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Lost Highway: Segmented and Precarious Employment of Migrants in the Green Transition*

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Abstract

The need to achieve a safe and just ecological transition is a key target of European policy makers. Green jobs are often presented as key levers to achieve this objective, as they enable the creation of new employment opportunities across a wide spectrum of occupations, including low skill ones. In this paper we investigate if and how these opportunities are seized by one of the most vulnerable segment of the labor force, namely migrants. By relying on detailed administrative data covering more than 12 million contract activations in the Emilia-Romagna Region (Italy) we document that, after controlling for potential confounders, migrants are less likely than natives to find employment in green jobs. Moreover, when they do, they have higher chances to be hired with either a fixed-term or an agency contract. Heterogeneity analysis across industries and occupations reveals that such precarious employment patterns are driven primarily by firm attempts to reduce green costs. These results are rationalized through the lenses of institutional segmentation theory. Related policy implications are discussed.

Keywords: Green Jobs, Migrant Workers, Precarious Employment, Institutional Segmentation

JEL Codes: Q52, J24, J15, J41,

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1 Introduction

In recent years the drive for environmentally sustainable growth has become a key priority on the policy agenda, especially in Europe. Initiatives such as Europe's 2020 strategy (European Commission 2010) and the European Green Deal (European Commission 2019) demonstrate significant public commitments to fostering a sustainable and inclusive ecological transition. While relevant to address the challenges imposed by climate change, this transition is also presented as a key opportunity to generate new quality employment across a wide spectrum of occupations, covering both high-skill technical positions (Falxa-Raymond et al. 2013) and low-skilled jobs (Bozkurt & Stowell 2016). These employment opportunities are conceived as important levers to foster productions that are not only green but also "just" and inclusive (Robins et al. 2018). A low-carbon economy that integrate the principles of social equity, labor rights, and justice, ensuring that all individuals benefit equitably from the transformation (Snell 2018, Galanis et al. 2025).

This paper contributes to this policy vision by investigating if and how the opportunities generated by the ecological transition are seized by one of the most vulnerable segment of the labor force, namely migrants. A growing literature has indeed documented that migrants are often exposed to processes of occupational segmentation, which lead them to find employment in the most marginalized segments of the economy (Piore 1979). Moreover, their employment conditions are often precarious and characterized by low wages (Dustmann et al. 2010, Algan et al. 2010, McCollum & Findlay 2015, Villarreal & Tamborini 2018, Krings 2021, Koumenta et al. 2022). Under these circumstances, the greening of productions offers a unique opportunity to invert such trend and involve migrants in a strategic and growing segment of the economy. In this view, green jobs may become the hook allowing migrants to climb the economic ladders (Martinson et al. 2010). However, although desirable, this outcome is far from obvious, and green jobs may also produce the reverse effect, introducing additional layers of segmentation and marginalization, which can ultimately worsen their chances of social inclusion.

Based on these premises, this paper explores the relevance of two contrasting mechanisms shaping the green employment of migrant workers. For one thing, many green jobs happen to be characterized by a large incidence of manual and elementary tasks, which make them easily accessible by workers with fewer qualifications, such as migrants. This feature should favor their involvement in production activities that, although low skilled, are likely to play a crucial role in the future, opening highways towards employment stabilization and possibly higher wages. At the same time, however, green occupations (even low-skilled ones) often require technical knowledge and procedural expertise (Consoli et al. 2016), which may pose barriers to the participation of migrants. Moreover, for a large number of firms, the activation of green jobs follows mandatory requirements imposed by legislation (Eurobarometer 2024), which lead them to consider these activities more a cost than strategic necessities. As a result, employers have strong incentives to minimize the expenses associated with these occupations, offering low-quality and precarious employment conditions. The combination of these two factors may lead migrants to be partially excluded from the emerging green segments of the labor market, or, when they are included, to be exposed to a large use of non-standard and precarious forms of employment. Such outcomes, rather than favoring inclusion, may point in the opposite direct, fostering greater economic and social marginalization.

To evaluate which one of these two mechanisms is predominant, we carry out an extensive empirical analysis relying on data retrieved from the SILER-ARTER system, an administrative archive covering all contract activations occurred in the Emilia-Romagna region (Italy) between 2008 and 2022. For each activation we have detailed information about the contract type (e.g. open-ended, fixed-term, agency), the worker characteristics (including the nationality), the employer (i.e. fiscal code) and the full digit occupational code. The latter is used to identify green jobs following the greenness framework proposed by Vona et al. (2018). To measure the incidence of green skills across occupations, we leverage European data from the European Skills, Competences, and Occupations (ESCO) database. We perform and validate a cross-walk

between the European and the Italian classification systems enabling us to assign a green score to all 5-digits occupational codes available in the SILER-ARTER system. After data merging and cleaning, we obtain information for nearly 11 millions contract activations covering all sectors of the economy, out of which nearly one-third qualify as green jobs (i.e. jobs that have at least one essential green skill according to ESCO). The final dataset allows a detailed analysis of the association between migrant status and the type of involvement in green jobs, including an evaluation of the different mechanisms shaping such relationship.

Overall, we obtain the following results. When we perform naive regressions with a limited set of control variables, migrant status correlates positively with the probability of performing a green job, which suggests a potential dynamics fostering greater inclusion of migrants in green productions. This result, however, turns out to be entirely driven by the skill profile of the different occupations. Indeed, when we include a comprehensive set of occupation fixed effects, the association becomes negative, suggesting that a process of technical segmentation may inhibit migrant involvement in the green economy. Furthermore, when we interact migrant status with different types of employment contract we find that migrants have higher chances to be hired in green jobs through atypical contracts compared to natives. This effect is larger for green occupations characterized by a higher incidence of routine tasks and for industries with higher incidence of unionization. All things considered, these results are consistent with the use of atypical contracts as devices to contain the costs of occupations through processes of institutional segmentation (Rubery & Piasna 2017).

These results contribute to the literature in two ways. First, they provide brand new evidence about the interplay between two of the most relevant transitions affecting contemporary capitalist economies, namely the ecological and the demographic (i.e. migration-related) transitions. While both of them have received wide attention in the literature (Curtis et al. 2024, Abel & Sander 2014), few studies have analyzed their combined effect on the employment prospects of marginalized workers. We do so by leveraging rich administrative data on a region that is often considered among

the most advanced in Europe in terms of economic and social integration. Second, our study extends the available evidence on the sources of atypical employment among migrants. While previous works focused primarily on the precarious employment of migrants in marginal and secondary segments of the economy (Piore 1979, Bauder 2006, McCollum & Findlay 2015, MacKenzie & Forde 2009), we document that similar patterns exist also in core activities linked with the green economy. This evidence poses a serious challenge to policy makers dealing with the ecological transformation, signaling the need of adequate measures aimed at preventing that marginalized social groups get “lost” in the transition.

The rest of the paper is organized as follows. Section 2 sketches the conceptual framework. Section 3 presents the data and some descriptive statistics. Section 4 discusses the results and, finally, Section 5 concludes.

2 Conceptual Framework

2.1 Migrants and the Skill Profile of Green Jobs

The employment consequences of the green transition have received growing attention in the literature and stimulated vibrant policy debates. Governmental agencies around the world expect green policy packages to have strong impacts on labor markets, inducing the reallocation of workers from higher-emission productions to those that are cleaner and more sustainable (IMF 2020). The IMF (2022), for instance, estimates that such reallocation processes will involve roughly 2 percent of the global workforce in the next 30 years, with important implications for career prospects and working conditions. Similar estimates are reported in the most recent *OECD Employment Outlook*, where it is argued that net-zero policies are likely to affect more than 25 percent of existing jobs in either positive or negative ways (OECD 2024).

Based on these prospects, a number of academic studies have furthered the analysis of green employment, broadening both the conceptual frameworks and the measurement tools used to investigate its dynamics. In particular, three main approaches

have emerged (for a detailed review, see Apostel & Barslund 2024). The first one, known as the entity-driven method, classifies green employment by looking at jobs within industries or companies actively engaged in the green productions (e.g., Elliott & Lindley 2017, Horbach & Janser 2016). This includes roles in manufacturing energy-efficient appliances, solar panels, and industrial processes such as recycling, water treatment, and waste management. The second approach, called the output-driven method, defines green jobs based on the nature of the goods or services a company or organization delivers (e.g., of Commerce 2010). For instance, jobs involved in manufacturing electric or hybrid vehicles, insulation materials, or environmental monitoring systems fall under this category. Finally, a third approach, known as the occupation-based method, focuses on the bundle of tasks involved in specific occupations. On this ground, it classifies as green those jobs involving tasks that can be related, more or less directly, to environmental sustainability (Vona et al. 2018).

Although no approach is free from criticisms, each of them presents some advantages in addressing specific questions. The occupation-based method, for instance, has been sometimes considered ill-suited to evaluate the contribution of individual jobs to green outputs (Apostel & Barslund 2024). At the same time, however, it is widely valued for its potential in providing a granular portray of the occupations involved in the green transition. On this basis, it allows researchers to go beyond an isomorphism between the structure and organization of knowledge at industry or firm level, enabling a more heterogeneous mapping of the distinctive characteristics of jobs associated with ecological transformations (Consoli et al. 2016).

In particular, one aspect of the occupation-based approach that turns out to be of particular value when studying processes of labor segmentation relates to its focus on the skill profile of the professions. In fact, in their most standard formulation (Piore 1979), segmentation theories emphasize the role of skills in shaping the divide between the primary and secondary segments of the labor market (Krings 2021). It is precisely the “hierarchy” of competencies introduced by employers, it is argued, that supports the emergence of distinctive job clusters, with the most marginalized social groups,

such as migrants, having disproportionally higher chances of finding employment in jobs located at the very bottom of the hierarchy (Bauder 2006, Landini & Rinaldi 2025).

When applied to the analysis of migrants' involvement in green jobs, the conceptualization of green occupations based on their skill profiles leads to potentially contrasting predictions as far as their contribution to social inclusion is concerned.

