Towards a twin transition in tourism in Latin America [1]

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Economies around the world are simultaneously undergoing two profound changes: the 'green' (sustainability-focused) transition and the 'automation' (digital-focused) transition. This dual or 'twin' transition has significant implications for the tourism industry, which is a crucial source of employment for many countries. This paper explores the potential for transitions to green and digital jobs in the tourism industry. We analyse household survey data for the seven largest economies of Latin America (Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, and Uruguay) for the period 2011-2024. Our main results show that the tourism sector in Latin America has high potential to reallocate workers from brown to green jobs, thereby reducing the adjustment costs of decarbonization. This capacity is particularly pronounced in Mexico and Ecuador, and is especially strong among younger cohorts, men, and workers with lower levels of formal education.

Keywords: green jobs, tourism, labor markets, Latin America.

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Introduction

Many countries are starting to transition to greener forms of production because of global warming concerns. Because of that, there has been a great deal of academic and political interest in designing policies towards green transition and sustainable development. According to Dierdorff et al. (2009), a 'green economy' involves those economic activities that focus specifically on reducing pollution. For instance, activities that directly or indirectly use less fossil fuel or reduce greenhouse gas emissions, as well as activities that promote energy efficiency or recycling materials, would be embodied in the green economy. In addition to reducing environmental risks, the United Nations Environment Programme adds that a 'green economy' should also have a positive impact on welfare and social equity. Similarly, the International Labour Organization's (ILO) Green Jobs initiative highlights that the creation of decent work in the new green activities and the implementation of social protection policies to mitigate the effects on the sectors that need transforming are key to ensuring the inclusiveness of the transition to greener economies.

At the same time, technological progress, automatization, new technologies, and rapid and constant advancements in digital technologies are reshaping work and employment conditions all around the world. The digital transformation involves issues related to digital employment services, promotion of digital jobs, and job creation within the ICT sector, among others (ILO, 2024).

Acknowledging the above, several countries have been developing strategies to foster the implementation of green technologies, the creation of sustainable industries, and the adoption of new technologies and the automatization of production processes. In line with the necessity of green jobs to be also decent ones, the coordination of digital transformation policies with national employment ones will assure the business and economic progress, the preservation of employment quantity and quality, and take into account the labour rights of workers (ILO, 2024). These strategies, in general, involve changing work or worker requirements within each sector of the economy. How quickly countries can adapt to these new strategies by greening and promoting digital economies depends on the number of workers and the type of jobs in each sector. For instance, those sectors that have higher proportions of green jobs will not probably face many difficulties in the transition to greener forms of production. Those sectors that employ distinctive human skills and could cope with a hybrid digitalized flexible labour model are promising if the transition is well managed (Willcocks, 2024).

Recently, the tourism sector has received special attention for its potential contribution to the green transition through more sustainable practices and climate change mitigation. Meanwhile, profound changes have characterized the sector, including increased automation and digital connectivity. After the COVID-19 crisis, the tourism industry is recovering its historical numbers: during 2024, tourism generates 10.3% of all jobs and 10.3% of global GDP (WTTC, 2024). In Latin America, tourism contributed 10% of total value added in 2024. As a result, this sector plays an important role in boosting a nation's economy. Given the importance of this sector in the Latin American economies, it is highly relevant from a global resource perspective. It has significant potential as a driver of growth for developing countries, particularly in promoting green and digital growth. Furthermore, it is

estimated that one job in the tourism industry can create about one and a half additional or indirect jobs in the tourism-related economy. Therefore, the greening of tourism can be expected to reinforce the employment potential of the sector. However, it is essential to also consider the offsetting situation of the digital process and transformation. In this context, studying how the greening and digital transformation of the labor markets will shape the tourism sector becomes crucial in regions like Latin America.

