, while sectoral mismatches are more pronounced in specific contexts such as public enterprises and certain industries. At the same time, firms that adopt international environmental standards and CSR practices experience fewer mismatches, highlighting the importance of structured and strategic approaches to sustainability. Moreover, there are significant sectoral differences, meaning that industries such as construction, ICT, finance and professional services exhibit particularly high levels of imbalance in green skills. This reflects the uneven pace of the green transition across sectors and underscores the need for targeted, sector-sensitive policy responses. Hence, the results point to a systemic misalignment between the current education and training system and the evolving needs of a green economy. In particular, the insufficient integration of green content into vocational education and training courses and is further exacerbating this gap.

Building on the identified green skills mismatches in North Macedonia, a coordinated and multi-level policy response is required in order to adhere to a new green business model. This can be achieved by greening the existing curricula on VET courses and in higher education, as well as designing new study programmes focused on renewable energy, the circular economy and sustainable production. One policy tool to increase environmental awareness is to promote work-based learning linked to green sectors into education systems at all levels, as a means of facilitating shifts in consumer behaviour towards environmentally sustainable goods and services. In this context, special attention should be given to balancing sector-specific technical skills with cross-sectoral competencies such as problem-solving, adaptability and environmental awareness. In addition, the government should expand adult learning and reskilling programmes, especially for workers in carbon-intensive or declining sectors, by encouraging firms to invest in on-the-job training, particularly in respect of emerging green technologies. This will improve workforce adaptability and reduce the risk of structural unemployment.

Furthermore, the government should actively support the adoption of green practices since the companies implementing them are facing higher skills mismatches. This can be done by providing financial incentives for firms investing in green technologies and employee training, promoting public-private partnerships for sector-specific training programmes and encouraging the adoption of international environmental standards and CSR practices, all of which are associated with lower skills gaps. Given cross-industry heterogeneity, targeted interventions should be designed for high-mismatch sectors (e.g. construction, ICT, finance, professional services) by establishing sector skills councils and promoting industry-led certification schemes for green skills. In addition, cross-sectoral green skills and awareness should be promoted by launching public awareness campaigns to encourage sustainable consumption/production and by supporting the development of soft and transferable skills that enable mobility across sectors. This helps build a resilient workforce capable of adapting to changing labour market demands.

Finally, in order to ensure a just and inclusive transition, there is a need to mitigate social risks by targeting vulnerable labour market segments such as low-skilled workers, workers in the informal sector, young people, etc. with inclusive training programmes. With respect to this, the government need to combine green transition policies with social protection and active labour market measures. In this context, 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. Attention simply must be paid to the equality of access to green skills development, including gender-sensitive approaches, so as to ensure that the benefits of the green transition are widely shared.

Hence, a successful green transition in North Macedonia requires simultaneous investment in human capital, institutional capacity and business transformation. Bridging green skills mismatches is not only a challenge for education but it is a system-wide policy priority essential to sustainable growth and competitiveness.

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