On the one hand, as widely documented by previous studies, a significant proportion of green jobs belongs to occupational groups characterized by low-skilled requirements, such as construction and extraction, transportation, and installation maintenance and repair (Consoli et al. 2016). Examples of such low-skilled green positions include refuse and recyclable material collectors, recycling and reclamation workers, biomass plant technicians, as well as solar photovoltaic and weatherization installers (Vona et al. 2018). Although confined to the mid-lower end of the wage distributions, these professions also have the advantage of being accessible to workers with fewer qualifications while providing a prospect of sustained growth in the future (Martinson et al. 2010, Gregson et al. 2016). In this sense, they may represent important entry points for migrants with low levels of education, favoring a gradual move from peripheral to core segments of the labour markets.

On the other hand, however, several studies document that most of these green jobs are not free of specialized and technical knowledge, which can push segmentation processes in the opposite direction. Vona et al. (2018), for instance, show that a large proportion of green skills fall into the category of engineering and technical competences, encompassing the whole spectrum of the technology life cycle, including design, development, and installation. For mid- and low-skilled professions, technical skills are mainly related to installation, requiring some degrees of vocational training and technical expertise to fully master production activities. Occupations in which these skills are relevant include solar installers, roofers, technicians, and construction workers. In addition, most of these occupations often also require monitoring skills, which are essential to ensure full compliance with regulatory standards (Vona et al. 2018). The combination of these distinct layers of technical knowledge can introduce

barriers to the access of low-skilled workers, which may include migrants.

Overall, based on these potentially contrasting mechanisms, it is difficult to establish *ex ante* whether green jobs are likely to promote or obstruct social inclusion. The latter turns out to be mainly an empirical question. Moreover, along with the analysis of migrants' involvement *per se*, it is relevant to consider the conditions under which such involvement eventually occurs, especially in contractual terms. In this respect, key insights can be gained by looking at the labor segmentation theories available in the literature, which have widely discussed the drivers and effects of atypical employment among marginalized social groups.

2.2 Labour segmentation, Green Employment and Migrant Workers

The increasing segmentation of labour across a variety of contractual arrangements is a well-documented fact (Kalleberg 2011, Allmendinger et al. 2013, Keune 2013, Koch & Fritz 2013). While in most advanced capitalist economies full-time and open-ended employment remains common, in recent years the use of atypical contracts has considerably risen, fostering precarization across many segments of the workforce. The extent to which these trends also characterize emerging green employment has not yet been thoroughly investigated, which makes our analysis of greater interest.

One of the most popular approaches used in the literature to study processes of contractual segmentation is human capital theory (see Becker 1993), which links individual performance of workers to investments in skills and knowledge (Chiswick 1978). In this view, career trajectories are mainly shaped by individual productivity, with education being the main factor driving the sorting of workers between core, usually permanent and well paid, positions and peripheral, mainly temporary and low paid, occupations (Atkinson 1984, Kalleberg 2001, Arrighetti et al. 2022). When used to interpret the contractual arrangements of green jobs, this theory predicts that such arrangements will depend on the position of these occupations within the labour market. Those green jobs that are perceived as drivers of firm competitiveness are likely to be considered core occupations and, as a result, have high chances to be of-

ferred a permanent contract. On the contrary, green occupations that contribute little to firm performance, such as those introduced primarily to comply with external regulations, are instead likely to be considered peripheral and therefore subject to less secure contractual arrangements, including temporary ones.

Although widely influential, human capital theory has been widely criticized for a number of reasons (Portes 1995, Krings 2021). One that is particularly relevant for our discussion is that it reduces the social processes shaping the elaboration of employment contracts to only one dimension, namely the availability (or lack thereof) of the competence necessary to perform certain work activities (Landini & Rinaldi 2025). Other, equally important, social dimensions tend to play nearly no role in the theory. For example, following this approach, one should expect the status of being a migrant as opposed to a native worker to exert no direct influence on the type of contract being offered in the hiring process, and this effect should hold across education levels and occupations, including those characterized by some positive green content.

An approach that can partially mitigate this weakness, while maintaining a similar focus on worker characteristics, is the one commonly associated with the so-called screening hypothesis. According to this view, while individual skills and knowledge remain of great importance in shaping employment dynamics, their assessment by firms can be costly. Oftentimes, workers need to have skills that are difficult to evaluate *ex ante*, especially for positions that are relatively novel to firms, such as those involved in the green transition. In these cases, employers can decide to reduce screening costs by relying on temporary contracts, which allow an assessment of individual skills before transiting into a permanent position (Baranowska et al. 2011, Faccini 2014, Portugal & Varejao 2010).

The implications of this argument for the contractualization of workers involved in green jobs are straightforward. Rather than being driven uniquely by the worker's availability of specific skills, the nature of the contract depends on the costs faced by firms in evaluating such skills. Whenever these costs are low, because the required knowledge is easy to assess *ex ante*, the incentive to use open-ended contracts rises,

especially for jobs that are considered strategic for the firms. On the contrary, in all those cases in which screening costs are high (i.e., the prior assessment of the required knowledge is difficult), the chances of using a temporary contract increase. Interestingly, the factors affecting the size of screening costs are not only technical (as in many green jobs, see above) but also social. For example, there is some evidence that employers may view the skills acquired by migrants through formal training or education as inferior to those of natives (Chiswick 1978), due to mistrust or uncertainty regarding the acquisition of country-specific skills, such as language proficiency and cultural knowledge (Brekke & Mastekaasa 2008). In all these cases migrants can be more exposed than natives to the use of temporary employment, even for green (and other) jobs with equivalent skill profiles.

Finally, alongside asymmetries related to the evaluation of individual skills, the greater exposition of migrant workers to atypical green employment could also be the result of their weaker bargaining position compared to natives. Indeed, one stream of research within the segmentation literature, known as institutional segmentation theory, argues that in many contexts segmentation processes occur through factors operating on both the demand and supply sides of the labor market (Marsden 1999, Rubery 1978, 2007, Wilkinson 1981). When the workforce is divided and socially stratified, employers can more easily exploit vulnerable groups, such as migrants, as a source of flexible and low-paid labor, ultimately containing labor costs (Landini & Rinaldi 2025). These processes are most likely to occur when labor market institutions introduce divides between highly protected incumbent workers and less organized new entrants, which oftentimes lead migrants to be considered one of the most convenient sources of external flexibility by firms.

When applied to the case of green employment, this theoretical approach suggests the existence of an alternative mechanism driving the precarious employment of migrant workers in green jobs through the combinations of two channels. First, as argued above, for many firms the recruitment of green occupations is often the consequence of external regulations, requesting the compliance with specific environmental stan-

dards. As a result, employers are inclined to consider these occupations more as an externally imposed cost than as strategic assets, favoring their recruitment through contracts allowing a reduction of the wage bill, such as atypical ones. Second, in many contexts, migrants represent one of the most easily accessible forms of weakly organized and cheap labor, especially when they co-exist alongside highly protected and well-paid native workers (e.g., in highly unionized sectors). It follows that employers may have a strong incentive to hire migrant workers for new green positions primarily through atypical contracts, at a rate that is comparatively larger than the one of natives.

Overall, the combination of these different theoretical approaches allow us to derive a set of alternative predictions concerning the incidence and quality of migrant involvement in green occupations. In the next sections we bring these predictions to the data by relying on a detailed set of administrative data.

3 Data and Descriptives

3.1 Data Sources

Our analysis relies on two main data sources. The first consists of administrative labor market data (so-called “comunicazioni obbligatorie”) collected by Italian regional governments, which correspond to first-level administrative entities at the NUTS 2 level. In Italy, regional offices are mandated to maintain a digital platform where private sector employers must report key information about their company, employees, and contract details whenever a contract change occurs. Such changes include hiring, dismissals, resignations, contract extensions, contract conversions, and significant modifications in contractual terms. In the Emilia-Romagna region, this digital platform is known as the SILER system (Sistema Informativo Lavoro — Emilia-Romagna). The dataset generated by this system encompasses all employment events involving contract changes in the private sector (excluding agricultural) from January 2008 to December 2022. In our analysis, we focus on contract activations, which amount to a total

of nearly 12 million contracts. Each record contains comprehensive details, including contract type, start and end dates, actual days worked, the occupational classification of the employee (using 6-digit CP codes), personal details such as gender, nationality, educational background, and the employer's identifier.¹

The second data source consists of the European Multilingual Classification of Skills, Competences, and Occupations (hereafter ESCO), which was launched in 2017 by the Directorate General Employment, Social Affairs and Inclusion (DG EMPL) of the European Commission. Being used as a tool to inform evidence-based skill and education policy at the EU level, ESCO works as a dictionary for the skill-based classification of occupations across Europe. It provides an extensive description of more than 3,000 occupations, defined as “a set of jobs whose main task and duties are characterized by high degree of similarity”, divided into multiple non-hierarchical levels from 5 to 8-digits (ESCO 2019). For each occupation, ESCO outlines a set of relevant skills, which are defined as “the ability to apply knowledge and know-how to complete tasks and solve problems” (ESCO 2019) in that specific profession.² Given its coverage of a wide range of occupations across the diverse and complex European landscape, ESCO acknowledges that some of the same occupation can slightly differ in terms of skill content depending on the regional/country context. For this reason ESCO distinguishes skills into two categories: essential skills, i.e., those that are typically relevant to an occupation, regardless of the work context, employer, or country; optional skills, which instead may vary depending on the context (ESCO 2019).

3.2 Identification of Green Jobs

By combining SILER and ESCO data, we identify green jobs within regional administrative labor market data through a novel approach that consists of three steps. First, we identify the green content of occupations building on Landini et al. (2025), which

¹For further information about the SILER system see Arrighetti et al. (2021).

²A related concept is that of competence which is defined as the “proven ability to use the specific skills” (ESCO 2019). Since these two dimensions are grouped together, we consider this as capturing a more concrete definition of task.

uses one of the latest versions (v1.1.2) of the ESCO dictionary explicitly flagging green skills at the occupation level. Second, we conduct a unique crosswalk between the ESCO occupational codes and the Italian occupational classification ISTAT “Classificazione delle professioni” (CP hereafter), developed by the Italian National Institute of Statistics (ISTAT). Finally, once the crosswalk is completed, we exploit our measure of green content and the 5-digits CP codes to identify green occupations within the SILER system. Here below we describe each step in detail.