In light of the above, this paper aims to characterize the potential of green jobs -defined as the ability of an occupation to be able to perform green tasks - in the tourism sector in the seven largest Latin American economies: Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, and Uruguay. We also characterize the potential of automated jobs in the sector. We apply an occupational approach to calculate green potential scores using US occupational data from O*NET. Specifically, we measure how many occupations within the tourism sector can be considered green; that is, how many jobs have high green potential in comparison to other sectors. We also measure an index of automatization that reflects the probability of jobs being replaced by technological and digital advances. We concentrate on tourism since it is one of the most dynamic and relevant sectors in the world. As a result, understanding and quantifying green and digital jobs in tourism is crucial if Latin American countries are to adapt their economies to greener ones. Besides, little is known about green jobs in the tourism sector in Latin America.

Our results show that the tourism sector in Latin America has a comparatively high potential to reallocate workers from brown to green jobs, thereby reducing the adjustment costs of decarbonization. This advantage is particularly evident in countries such as Mexico and Ecuador, and tends to be stronger among younger workers, men, and those with lower levels of formal education. At the same time, the regression analysis shows that the probability of automatization is negatively and significantly associated with the Green Transition Index, indicating that jobs most exposed to technological change are less likely to be absorbed by the green transition.

The remainder of the paper is organized as follows. Section 2 describes the literature review. Section 3 presents the sources of information used. Section 4 deals with descriptive analyses. Finally, Section 5 presents the results and Section 6 concludes. It is worth noticing that this is a preliminary version of the paper, which mostly presents calculations of employment shares, the estimation of the Green Transition Index and correlations of some key variables.

Literature review

Our work is related to two branches of the literature: one that seeks to estimate the green potential of jobs and how the different economic sectors can transition towards greener forms of production, and another that introduces the digitalization and automatization processes that posit an additional feature to consider in the transition processes. In particular, we focus on the twin transition -green and digital- of the tourism sector.

Green jobs and green transition

In order to adequately assess the implications of the transition to greener forms of production, we need to clarify what we understand about the green economy. According to the ILO's Green Jobs Initiative, 'green jobs' refer to those that take place in economic activities that are more environmentally sustainable than the conventional alternative and which also offer working conditions that meet accepted standards of 'decent work'. Specifically, the dimension of 'decent work' refers to the necessary conditions of an employment relationship to be carried out 'in conditions of freedom, equity, security and human dignity'. Thus, for work to be considered decent, workers must have: (1) productive jobs with a fair wage, (2) good working conditions, (3) social protection, (4) labor rights, (5) equal opportunities between genders and (6) a say in decisions which will affect their lives.

Green jobs are therefore both environmentally sound and 'decent' in social terms. However, the existing literature has not yet agreed on a widely accepted definition of what a green job is, and most importantly, on how to identify these types of jobs in practice. Indeed, the empirical literature has taken three main approaches to identify green jobs based on: i) the industry affiliation; ii) the production methods used; and iii) the task content of occupations. Below, we briefly describe each approach and discuss the pros and cons.

According to the industry affiliation approach, those sectors that produce goods and services that contribute to the protection of the environment or the conservation of natural resources are green sectors, and all employees working in those sector are considered green workers. However, as pointed out by ILO (2018) this definition considers neither the jobs that eventually improve production processes with respect to their environmental impact nor the skills necessary to carry out environmentally friendly activities to achieve a sustainable economy. Besides, this approach is unable to identify green (brown) jobs in brown (green) industries. The second approach consists in considering employees who actively participate in green processes, that is, those who are specialized in activities that seek the protection of the environment, such as recycling. Nevertheless, Vona et al. (2019) noted that even though this method provides a precise identification of green jobs, it clearly omits those activities devoted to the whole re-design of products that are often carried out by specialized suppliers of machinery and engineering, and architecture solutions.