Since 2022, ESCO has provided a list of skills explicitly defined as ‘green’ based on the operationalization of Cedefop (2012) definition of green skills, namely, “the knowledge, abilities, values and attitudes needed to live in, develop and support a society which reduces the impact of human activity on the environment” (ESCO 2022). A total of 384 green skills have been identified, representing 3.5 percent of all the skills available in the dictionary. They include activities such as: “ensure compliance with environmental standards”, “dispose waste”, “analyze environmental data”, etc.³. In terms of distribution across skill groups, green skills turn out to be quite transversal. According to ESCO (2022), the largest group of green skills belong to information skills, followed by communication, collaboration and creativity, assisting and caring and management skills. This wide range of applications confirms the versatility of green skills across diverse occupations and sectors.

Leveraging ESCO data allows us to build a skill-based classification of occupations that is aligned with the most recent developments in the economic literature, particularly the task-based approach, widely used to compute the exposition of occupations to technological changes (Autor et al. 2003, Autor & Handel 2013, Vona et al. 2018, 2021). In addition, the skill-based approach aligns with the EU Commission’s policy framework for the green transition, which emphasizes skills as the main analytical dimension for policy design (ESCO 2022). In fact, preliminary evidence suggests that skill-based hiring is becoming increasingly common, exceeding the traditional reliance on general human capital (Fuller et al. 2022). This trend is especially relevant in sec-

³For a list of the most frequent green skills across occupations see table A1

tors that experience labor shortages, such as those most directly affected by the green transition (Bone et al. 2025). For these reasons, we consider the skill-based approach as the most suitable solution to identify green jobs in our framework.

ESCO's multi-country framework can create distortions in the analysis whenever researchers attempt to derive skill metrics that are specific to a single country. This is due to the heterogeneous composition of the skill-job matrix across countries, which is clearly affected by differences in economic and social institutions. For this reason, we minimize the risk of misclassifications and avoid considering skills unlikely to be relevant across most countries by focusing exclusively on green skills that are flagged as essential in the ESCO framework (ESCO 2019). On this ground, we identify green jobs through a dichotomous variable that takes value 1 when the occupation contains at least one 'essential' green skill and 0 otherwise. This green job indicator is built for all occupations available in the ESCO dictionary.

The next step involves assigning our green indicator to the Italian occupations available within the SILER database. Since ESCO's occupational classification, based on the international ISCO codes,⁴ is not directly compatible with the Italian CP system, we performed an ad-hoc crosswalk between the two. The CP system is a structured classification that categorizes professions across five hierarchical aggregation levels. Each level is defined by a specific code and title, along with a description that outlines the general contents and features of the job. ISTAT originally performed and validated a crosswalk between 5-digits CP and 3-digits ISCO occupations.⁵ For this study, however, our aim was to establish a more granular correspondence between the two classification systems, focusing on the set of 5-digit CP occupations, which comprise nearly 800 occupational titles.⁶

To achieve this objective, we proceed to a 1 to 1 correspondence between CP and

⁴The International Standard Classification of Occupations (ISCO) is the official system employed by the International Labour Organization (ILO) to classify occupations around the world. For more detail see <https://ilostat.ilo.org/methods/concepts-and-definitions/classification-occupation/>

⁵See Appendix C at chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.istat.it/en/files/2013/07/la_classificazione_delle_professioni.pdf

⁶For more details, see <https://professioni.istat.it/sistemainformativoprofessioni/cp/>

all ESCO available occupations. The matching process was carried out independently by the authors of the paper and was based on job titles and detailed descriptions of the profession available in both classification systems.⁷

Once the CP-ESCO correspondence was established, we formally assigned the green job status to Italian occupations. While a 1-to-1 correspondence was in most cases the preferred outcome, some CP occupations correspond to multiple ESCO occupations and *vice versa*. In these cases, 1-to- n and n -to-1 correspondences were identified.⁸ Hence, while for all 1-to-1 matches the identification as a green job was straightforward, for the 1-to- n and n -to-1 matches we had to specify an assignment rule. To preserve a symmetry between the two cases, we classified the CP profession as green if at least one of the corresponding ESCO occupations was flagged as green. This implies that all the n CP occupations corresponding to 1 green job based on ESCO were classified as green. As a robustness check we tried also some alternative matching rules based on more restrictive conditions for the selection of green jobs (e.g., an CP occupation is green if at least half of the corresponding ESCO occupations are green) and results do not change (see below).

To the best of our knowledge, the final outcome represents one of the first attempts to successfully identify green jobs in Italian data using a crosswalk with ESCO at such a detailed occupational level.

3.3 Identification of Migrant Workers

The key independent variable in our analysis is the nationality of the worker, as recorded in the SILER system. We construct a binary indicator, *migrant*, which takes value 1 if the worker has a nationality outside the EU-15 and 0 otherwise. This classification allows us to focus on the segment of foreign workers that is most likely to face economic vulnerability and structural disadvantages in the Italian labor market. The rationale

⁷Please refer to Appendix B for a more clear and robust explanation of the methodology used for the cross-walk.

⁸The number of 1(CP)-to- n (ESCO) matches remains limited representing less than the 25%. The other way around is less common, less than 10 %. For more on this please refer to Appendix B.

for defining migrants as Extra-EU-15 rather than just non-Italian or Extra-EU stems from the composition of foreign employment in the Emilia-Romagna region, where a significant share of workers originates from low-income EU-28 countries, particularly Romania, Poland, and Bulgaria. These workers, despite benefiting from EU freedom of movement, frequently engage in low-wage and precarious employment (Gregson et al. 2016). Conversely, workers from EU-15 countries such as Germany, France, and the Netherlands represent a negligible share of foreign employment and typically do not experience comparable labor market disadvantages.

Supporting evidence for these migration patterns is reported in Table ?? in Appendix A, which provides a detailed breakdown of the nationality distribution of migrant workers across EU-15, EU-28, and Extra-EU countries for all contract activations available in SILER. Among migrants classified as Extra-EU, the most prevalent nationalities include Albania (9.48%), Morocco (9.33%), and Ukraine (6.44%). Instead, among the EU-28, the highest share of foreign workers comes from Romania (21.23%), Poland (2.24%), and Bulgaria (1.14%), all of which have long-standing migration flows directed toward Italy, particularly in low-skilled employment sectors. At the same time, our classification excludes workers from EU-15 countries, such as Germany (0.36%), France (0.33%), and the United Kingdom (0.23%), who represent a negligible share of foreign employment and generally do not face the same structural disadvantages as non-EU-15 migrants. For the sake of completeness, a series of robustness checks were carried out considering alternative specifications for the migrant status (non-Italian and extra-EU, see below), with no major changes in the final results.

3.4 Descriptive Evidence

As a first step of our empirical analysis, we discuss some descriptive evidence about the features and evolution of green jobs and migrant employment in Emilia-Romagna, focusing on the whole set of contract activations available in the SILER system. Although they do not allow for the analysis of sustained employment within the same profession, contract activations offer a comprehensive view of entry dynamics in the

labor market, thereby enabling a careful investigation into whether and how green jobs influence migrant access to work.

Figure 1 displays the evolution of green jobs and migrant employment as a share of total contract activations between 2008 and 2022. During this period green jobs experienced a moderate increase, partly reflecting the growing emphasis placed on environmental sustainability by most policy-oriented actors at all administrative levels. While in 2009 green jobs accounted for approximately 22.5% of total activations, in 2016 this figure raised well above 26%, reaching a peak just above 27% in 2021. This trajectory unfolded alongside the sustained presence of migrant employment in the regional labor market. Indeed, during these years the share of contract activations involving a migrant worker ranged between a minimum of 23.5% in 2015 and a maximum of 27.1% in 2020, confirming the relatively high exposition of the local economy to sustained inflow of migrant employees.

As argued above, green jobs can favor the employment of migrants thanks to their concentration in low-skilled segments of the labor market. To check for this, we report in Figure 2 the incidence of green jobs and migrant workers in contract activations across 1-digit occupational groups. The result confirms a strong presence of green jobs across different skill levels, with a particularly high concentration in low-skilled occupations. While managers, professionals, and technicians exhibit some positive degree of green-related activities, the largest incidence is observed among craft and related trades workers as well as elementary occupations. These categories typically involve manual and routine-intensive tasks, such as waste management, construction, and industrial maintenance, all of which are central to sustainability-driven production processes. This distribution aligns with previous evidence emphasizing how green employment extends beyond high-skilled technical professions to include low-skilled occupations that are in principle accessible to workers with lower educational qualifications (Vona et al. 2018, Consoli et al. 2016), including migrants.

This intuition is confirmed when we look at the incidence of migrant employment across occupational categories. Indeed, contract activation involving a migrant

worker tend to be significantly overrepresented in the very same low-skilled occupations where green jobs are most prevalent. Although purely descriptive, this evidence confirms the potentially relevant role played by green occupations in fostering the labor market participation of migrants. By creating employment opportunities in professions that a) require low level of formal qualifications and b) are projected to growth in the future, these jobs could serve as key entry points for workers from low-income countries, who could find employment in stable and strategic sectors of the economy. At the same time, however, as argued above, it is important to acknowledge that not all low-skilled occupations are the same and that the specific competence requirements of green jobs may introduce barriers to the participation of migrants. Were this the case, the potential role of green jobs driver of work inclusion would turn out to be reduced.

Finally, Table 1 reports descriptive statistics for the main variables used in our analysis, distinguishing mean values between native and migrant workers. In line with the evidence discussed above, migrant workers exhibit a relatively higher involvement in green job activations compared to natives (31.3% vs. 23.1%). At the same time, the large majority of migrants report the absence of any form of higher-level- education title, such as university degree (only the 2.6% of them has got one). This pattern is slightly more favorable for natives, who report holding a university degree in nearly one out of every ten contract activations. In terms of employment contract, the use of fixed-term arrangements remain by far the most common form of activation for both natives (53.1%) and migrants (47.3%), followed by agency contracts (15.1% and 20.9%, respectively) and other type of atypical arrangements (20.4% and 14.8%). Open-ended contract are used in 11.3% and 17% of the cases for natives and migrants respectively, confirming previous evidence about the limited use of permanent employment contracts as entry arrangement in the Italian labor market (Cirillo et al. 2017).

Overall, the descriptive evidence offers some valuable insights related to our research hypotheses, although some key issues remain to be addressed. In particular, while there exist preliminary evidence suggesting that migrants could be likely to find employment in low-skilled green occupations, it remains unclear whether this result

holds keeping the competence requirements of specific occupations constant. Additionally, the widespread use of atypical arrangements in the hiring process suggests that the contractual dimension is key aspect to take into account: if migrants predominantly access green jobs through temporary or agency contracts, their participation in these occupations may not translate into long-term employment stability, thus weakening their possibilities of employment upgrading. To address these pending issues, a more rigorous analysis is required. In the following section, we estimate a battery of multivariate regression models testing the relationship between migrant status and green employment, while controlling for a range of individual, occupational, and firm-level characteristics. This allows us to assess whether the patterns observed in the descriptive analysis persist after accounting for potential confounders, and to evaluate whether the involvement of migrants in green jobs is a genuine opportunity or a reflection of structural segmentation dynamics.

4 Empirical Results

4.1 Baseline

We begin by considering the following regression model:

$$\text{PR}(GJ_i = 1) = \text{logit}(\beta_1 \text{Migrant}_i + \mathbf{A}'_i \mathbf{a} + \mathbf{B}'_f \mathbf{b} + \omega_o + \sigma_s + \pi_p + \tau_t + \epsilon_i) \quad (1)$$

where subscripts i , o , f , s , p , and t denote the individual, occupation, firm, sector, province, and time, respectively; GJ_i is a dummy variable equal to 1 if the contract activation that involves individual i corresponds to a green job; migrant_i is a dummy variable equal to 1 if individual i has a migrant status; \mathbf{A}_i is a vector of individual-level controls; \mathbf{B}_f is a vector of firm-level controls; and ω_o , σ_s , π_p , and τ_t are occupation, sector, province, and time fixed effects, respectively. To assess the role of potential confounders we estimate model (1) by introducing regressors in a stepwise fashion,

starting from individual controls and then adding occupation and firm-level characteristics. The model is estimated using a logistic regression.

In column (1) of Table A2, we present the results of a naive specification that includes only migrant status alongside industry, year, and province fixed effects. The estimated odds ratio for migrant workers is positive and significant. In marginal terms, being a migrant is associated with an increase in the probability of carrying out a green job of about 6 percentage points compared to being a native. Apparently, this first result confirms the evidence emerging from the descriptive analysis, indicating green occupations as activities that facilitate migrants' entrance into the labor market. At the same time, however, it is important to further explore the channels through which this positive association unfolds. For instance, firms may prefer to hire migrant workers for green jobs because they are considered to have skills better suited for such occupations. Otherwise, it could also be the case that this positive effect mainly reflects the high concentration of green jobs in low-skilled occupations that, as we saw above, are also the ones in which migrants usually find employment.

To explore these possibilities, in column (2) we add individual-level controls, including education (a binary variable that takes value 1 if the worker holds a university degree, and 0 otherwise), age at the time of contract activation, and gender. The magnitude of the odds ratio for migrant workers slightly decreases, but the effect remains positive and significant. The estimated marginal coefficient remains the same as in the previous specification. Overall, this result suggests that differences in individual characteristics between migrants and natives explain little of the observed disparity in the chances of holding a green job. If anything, this association seems to be driven by more structural features of the job, which may have to do with either the nature of the occupation or the characteristics of the firms in which migrants are employed.

To start addressing some of these issues, we run an additional regression that includes occupation fixed effects. To avoid perfect prediction of the dependent variable (which is computed at 5-digits), we use CP codes at 1 digit to specify our controls. The results are reported in column (3). Interestingly, the odds ratio for migrant workers

turns negative and statistically significant. In marginal terms, being a migrant worker is associated with a reduction in the probability of holding a green job of about 1.3 percentage points compared to being a native. This result suggests that the initial positive association was largely driven by processes of occupational segmentation that lead migrants to be employed mainly in semi- or low-skilled occupations. Once such segmentation dynamics is controlled for, the effect of being a migrant becomes negative, indicating that these workers are actually less likely to hold a job with some positive degree of green content compared to natives.

In column (4), we further refine our analysis by including firm-level controls. One strategy to retrieve these variables would be to merge SILER data with usual databases containing firms' balance sheets and financial accounts. However, such databases usually provide only partial coverage of firms and industries (for instance, one of the most used commercial version includes only limited liability and join-stock companies, i.e., *società di capitali* in the Italian framework) and they thus risk to distort the results. Alternatively, we decided to rely on information available in SILER to derive firm-level metrics that help to control for firm-specific characteristics that we deem relevant for the analysis. More specifically, we created two variables: first, we computed the firm's mean annual number of activations, which we consider a time-invariant proxy of firm size; second, we calculated firm's mean annual incidence of workers with a university degree on total activations, which is meant to proxy the firm's level of human capital (and thus productivity). Once both variables are included in the regression, the estimated odds ratio for migrant workers remains negative and statistically significant. The magnitude of the marginal effect is in line with the previous specification (column 3), confirming the robustness of the finding to the inclusion of firm-level controls.

Finally, in column (5) we check the robustness of our results to alternative specifications of the migrant status. Indeed, as argued above, our preferred solution was to identify migrant workers as those coming from a country that is outside the EU-15 area. In this way, we could capture migration inflows originating mainly from low-income countries both inside and outside the EU. At the same time, however, it is

reasonable to expect that migrants within the EU-15 area may also face some partial gaps when entering into the Italian labor market compared to natives, for instance in cultural and linguistic terms. For this reason we run an additional specification in which we re-code migrant status to include all non-Italian workers (thus, also other EU-15 citizens). The main result does not change: migrant workers are significantly less likely to hold a green job compared to natives.⁹

4.2 Heterogeneity: Employment Contracts

The first set of baseline regressions reveals the existence of a potential segmentation process operating against migrant workers within the green transition. In fact, for similar characteristics of the individual, the firm and the occupation, green jobs turn out to be relatively less accessible to migrants compared to natives. Although involvement *per se* is clearly an important aspect, an additional dimension that we ought to consider concerns the type of employment contract through which migrants are effectively hired. Indeed, as emphasized by an extensive literature on labor market segmentation, in many contexts processes of occupational marginalization intersects with growing layers of atypical and precarious employment, which tend to deepen the vulnerability of already disadvantaged social groups.

To further explore these issues, we estimate the logistic model defined above adding a set of interaction terms between migrant status and the type of employment contract through which the worker is hired. We consider four main categories of contract: open-ended, fixed-term, agency, and other atypical contracts. The latter include primarily on-call and other intermittent forms of employment. The estimated odds ratios with the full set of control variables are reported in column (1) of Table ??, while the marginal effects are shown in Figure 3.¹⁰ Panel A reports the estimated overall ef-

⁹To test the robustness of our results, we repeat the analysis using a more restrictive definition of green jobs. Since a CP can be linked to one or more ESCO occupations, each of which may be green or not, in this restricted version we codify a CP as green only if more than 50% of the ESCOs it is associated with are green (unlike in the main analysis, where a single green ESCO was sufficient). The results remain robust and are reported in Table A3 in the Appendix A.

¹⁰As a robustness check, column (2) of Table 3 reports the odds ratios estimated with same model specification, but considering migrant status as non-Italian instead of extra EU-15. The main results do

fect, namely the average marginal effect across the entire sample, while Panel B breaks down the marginal coefficients by type of employment contract.

When we look at the overall effect, migrants turn out to be significantly less likely to be employed in green jobs compared to natives. The estimated marginal effect is about -0.9 percentage points. Although the magnitude of the coefficient is not large, this result confirms the previous evidence suggesting that migrant workers can face structural barriers or distinct employment patterns that limit their access to jobs directly involved with the green transition. As we decompose this effect across distinct employment contracts, additional interesting patterns begin to emerge. While both migrant and native workers are most likely to be hired in a green job through either a fixed-term or an agency contract, for natives the chance of having stable and permanent employment is considerably larger. Indeed, migrants are more than 2 percentage points less likely to hold a green job with an open-ended contract compared to natives. This gap is compensated by a significant increase in the probability of being hired through other atypical contracts, while the use of fixed-term and agency contracts changes only marginally between the two worker groups.¹¹

Overall, these results add a contractual dimension to the segmentation dynamics operating against migrant workers that we discussed above. Indeed, not only are migrants less likely than natives to find employment in jobs with some positive degree of green content, but when they do, there is a comparatively small probability that this takes place through contracts ensuring standard and permanent career perspectives. Rather, this tends to happen primarily through non-standard and atypical forms of contract. As argued above, different theoretical mechanisms could provide an explanation for such employment trends, going from human capital and screening hypotheses to processes of institutional segmentation. Independently of the main mechanism at stake (which will be the focus of the next section), this evidence delivers an important message for discussions about the just transition, as it highlights

not change.

¹¹Once again, we assess the robustness of our results using a more restrictive definition of green jobs, whereby a CP is classified as green only if more than 50% of its associated ESCOs are green (see footnote 9). The findings remain robust and are reported in Table A4 in Appendix A.

green jobs as a potential source of flexible and precarious employment, especially for workers that belong to most vulnerable social groups, such as migrants.

4.3 Mechanisms

The precarious involvement of migrant workers in green jobs can be driven by a variety of mechanisms. In the first instance, as argued above, there could be a human capital effect, which is related to the fact that migrants do not have the right amount of competences necessary to perform these occupations. However, in all the previous estimates we do control for proxies of human capital at the individual level, such as education. Despite this, the negative associations between migrant status and involvement in a green job remains significant. Hence, human capital *per se* does not seem to be a major driver of the estimated effect.

Another potential mechanism is related to the so-called screening hypothesis, which links the use of atypical contracts to the need to evaluate the skills of workers before moving into a permanent position. In the case of green jobs, this theory predicts that migrants could be more exposed to the risk of precarious employment due the higher cost of evaluating their skills compared to natives. To test the validity of this argument, we carry out an empirical exercise where we evaluate how the use of different employment contracts change depending on the task profile of the occupation. In particular, we rely on occupation-level data retrieved from the 2012 ICP dataset (*Indagine Campionaria sulle Professioni*),¹² a survey conducted by INAPP (*Istituto Nazionale per l'Analisi delle Politiche Pubbliche*) in collaboration with ISTAT (*Istituto Nazionale di Statistica*) reporting (among other things) how often an occupation requires workers to perform repetitive tasks.¹³ On this ground, we compute an index of task repetitiveness and estimate the marginal effect of migrant status on the probability of holding

¹²ICP should not be confused with CP: the former refers to the survey, while the latter pertains to the already widely discussed occupational classification.