Contrary to the approaches discussed above, the third method applies the task-based approach (Autor, 2013; Autor and Dorn, 2013; Acemoglu and Autor, 2011), identifying green jobs according to the number of green tasks that a given occupation requires the worker to do. In particular, this strategy addresses the problem discussed when using the industry approach: much of the variation in the share of green employment is observed within rather than between industries. The key issue with this approach is to find appropriate data for the determination of green jobs and skills[3]. Most of the studies exploiting this approach use the US Occupational Information Network (O*NET) data. The O*NET database contains not only detailed information on the task and skill content of occupations but also detailed text descriptions for a subset of tasks specific to each occupation. Furthermore, the 'Green Economy Program' developed by O*NET details the work tasks of green jobs, allowing

[3] In fact, for developing countries, like those in Latin America, it is also difficult to find appropriate/available data for identifying green jobs using either the industry or the production approach.

researchers to understand the changes in occupation and skill requirements that may be triggered when a country transitions to a greener economy. This information can then be used to identify green jobs based on two broad types of definitions: i) a binary definition where an occupation is considered either green or non-green; ii) a continuous definition of occupational greenness that exploits information on the greenness of the task content of occupations.

Several studies have relied on the O*NET data to measure and characterize green employment in the US. Consoli et al. (2016) classify occupations as either green or non-green and show that green occupations in the US require higher levels of cognitive and interpersonal skills, higher levels of education, greater work experience, and greater on-the-job training. A novel approach by Vona et al. (2018) computes a continuous greenness measure for each occupation. On this basis, they assess the importance of green skills in the US and find that green occupations have a higher technical skill requirement, even though they note that the overall skills gap between green and brown occupations is relatively small. In addition, they study the characteristics of green jobs between 2006 and 2014 and suggest that green occupations yield a wage premium in contrast to non-green jobs. While using O*NET's broad definition of green jobs, Bowen et al. (2018) find that 19.4% of the US workforce is part of the green economy, although most green employment is 'indirectly' rather than 'directly' green, with only 13% of the total workforce using any specifically green tasks in their jobs.

Research on this topic using O*NET to target green jobs has also extended outside the US, where occupational level data availability is a limitation (Rutzer and Niggli, 2020; Lobsiger and Rutzer, 2021; Valero et al., 2021; de la Vega, Porto and Cerimelo, 2024). The main criticism that these studies have received is that the task content varies depending on the level of development and, therefore, it would not be correct to extrapolate estimates based on the United States to other countries, particularly emerging ones.

Although several studies have estimated and described the share of green jobs in the economy, most of them are based solely on developed countries. Green jobs assessments in the developing world are scarce, since these countries do not usually have as much available data as the developed ones. For Latin America and the Caribbean, ILO has conducted several studies to measure green jobs through surveys or questionnaires that are sent directly to companies, government departments, or other key actors. Another example is the previously mentioned work of de la Vega, Porto and Cerimelo (2024) for Argentina.

Green jobs in tourism

In addition, our paper is closely related to those recent studies that estimate green jobs in tourism. From an occupational approach, Esposito (2016) uses US O*NET data to identify how many occupations within the construction and tourism industry have the potential to transform into green jobs or how many new occupations can emerge in the tourism sector as a consequence of the greening of the economy. The authors estimate the skills needs and gaps in those sectors as well. From a different perspective, Arnedo et al. (2021) provide a qualitative analysis of the green jobs in the hospitality sector of Spain. Given that information about green jobs is not available in Spain, the authors rely on interviews with sustainability

experts in the hotel industry and on the corporate social responsibility report from top Spanish hotel chains. They find that green jobs are mostly circumscribed to the headquarters, with some activities delegated in hotel managers, and are still limited in the Spanish tourism industry.

Some literature focuses on specific cases relating to tourism green employment. For example, a report from ILO (2023a) analyzes the social and employment impacts of Burkina Faso's national sustainable tourism strategy, evaluating the sector's potential for economic growth and job creation. Using a Green Jobs Assessment Model (GJAM) based on 2019 data, the study projects that a sustainable tourism scenario could generate approximately 3,000 jobs, while considerably reducing greenhouse gas emissions. The sustainable scenario comprises tourism practices according to the value-chain management of activities that should be promoted domestically (both for products and services which tourists consume and a range of potential highly valued export products) and strategies of ecotourism that combine tourism and heritage protection. The report emphasizes the need for complementary employment policies, such as technical and vocational training, to convert growth benefits into formal, skilled jobs, as most jobs created are for contributing family workers and the self-employed. It also suggests exploring alternative financing options to a CO2 tax, which might be perceived as unfair for a country not a major global polluter.

Another report from Mongolia (ILO, 2023b) evaluates green job opportunities, gaps, and barriers in Mongolia's "Ger and Nature" tourism, a type of community-based eco-cultural tourism.[4] The study, employing qualitative and quantitative methods, including a survey of residents, reveals a strong domestic demand for nomadic family holiday experiences, with 85% of respondents having visited herders. Visitors prefer longer stays in regions with forests, lakes, and rivers (khangai), and are interested in activities such as horseback riding and dairy making. However, significant barriers exist, including the lack of a formal reservation system for domestic tourists and a labor shortage for traditional activities like animal milking and horse training due to modernization. Furthermore, households with less livestock have fewer opportunities to benefit from tourism, and the lack of eco-friendly facilities (such as toilets and handwashers) in herding communities is a concern. The report highlights the need for a platform to connect herders with the tourism market and for training programs for herders in sustainable tourism practices, marketing, labor rights, and digital skills.

Automatized jobs and the transition

To evaluate the automatization of jobs, our departure point is defining what we understand by the 'digital economy'. The concept of the digital economy addresses the impact of the digital transformation on economic sectors; indeed, producing and consuming goods and services is increasingly affected and shaped by digitalisation (World Trade Organization, Organization for Economic Co-operation and Development, International Monetary Fund and United Nations, 2023). Technological advances and their implementation in productive

[4] The "*ger*" in "*Ger* and Nature" refers to the traditional circular tent dwellings used by nomadic herders in Mongolia, and which would be used to offer hospitality to both domestic and international tourists.

processes are not new. However, the last few decades have seen a particularly fast incorporation of greatly disruptive technologies in diverse sectors of the economy, including automation, robotics and artificial intelligence (ILO, 2016). These rapid societal and economic changes have only been exacerbated by COVID-19 and social distance measurements taking place at the time of the pandemic.

The digital transformation calls for new skills among workers and job-seekers. Information Comunication Technology (ICT) becomes particularly relevant, but so are complementary 'softer' skills like communication and problem-solving (OECD, 2024). The International Labour Organisation highlights the relevance that not only workers but also governments and policymakers adapt to these new technologies, particularly in the context of developing and emerging economies that are less technologically advanced and usually have a lower-skilled workforce (ILO, 2016).

Recent estimates of potential occupational exposure to generative AI indicate that few jobs around the world (3.3%) face high risk of automatization; instead, automation is primarily *transforming* —and not necessarily *replacing*— jobs (ILO, 2025). The study, based on world estimates following a detailed 6-digit national occupational classification, highlights that job quality will be directly impacted by the automation transformation of work. It is not, however, clear yet if the effects on jobs quality will be positive or negative: for example, automation might give workers time to work on more fulfilling tasts (i.e. increase in job quality) or could mean increased employee monitoring (i.e. decrease in job quality).

Automatized jobs in tourism

The tourism sector is not exempt from the digital transformation. Tuomi and Ascençao (2021) specifically looked at the influence of automation in the UK frontline food service. By looking at occupational classification data, they identified the types of intelligence that frontline food service tasks required, with 58.8% needing mechanical, 26.8% analytical, 11.3% intuitive and 3.1% empathetic intelligence. Their findings suggest that, for this particular context, automatability will be mainly driven by autonomous navigation, object manipulation and natural language processing.

From a qualitative perspective, Tuomi et al. (2020) relate the process of automation with decent jobs in tourism. The authors propose a theoretical model encompassing three elements as fundamental to providing decent work through automation: the effectiveness of human-machine cooperation (for instance, utilising optimum systems), the working conditions (e.g. adequate remuneration), and the level of empowerment (e.g. task autonomy for employees).