¹³The survey asks individual workers how often in their jobs they perform repetitive tasks. Values are self-reported on a scale ranging from 0 (never) to 5 (all the time), then aggregated by INAPP at 5-digit occupation level, normalized between 0 and 100. To maintain enough observations within each occupation cell, we aggregate responses at the 5-digits ISCO occupational code and merge this information with the SILER-ARTER database exploiting access to the occupational code of each contract.

a green job across contract types and for occupations characterized by different levels of task repetitiveness. If the screening hypothesis is correct, we should expect that, especially for migrants, the use of atypical contracts is more prevalent in occupations where skills are most difficult to assess — such as jobs involving a high degree of non-routine tasks. Conversely, in roles where tasks are more repetitive, and thus skills can be more easily assessed, the reliance on atypical contracts should decrease, assuming that all other individual and firm-level characteristics remain constant.

Figure 4 reports the results of this empirical exercise. Panel A shows the marginal effects on the probability of holding a green job for native workers, while Panel B focuses on migrants. Overall, the results are relatively inconsistent with the screening hypothesis. Indeed, although for both groups of workers the use of open-ended contracts increases with the incidence of repetitive tasks (and relatively more so for migrants than for native workers), the use of atypical contracts raises too, and for some contract types it does so at a much steeper pace. In the case of migrants, for instance, the probability of being hired in a green job with other forms of atypical contract increases with task repetitiveness, following a pattern similar to that of open-ended contracts. For agency contracts, this increase is even greater, and in relative terms, it is significantly higher than that observed for native workers. This result supports previous findings that highlight the limited use of such contracts for screening purposes (Landini & Rinaldi 2025), suggesting that alternative mechanisms may be driving the precarious employment of migrants in green occupations.

In this respect, an alternative explanation may be provided by the theory of institutional segmentation. As argued above, this theory posits that atypical contracts are used mainly as a tool to economize on production expenses, transforming labor from fixed into variable cost. Especially in sectors in which the workforce is stratified between highly protected (typically natives) and not protected workers (mainly migrants), employers have strong incentives to pursue this strategy by relying primarily on migrant workers, which often represent an easily accessible pool of cheap and flexible labor. This is particularly true for roles that are not considered strategic to the firm,

which may include many low-skilled green jobs. To test this mechanism, we carry out an additional exercise where we estimate the heterogeneous effect of migrant status across industries characterized by different degrees of collective organization as captured by the unionization rate. The latter is calculated using information from the 2015 wave of RIL survey (*Rilevazione Imprese e Lavoro*), which was carried out by INAPP on a representative sample of non-agricultural firms in Italy.¹⁴ If the institutional segmentation hypothesis is correct, an asymmetry in the probability of being hired into a green job with an atypical vs. an open-ended contract should exist between natives and migrants depending on the strength of unionization. In particular, for higher levels of unionization, the use of open-ended contracts should increase more for natives than for migrants, with opposite trends for atypical employment.

The results are reported in Figure 5, once again distinguishing the marginal effects computed for natives (Panel A) and migrants (Panel B). In line with the institutional segmentation theory, native workers have a larger probability of being hired into a green job with an open-ended contract in industries with higher unionization rate. The same is not true for migrants, as for latter the effect associated with this type of contract reduces as the incidence of unionization increases. Moreover, for this group of employees an higher incidence of collective organization goes together with an increased likelihood of being hired with a non-standard contract, either temporary or other type of atypical contract. These trends align with employers' efforts to shift the burden of non-strategic job positions onto the less organized segments of the workforce. While in industries with low rates of unionization the incentives to implement this type of segmentation is small, because both natives and migrant are weakly protected, when the incidence of unionization raise such incentives increase. Indeed, it is precisely in such industries that we observe a divergence between open-ended being the most common for natives, and temporary as well as other atypical being the most likely choice for migrants. Overall, these patterns are consistent with predictions

¹⁴Among other things, the survey asks to firm how many employees are enrolled in a trade union, and these data are aggregated using sample weights at the sectoral ATECO-2-digits level as a percentage of unionized workers in the sector. Such data is then merged with the SILER-ARTER database exploiting information about the industry in which the firm activating the contracts is operating.

based on the institutional segmentation theory.

5 Conclusions

This paper has investigated whether and under what conditions migrant workers are included in the emerging green segments of the labor market. The green transition is frequently presented as a dual opportunity to support environmental goals while fostering more inclusive economic growth. However, relatively little is known about the extent to which these opportunities are equitably distributed, especially with regard to migrant workers, a group that continues to face structural disadvantages in many advanced labor markets.

We examined this question using rich administrative data covering over 11 million contract activations in the Emilia-Romagna region of Italy between 2008 and 2022. We constructed a novel crosswalk between the Italian CP occupational classification and the European ESCO framework to identify green jobs based on skill content. To the best of our knowledge, this represents one of the first efforts to apply a detailed skill-based classification of green employment to Italian data, moving beyond industry-level proxies and toward a more granular understanding of the nature of green work.

Our empirical analysis produced three main findings. First, although naive regressions suggest a positive association between migrant status and green job employment, this relationship becomes negative once we control for occupation and firm characteristics. Second, we document that when migrants are employed in green jobs, they are significantly more likely than natives to do so under non-standard contractual arrangements, including fixed-term and agency contracts. Third, heterogeneity analysis suggests that these patterns are more pronounced for green occupations performing relatively routine tasks and in sectors characterized by higher degree of stratification between highly unionized (oftentimes) native workers and not protected migrants.

These findings speak to three strands of theoretical interpretation. The limited

role of human capital characteristics in explaining migrant disadvantage suggests that productivity-based sorting alone does not account for observed patterns. While the screening hypothesis may explain some use of atypical contracts, our evidence shows that contract precariousness increases even in highly routine green occupations, where information asymmetries should be minimal. Instead, the results align more closely with institutional segmentation theory. In settings where labor markets are stratified and where green jobs are introduced to meet external mandates, employers appear more likely to allocate precarious roles to vulnerable groups, particularly migrants.

We acknowledge some limitations of our analysis. First, although our approach allows for detailed occupation-level analysis, we rely on a static definition of green skills based on ESCO classifications and cannot observe within-occupation variation over time. Second, our data are confined to a single Italian region. While Emilia-Romagna represents an advanced and industrially diversified labor market, future research could assess the extent to which our findings generalize to other national or sub-national contexts. Finally, we cannot infer a causal interpretation of the relationship between migrant status, access to green employment, and contract type, and the findings must therefore be interpreted with caution. Nonetheless, while acknowledging these limitations, we are reassured by the consistency of the results across multiple estimation strategies, all of which point to a coherent pattern of disadvantage for migrant workers in both access to green jobs and the quality of contractual arrangements through which they are employed.

Taken together, these results contribute to current policy debates about the inclusiveness of the ecological transition. Green jobs are frequently cited as tools to promote both sustainability and social justice. Our findings suggest that this potential is not automatic. In the absence of targeted measures, there is a risk that green employment reinforces rather than mitigates existing forms of labor market segmentation. This evidence poses a serious challenge to policymakers dealing with the ecological transformation, signaling the need for adequate measures aimed at preventing that marginalized social groups get “lost” in the transition. Addressing this challenge re-

quires policies that not only expand the quantity of green jobs, but also ensure their quality and accessibility for all segments of the workforce, including migrants. Without such efforts, the green transition may fall short of its equity ambitions, leaving key groups behind in the very sectors that are expected to define the future of work.

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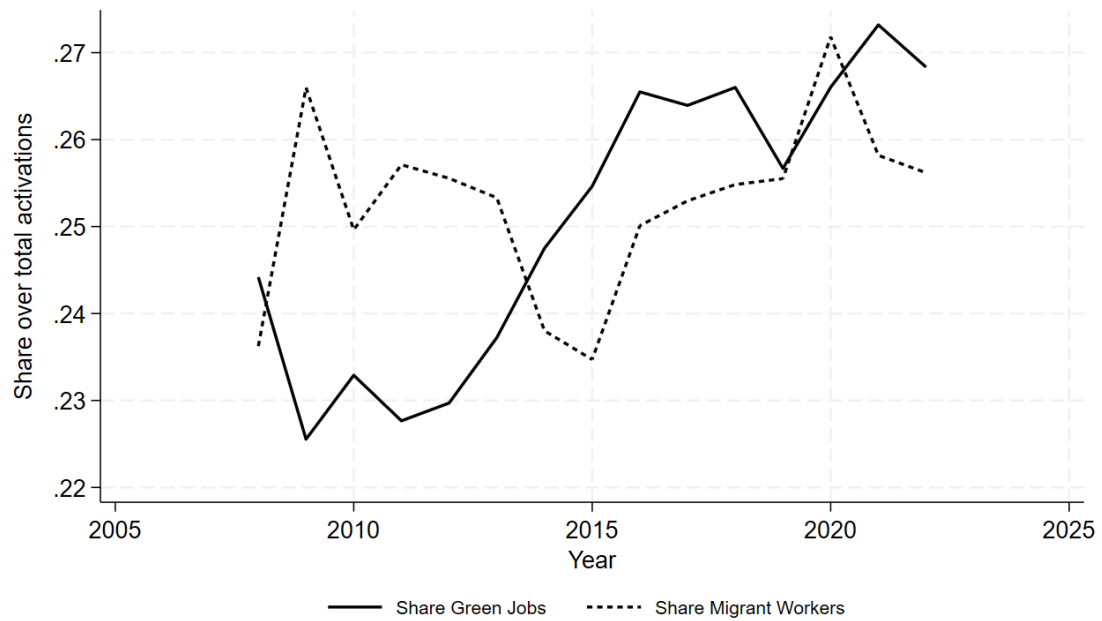
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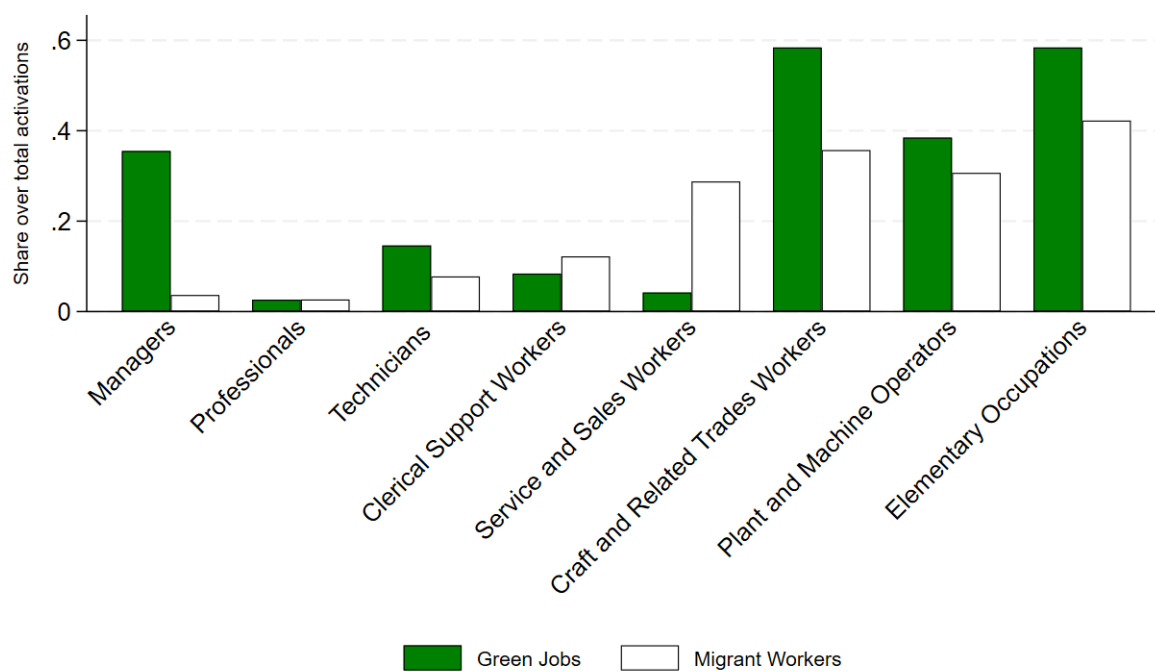
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Figure 1: Evolution of green jobs and migrant workers, 2008–2022



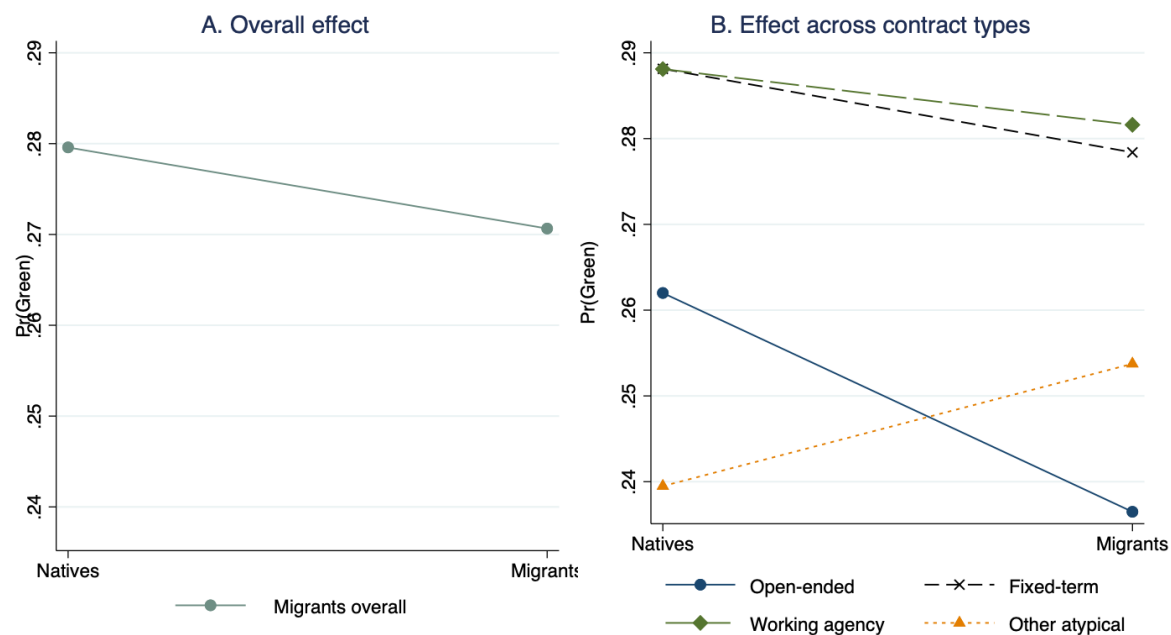
Notes: Authors' own elaboration based on the population of contract activations available in SILER (period 2008-2022). Green jobs are identified as 5-digits CP occupations with at least 1 green essential skills based on the ESCO dictionary. Migrant workers are identified as workers with a nationality outside the EU-15 country group.

Figure 2: Share of green jobs and migrant worker by occupational groups



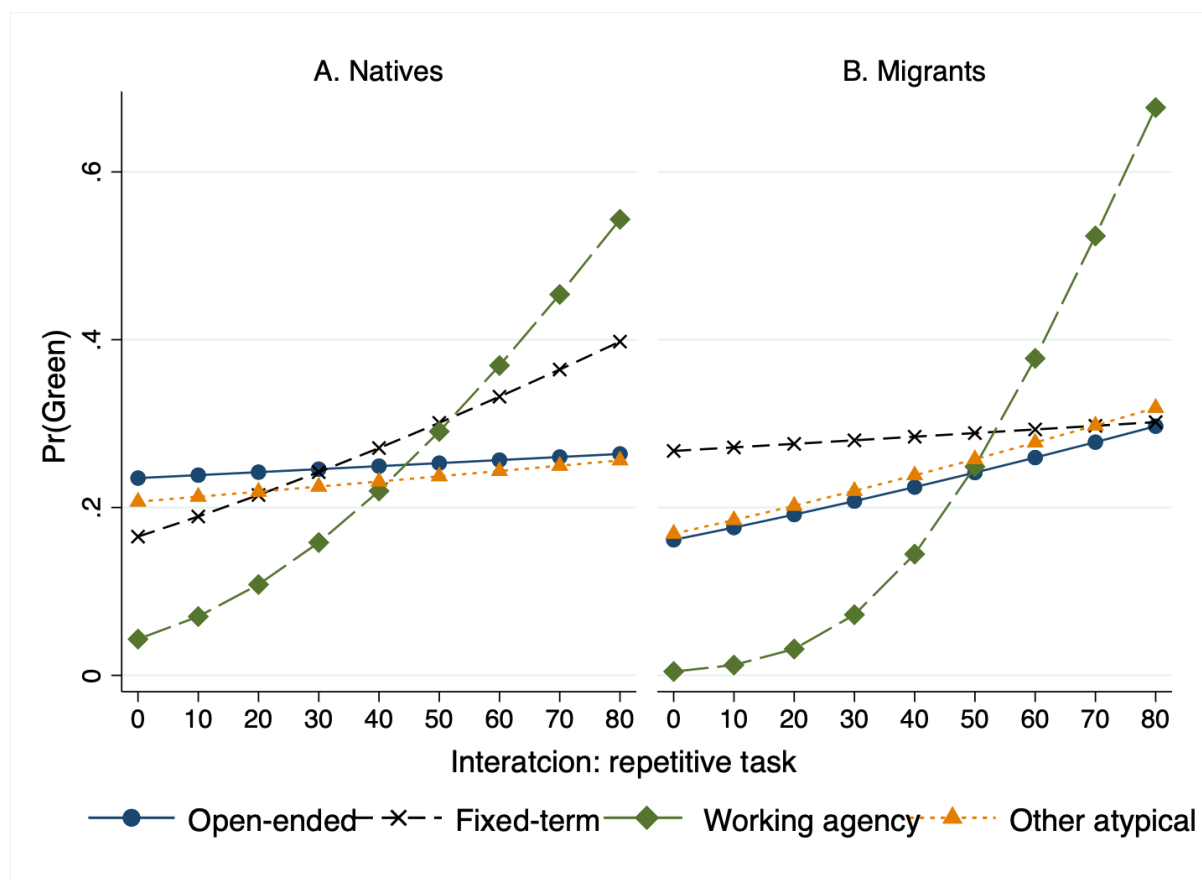
Notes: Authors' own elaboration based on the population of contract activations available in SILER (period 2008-2022). Green jobs are identified as 1-digits CP occupations with at least 1 green essential skills based on the ESCO dictionary. Migrant workers are identified as workers with a nationality outside the EU-15 country group.