The twin transition

The "twin transition" for tourism refers to the simultaneous and accelerated shift towards green (environmental sustainability and climate neutrality) and digital transformations within the tourism ecosystem. On one hand, the green transition involves integrating environmental objectives and legislative initiatives to achieve climate neutrality by 2050 and reduce greenhouse gas emissions by 55% by 2030. It also means meeting growing customer demand for sustainable practices, including consuming local products, reducing waste and

water consumption, choosing ecological transport, and supporting local communities. On the other hand, the digital transition focuses on leveraging digitalization and data to transform tourism services, creating innovative, technologically enriched, and personalized experiences. This includes improving access to data, developing data spaces, enhancing online platform regulations, and fostering digital tools for destination management and seamless travel. Both aspects are crucial for the long-term sustainability and adaptability of the tourism sector. The implications of this twin transition for tourism are far-reaching, affecting various stakeholders from businesses and public authorities to travelers and local communities. The twin transition seeks to create a more robust, competitive, and socially responsible tourism ecosystem that balances economic growth with environmental protection and enhanced visitor/resident well-being, while ensuring fair and accessible services for all (Wettstein, F. (2024))

Data sources and variable definition

This paper adopts a methodology similar to that used by Tyros et al. (2023), de la Vega et al. (2024), Cerimelo et al. (2024), adapting it to the specific analysis of the tourism sector in Latin America. The strategy is based on combining microdata from national household or employment surveys for each country with detailed job information provided by the United States' O*NET (Occupational Information Network). Specifically, we will use the SEDLAC database (a joint collaboration between CEDLAS-UNLP and the World Bank), with employment data by occupation in the tourism sector for seven Latin American countries: Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, and Uruguay for the 2011-2024 period, using the official surveys available in each case (e.g., household surveys or continuous labor force surveys). These surveys will determine the number of workers employed in each tourism-related occupation (e.g., tour guides, hotel receptionists, restaurant staff, passenger transport, etc.) and their basic characteristics.

In order to measure and characterize how many green jobs are in the Latin American countries selected, we follow the same strategy as Porto et al. (2022). We combine information at the individual level from the household surveys with information about the task composition of occupations from O*NET. The household surveys of each country include cross-sectional information on sociodemographic and labor variables over an extensive period. In particular, to gain sample size, we use household data from 2011 to 2024 (SEDLAC, 2022). The final sample is restricted to those between 15 and 65 years old to avoid the influence of educational and retirement decisions on labor market participation. Table 1 in the Appendix describes in greater detail each of the household surveys considered for each country.

We rely on information on the task composition of occupations from O*NET since there is no information available for the countries considered.[5] Consequently, we estimate occupational

[5] O*NET is a public database that contains hundreds of standardized and occupation-specific descriptors on almost 1,000 occupations covering the entire U.S. economy. It describes occupations in terms of the knowledge,

greenness scores based on US data and then extrapolate it to the occupational structure of the countries considered. Specifically, we calculate the greenness scores proposed in the O*NET dataset at the Standard Occupational Classification (SOC) level, and then extrapolate them to the occupational classification of each country to impute them to each person employed in the corresponding household survey. This procedure has already been applied in several papers and is common in the automation literature and, more recently, in the teleworking literature. As stated in the previous section, these studies have been criticized because the task content varies depending on the level of development, and, therefore, it would not be correct to extrapolate estimates based on the United States to other countries, particularly emerging ones. However, we lack alternatives based on data availability. The rest of this section explains how the greenness scores are calculated.