Figure 3: Green jobs, migrant status and employment contract, marginal effects



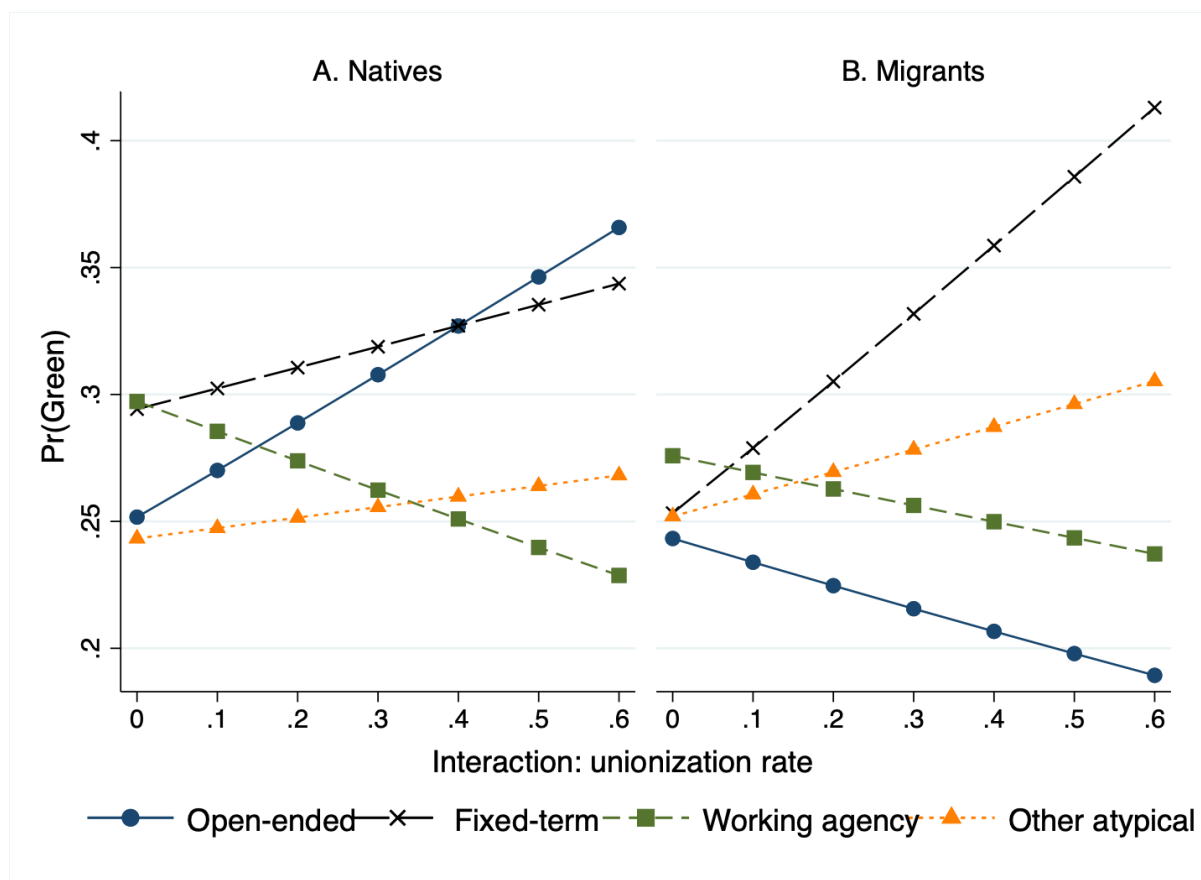
Notes: Authors' own elaboration based on the population of contract activations available in SILER (period 2008-2022). Marginal effects estimated through a logistic model with a full set of control variables. Dependent variable: being employed in green job (0/1). Migrant: the worker has a migrant status (0/1). Open-ended contracts (benchmark category): includes subordinate contract with no explicit termination (0/1). Fixed-term contract: includes subordinate contract with explicit termination (max 24 months) (0/1). Working agency contract: includes contract managed by an external work agency (0/1). Other atypical: includes other non-standard contract such as on-call and intermittent contracts (0/1). Individual-level controls include: male (0/1), age at activation, university degree (0/1). Industry dummies are ATECO at 2-digits, occupation dummies are CP at 1-digit. Firm-level controls include: number of contract activations (mean over years), ratio of contract activations with university degree over the number of overall contract activations (mean over years). Observation unit: activation of a worker contract in a firm.

Figure 4: Green jobs and migrant status: marginal effects across contract types and task repetitiveness



Notes: Authors' own elaboration based on the population of contract activations available in SILER (period 2008-2022). Marginal effects estimated through a logistic model with a full set of control variables a triple interactions between migrant status, contract type and index of task repetitiveness. Dependent variable: being employed in green job (0/1). Migrant: the worker has a migrant status (0/1). Open-ended contracts (benchmark category): includes subordinate contract with no explicit termination (0/1). Fixed-term contract: includes subordinate contract with explicit termination (max 24 months) (0/1). Working agency contract: includes contract managed by an external work agency (0/1). Other atypical: includes other non-standard contract such as on-call and intermittent contracts (0/1). Task repetitiveness: Incidence of repetitive tasks at the occupation level; Individual-level controls include: male (0/1), age at activation, university degree (0/1). Industry dummies are ATECO at 2-digits, occupation dummies are CP at 1-digit. Firm-level controls include: number of contract activations (mean over years), ratio of contract activations with university degree over the number of overall contract activations (mean over years). Observation unit: activation of a worker contract in a firm.

Figure 5: Green jobs and migrant status: marginal effects across contract types and unionization rate



Notes: Authors' own elaboration based on the population of contract activations available in SILER (period 2008-2022). Marginal effects estimated through a logistic model with a full set of control variables a triple interactions between migrant status, contract type and sectoral unionization rate. Dependent variable: being employed in green job (0/1). Migrant: the worker has a migrant status (0/1). Open-ended contracts (benchmark category): includes subordinate contract with no explicit termination (0/1). Fixed-term contract: includes subordinate contract with explicit termination (max 24 months) (0/1). Working agency contract: includes contract managed by an external work agency (0/1). Other atypical: includes other non-standard contract such as on-call and intermittent contracts (0/1). Unionization rate: share of workers enrolled in a trade union at the industry level (2 digits); Individual-level controls include: male (0/1), age at activation, university degree (0/1). Occupation dummies are CP at 1-digit. Firm-level controls include: number of contract activations (mean over years), ratio of contract activations with university degree over the number of overall contract activations (mean over years). Observation unit: activation of a worker contract in a firm.

Table 1: Descriptive statistics.

Variable	Description [Sources]	Natives		Migrants		Obs.	F-test
		Mean	S.D.	Mean	S.D.		
Green job (0/1)	The occupation contains at least one green task (1 Yes, 0 No) [E, S]	0.231	0.421	0.311	0.463	12,925,370	***
Contract: open-ended (0/1)	Worker is hired with an open-ended contract (1 Yes, 0 No) [S]	0.113	0.317	0.170	0.376	12,229,450	***
Contract: fixed-term (0/1)	Worker is hired with a fixed-term contract (1 Yes, 0 No) [S]	0.531	0.499	0.473	0.499	12,229,450	***
Contract: working agency (0/1)	Worker is hired with an agency contract (1 Yes, 0 No) [S]	0.151	0.358	0.209	0.406	12,229,450	***
Contract: other atypicals (0/1)	Worker is hired with other non open-ended contracts (1 Yes, 0 No) [S]	0.204	0.403	0.148	0.355	12,229,450	***
Full time (0/1)	Worker works full time (1 Yes, 0 No) [S]	0.669	0.470	0.584	0.493	11,918,340	***
Sex (0/1)	Worker is male (1 Yes, 0 No) [S]	0.455	0.498	0.522	0.499	12,925,358	***
Age at activation	Worker's age at the time of contract activation [S]	36.100	12.236	35.918	11.257	12,925,370	***
University degree (0/1)	Worker has a university degree (1 Yes, 0 No) [S]	0.084	0.277	0.026	0.159	12,925,370	***
Firm's size (proxy)	Firm's mean annual activations [S]	148.405	343.389	83.256	221.256	12,925,370	***
Firm's human capital, log (proxy)	Firm's mean annual ratio of degree-holder contract activations to total activations, in log [S]	0.077	0.089	0.025	0.054	12,925,370	***
Occupation repetitive tasks	Incidence of repetitive tasks at the occupation level [I]	40.417	16.184	48.439	12.180	12,925,299	***
Unionization rate (industry)	Share of workers enrolled in a trade union at the industry level [R]	0.082	0.093	0.113	0.097	11,534,197	***

Notes: authors' own elaboration on ESCO [E], SILER [S], ICP [I] and RIL [R] data. For each variable the data sources used to compute mean and standard deviation (S.D) values is reported. The last column shows the result of an F-test on the difference between the mean values for migrant and native workers. * 10%; ** 5%; *** 1%

Table 2: Green jobs and migrant status, logistic regressions

	(1) Pr(green job) Migrant: Extra EU-15	(2) Pr(green job) Migrant: Extra EU-15	(3) Pr(green job) Migrant: Extra EU-15	(4) Pr(green job) Migrant: Extra EU-15	(5) Pr(green job) Migrant: Non-Italian
Odds ratio					
Migrant	0.406*** (0.002)	0.404*** (0.002)	-0.124*** (0.002)	-0.096*** (0.002)	-0.095*** (0.002)
Marginal effects					
Migrant	0.060*** (0.000)	0.060*** (0.000)	-0.013*** (0.000)	-0.010*** (0.000)	-0.010*** (0.000)
Individual-level controls	No	Yes	Yes	Yes	Yes
Occupation dummies	No	No	Yes	Yes	Yes
Firm-level controls	No	No	No	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes	Yes
Observations	12,922,551	11,915,631	11,915,631	11,915,631	11,917,941
Pseudo R-squared	0.191	0.201	0.397	0.399	0.399
Log pseudolikelihood	-5894345.5	-5478436.3	-4133076.6	-4118337.9	-4119005.1

Notes: authors' own elaboration on SILER and ESCO data. Robust standard errors clustered at individual level in brackets. Logit model, odds-ratio coefficients. Dependent variable: being employed in green job (0/1). Migrant: the worker has a migrant status (0/1). Individual-level controls include: male (0/1), age at activation, university degree (0/1). Industry dummies are ATECO at 2-digits, occupation dummies are CP at 1-digit. Firm-level controls include: number of contract activations (mean over years), ratio of contract activations with university degree over the number of overall contract activations (mean over years). Observation unit: activation of a worker contract in a firm. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3: Green jobs, migrant status and employment contract, logistic regressions

	(1) Pr(green job) Migrant: Extra EU-15	(2) Pr(green job) Migrant: Non-Italian
Migrant (0/1)	-0.234*** (0.005)	-0.224*** (0.005)
Fixed-term	0.230*** (0.003)	0.233*** (0.003)
Working agency	0.230*** (0.004)	0.230*** (0.004)
Other atypicals	-0.205*** (0.005)	-0.202*** (0.005)
Migrant × Fixed-term	0.148*** (0.006)	0.138*** (0.006)
Migrant × Working agency	0.176*** (0.006)	0.174*** (0.006)
Migrant × Other atypicals	0.363*** (0.008)	0.349*** (0.008)
Observations	11,287,362	11,289,256
Pseudo R-squared	0.390	0.390
Log pseudolikelihood	-4058306.4	-4059011.4

Notes: authors' own elaboration on SILER and ESCO data. Robust standard errors clustered at individual level in brackets. Logit model, odds-ratio coefficients. Dependent variable: being employed in green job (0/1). Migrant: the worker has a migrant status (0/1). Open-ended contracts (benchmark category): includes subordinate contract with no explicit termination (0/1). Fixed-term contract: includes subordinate contract with explicit termination (max 24 months) (0/1). Working agency contract: includes contract managed by an external work agency (0/1). Other atypical: includes other non-standard contract such as on-call and intermittent contracts (0/1). Individual-level controls include: male (0/1), age at activation, university degree (0/1). Industry dummies are ATECO at 2-digits, occupation dummies are CP at 1-digit. Firm-level controls include: number of contract activations (mean over years), ratio of contract activations with university degree over the number of overall contract activations (mean over years). Observation unit: activation of a worker contract in a firm. *** p<0.01, ** p<0.05, * p<0.1.

Appendix A

Table A1: Green skills frequency - ESCO v1.1.2

Green Skills	Frequency
Follow health and safety procedures in construction	108
Ensure compliance with environmental legislation	68
Ensure correct goods labelling	52
Monitor the welfare of animals	39
Assess environmental impact	19
Monitor water quality	18
Reduce environmental impact of footwear manufacturing	18
Advise on animal welfare	17
Collect biological data	17
Follow procedures to control substances hazardous to health	17
Mitigate waste of resources	16
Promote environmental awareness	16
Replace defect components	16
Abide by regulations on banned materials	15
Manage environmental impact of operations	15
Develop environmental policy	13
Execute disease and pest control activities	13
Manage animal welfare	13
Use meteorological information	13
Analyse environmental data	12

Table A2: Distribution of Foreign Workers by Country of Origin (Top 10 Nationalities)

EU15		EU28		Extra EU	
Country	Percent	Country	Percent	Country	Percent
Germany	0.36	Romania	21.23	Albania	9.48
France	0.33	Polonia	2.24	Morocco	9.33
United Kingdom	0.23	Bulgaria	1.14	Ukraine	6.44
Greece	0.13	Slovacchia	0.22	Moldova	5.57
Portugal	0.09	Croazia	0.21	China	4.77
Netherlands	0.07	Ungheria	0.21	Pakistan	3.91
Austria	0.06	Repubblica	0.16	Tunisia	2.99
Belgium	0.05	Lituania	0.16	Senegal	2.80
Ireland	0.03	Lettonia	0.10	Nigeria	2.53
Sweden	0.03	Slovenia	0.04	Ghana	2.12
Total	1.40	Total	25.72	Total	72.85

Notes: Authors' own elaboration based on the population of contract activations available in SILER (period 2008–2022). Only the first ten nationalities for group are reported. The category EU-15 includes workers with nationality from the 15 pre-2004 EU member states; EU-28 includes workers from the EU before Brexit; and Extra-EU refers to workers from countries outside the EU.

Table A3: Green jobs (restricted values) and migrant status, logistic regressions

	(1) Pr(green job) Migrant: Extra EU-15	(2) Pr(green job) Migrant: Extra EU-15	(3) Pr(green job) Migrant: Extra EU-15	(4) Pr(green job) Migrant: Extra EU-15	(5) Pr(green job) Migrant: Non-Italian
Odds ratio					
Migrant	0.322*** (0.002)	0.322*** (0.002)	-0.102*** (0.002)	-0.071*** (0.002)	-0.070*** (0.002)
Marginal effects					
Migrant	0.042*** (0.000)	0.047*** (0.000)	-0.011*** (0.000)	-0.007*** (0.000)	-0.007*** (0.000)
Individual-level controls	No	Yes	Yes	Yes	Yes
Occupation dummies	No	No	Yes	Yes	Yes
Firm-level controls	No	No	No	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes	Yes
Observations	12,922,551	11,915,631	11,915,631	11,915,631	11,917,941
Pseudo R-squared	0.157	0.162	0.340	0.343	0.343
Log pseudolikelihood	-5417183.8	-5032558.9	-3994337.9	-3976157.7	-3976741.9

Notes: authors' own elaboration on SILER and ESCO data. Robust standard errors clustered at individual level in brackets. Logit model, odds-ratio coefficients. Dependent variable: being employed in green job (0/1). Migrant: the worker has a migrant status (0/1). Individual-level controls include: male (0/1), age at activation, university degree (0/1). Industry dummies are ATECO at 2-digits, occupation dummies are CP at 1-digit. Firm-level controls include: number of contract activations (mean over years), ratio of contract activations with university degree over the number of overall contract activations (mean over years). Observation unit: activation of a worker contract in a firm. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A4: Green jobs (restricted values), migrant status and employment contract, logistic regressions

	(1) Pr(green job) Migrant: Extra EU-15	(2) Pr(green job) Migrant: Non-Italian
Migrant (0/1)	-0.188*** (0.005)	-0.180*** (0.005)
Fixed-term	0.290*** (0.006)	0.294*** (0.003)
Working agency	0.104*** (0.007)	0.104*** (0.004)
Other atypicals	-0.230*** (0.008)	-0.226*** (0.005)
Migrant × Fixed-term	0.116*** (0.006)	0.105*** (0.006)
Migrant × Working agency	0.154*** (0.007)	0.154*** (0.007)
Migrant × Other atypicals	0.386*** (0.009)	0.368*** (0.009)
Observations	11,287,362	11,289,256
Pseudo R-squared	0.334	0.390
Log pseudolikelihood	-3926903.3	-4059011.4

Notes: authors' own elaboration on SILER and ESCO data. Robust standard errors clustered at individual level in brackets. Logit model, odds-ratio coefficients. Dependent variable: being employed in green job (0/1). Migrant: the worker has a migrant status (0/1). Open-ended contracts (benchmark category): includes subordinate contract with no explicit termination (0/1). Fixed-term contract: includes subordinate contract with explicit termination (max 24 months) (0/1). Working agency contract: includes contract managed by an external work agency (0/1). Other atypical: includes other non-standard contract such as on-call and intermittent contracts (0/1). Individual-level controls include: male (0/1), age at activation, university degree (0/1). Industry dummies are ATECO at 2-digits, occupation dummies are CP at 1-digit. Firm-level controls include: number of contract activations (mean over years), ratio of contract activations with university degree over the number of overall contract activations (mean over years). Observation unit: activation of a worker contract in a firm. *** p<0.01, ** p<0.05, * p<0.1.

Appendix B

A.1 Cross-walk ESCO-CP

The CP-ESCO cross-walk is performed starting from the Italian occupational classification at 5-digit level and by identifying, when possible, a 1:1 correspondence using the ESCO occupational classification system. The cross-walk has been conducted by three of the authors of the paper, following these steps:

1. All CP occupations have been firstly subdivided by broader groups ISCO 1-digit.
2. These groups have been separately assigned to the authors of the paper. For instance, manager and professionals occupations (ISCO 1 and 2 code) were assigned to one author; technicians and clerical occupations (ISCO 3 and 4) were assigned to another author and so on;
3. Each author has independently performed the cross-walk. During the manual classification phase, care was taken to prevent communications among the independent researchers carrying out the crosswalk.
4. Once the separated cross-walk exercises were completed, the independent cross-walks were collaboratively validated through a joint review process, which lead to the final CP-ESCO digits crosswalk.

The CP-ESCO occupation matching process primarily relied on similarities between jobs titles, but in particular, on job description similarities. Both classifications system provide detailed job descriptions, outlining key tasks, content, and the scope of each occupation. For clarity, table B1 presents an example of a match.

Whenever possible, the preferred approach was to assign a single ESCO occupation to each CP 5-digit occupation. However, this was not always feasible. In several instances, the CP occupational descriptions were broader in scope than those provided by ESCO, requiring the assignment of multiple ESCO occupations to adequately represent a single CP classification. This is the case for instance of "Energy Saving and

Renewable Energy Technicians” CP occupation that is matched with two ESCO occupations: “Energy Conservation Officers” and “Energy Consultants” (see table B2).

As shown in table B3, in more than 75 % of the cases, CP occupations are match with a single ESCO occupation. Finally, as an additional check, we examine the share of matches using a unique ESCO occupation—defined as an ESCO occupation that corresponds to only one CP match. Table B4 presents the results of this check. Overall, 72% of CP occupations are matched with a unique ESCO occupation, supporting the consistency and specificity of the cross-walk. These analysis are meant to highlight the special cases and at the same time to render more robust our cross-walk.

Table B1: Cross-walk example

	Code	Job title	Description
ESCO	8143.8	Paper stationery machine operator	Paper stationery machine operators work with machines that perform one or more operations on paper to make it suitable for specific markets, such as punching holes, perforating, creasing, and collating with a carbon coated sheet.
CP	7.5.2.5.0	Operators of machinery for the manufacture of paper and cardboard products	The professions included in this unit operate plant and machinery for the mass production of paper and board products, variously processed, intended for the manufacture of industrial products and the production of other articles for final consumption and industries

Notes: The CP job title and job description is translated in English by the authors. Originally the matching is performed in Italian.

Table B2: Cross-walk - more than one ESCO

CP	ESCO
3.1.3.6.0 Energy saving and renewable energy technicians	3112,6 Energy conservation officers
The professions classified in this unit assist specialists in the production of renewable energy and the application of energy-saving techniques, i.e. they apply and implement procedures and techniques to identify new methods of energy conversion from primary sources available in nature, in order to increase energy savings and reduce environmental impact; they verify the conditions and elements necessary for the design of renewable energy production plants.	Energy conservation officers promote the conservation of energy in both residential homes as in businesses. They advise people on ways to reduce their power consumption by enforcing energy efficiency improvements and implementing energy demand management policies.
	3112,7 Energy consultants
	Energy consultants advise clients on the advantages and disadvantages of different energy sources. They help clients to understand energy tariffs and try to reduce their energy consumption and carbon footprint by using energy efficient products and methods.

Table B3: Share of cross-walk 1 to 1 occupation

	Freq.	Percent
All sample	537 (705)	76.17
Managers	69 (74)	93.24
Professionals	94 (95)	98.95
Technicians	103 (146)	70.55
Clerical Support Workers	25 (30)	83.33
Service and Sales Workers	47 (62)	75.81
Craft and Related Trade Workers	119 (167)	71.26
Plant and Machine Operators	65 (103)	63.11
Elementary occupations	15 (28)	53.57

Notes: The table shows the share of CP match using only one ESCO occupation. Table shows all occupation share and by ISCO 1-digit shares. The numbers in parentheses express the total and by ISCO 1-digit group occupation.

Table B4: Unique ESCO

	Freq.	Percent
All sample	514 (705)	72.9
Managers	14 (74)	18.92
Professionals	83 (95)	87.37
Technicians	115 (146)	78.77
Clerical Support Workers	21 (30)	70.00
Service and Sales Workers	37 (62)	59.67
Craft and Related Trades Workers	120 (167)	71.85
Plant and Machine Operators	96 (103)	93.20
Elementary Occupations	28 (28)	100

Notes: The table shows the share of matches between CP occupation and ESCO unique occupation. Table shows all occupation share and disaggregation by ISCO 1-digit shares. The numbers in parentheses express the total and by ISCO 1-digit group occupation.