As explained in Vona et al. (2021), O*NET identifies three groups of green occupations that will be affected by the greening of an economy: (i) occupations that are expected to experience an increase in demand (Green Increased Demand); (ii) occupations that will see major changes to the tasks content of work (Green Enhanced Skills); and (iii) occupations that did not exist before and that will be created (Green New and Emerging)[6]. For (ii) and (iii), O*NET also identifies green tasks within each occupation, but not for (i) because they may benefit only indirectly from the greening of an economy. In consequence, green jobs can be identified by using O*NET data in two ways: i) a binary definition where an occupation is considered either green or non-green; ii) a continuous definition of occupational greenness that exploits information on the greenness of the task content of occupations. In this paper, we only focus on the second definition. Following Vona et al. (2021), we calculate the greenness of an occupation j as follows:

$$greenness_j = \frac{\#green\ tasks}{\#\ total\ tasks}$$

which takes values greater than zero only for Green Enhanced Skills and Green New and Emerging occupations. The greenness indicator can be considered as a proxy for the amount of time spent on green activities and technologies in the average job post within a certain occupation. For a complete description of the methodological framework, see de la Vega, Porto and Cerimelo (2024).

Since the goal of this paper is to analyze what is the situation in terms of green jobs in the tourism sector, we have to properly define what we are going to consider under the sphere of tourism. We follow Porto et al. (2020) and define tourism sector employment based on a supply approach. Specifically, tourism employment consists of any establishment whose primary economic activity is any of the following: 1) accommodation services, 2) restaurants, 3) passengers' transport services, 4) travel agencies and complementary

skills, and abilities required as well as how the work is performed in terms of tasks, work activities, and other descriptors.

[6] It is worth remembering that non-green occupations are not necessarily 'dirty' or 'brown' but are not affected by the greening of an economy.

touristic support services and 5) entertainment, cultural and sport services. The non-tourism sector includes all economic activities of services not related to tourism.

To identify brown occupations, we follow the identification made in Vona et al. (2018). The authors identify brown occupations as those that have a large share of their employment in highly polluting industries. These industries are taken to be the top 5% of US industries in terms of emissions per worker. Estimating the green skill level of workers in brown jobs, they find that within most broad occupation categories, the green skills of workers in brown jobs are of a similar level to those in green jobs. This means that, although green skills are defined as those more correlated with green jobs, they are not possessed only by green job workers, but, importantly, by brown job workers as well. One potential implication is that the transition costs arising from the labour reallocation required to supply the Green Transition may be lower than otherwise thought.

Finally, we follow the study of Frey and Osborne (2017) to identify highly-automatable occupations. Their empirical analysis proceeds in two steps. First, they use the 2010 version of O*NET, a database of information on the task content of 903 occupations in the US, constructed from the assessments of labor market analysts, experts, and workers. The O*NET data is matched to the 702 occupations of the Labor Department's Standard Occupational Classification (SOC). Second, they assign to each occupation a probability of automation. In order to do that, they asked machine learning researchers to classify occupations into being either automatable or not, based on the reported task content.1 In particular, they select 70 occupations whose labelling the experts were highly confident about, and then they impute the automatability to the remaining occupations based on a model of an occupation's automatability on some attributes (e.g., manual dexterity, originality, social perceptiveness). The model returns an estimate of the automation potential, and those with a larger than 70% probability of being automated in the future have a high risk of automation.

Following Tyros et al. (2023), we applied the Green Transition Index (GTI) to assess the potential for worker relocation within the broad occupational spectrum in the face of the ecological transition. The GTI is calculated by examining, within each broad occupational group, the coexistence of green jobs and "brown" (high-emitting) jobs within that group. A high GTI means that within the same occupational field, there are both emerging green occupations and traditional high-emitting occupations, which increases the feasibility of transition because workers could move from one role to another, leveraging their similar experience and basic skills.

The GTI therefore offers a quantitative measure of the elasticity of the tourism labor market to relocate workers from obsolete or polluting jobs to sustainable jobs in the same sector. In this sense, GTI indicates which countries have a high potential to reallocate brown job workers to green jobs within their broad occupations. In each country I, we calculate the GTI for each broad occupation, O, as the ratio of the average greenness of its detailed occupations over their brown employment share:

$$GTI^{i}{}_{O} = \Sigma_{o\epsilon O} e^{i}{}_{O} G_{O}{}^{O*NET} / \Sigma_{o\epsilon O} e^{i}{}_{O} B_{o}$$

where $eo\ i$ is the employment share of the specific occupation o in the country, $GoO{*}NET$ its greenness according to the O*NET data, and Bo[7] an index indicating whether the job is brown or not, based on US occupation data. This indicates how many green jobs there are within the broad occupation per brown job. The GTI is a measure of the potential reallocative capacity from declining brown to – newly created – green jobs. The aggregate GTI is then constructed as the employment share weighted average of the broad occupation GTIs

$$GTI^{i} = \Sigma_{O} GTI^{i}{}_{O} e^{i}{}_{O}$$

Results

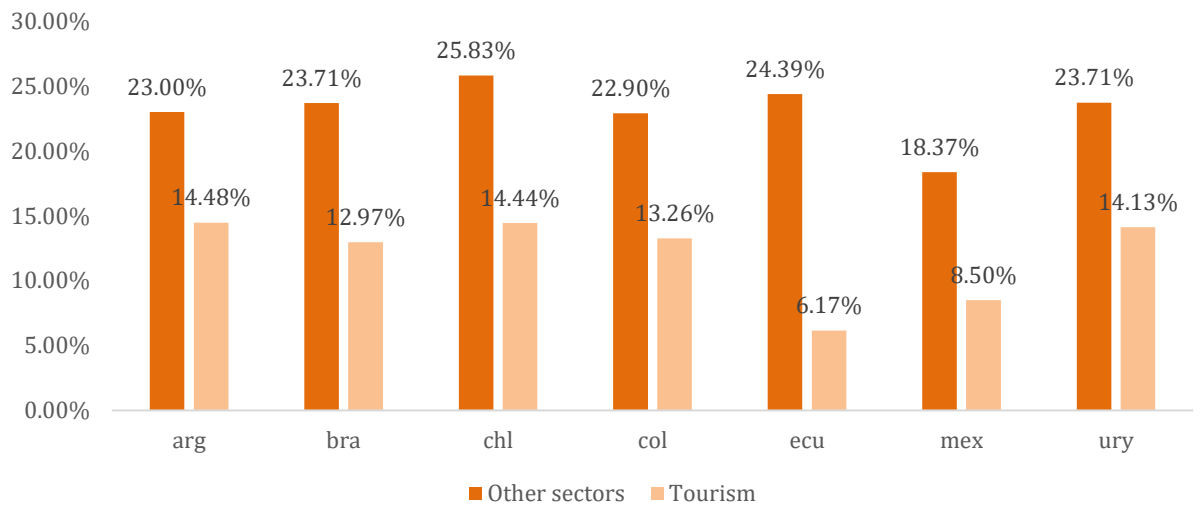
The Figures 1, 2 and 3 present the green, brown, and highly-automatized employment shares in the seven largest economies of Latin America. On the one hand, the share of green jobs is consistently lower in tourism (between 6% and 15%) than in other sectors (18%–26%). This suggests that while tourism has high reallocation potential (as shown by the GTI results), its direct contribution to green employment creation remains limited.

In terms of brown jobs, tourism generally shows a much lower incidence than other sectors. Argentina, Chile, and Ecuador display less than 2% of brown employment in tourism, compared to 9–11% in the rest of the economy, while Mexico and Uruguay also remain below the national averages. The exception is Colombia, where the share of brown jobs in tourism (12%) actually exceeds that of other sectors, highlighting country-specific vulnerabilities.

Finally, regarding highly automatable jobs, tourism is less exposed than other sectors in Argentina, Brazil, Chile, and Uruguay (20–39%), but highly exposed in Colombia (62%) and, to a lesser extent, in Ecuador and Mexico (44% and 53%). This underscores that automation may represent an even greater structural challenge for the region than the green transition itself.

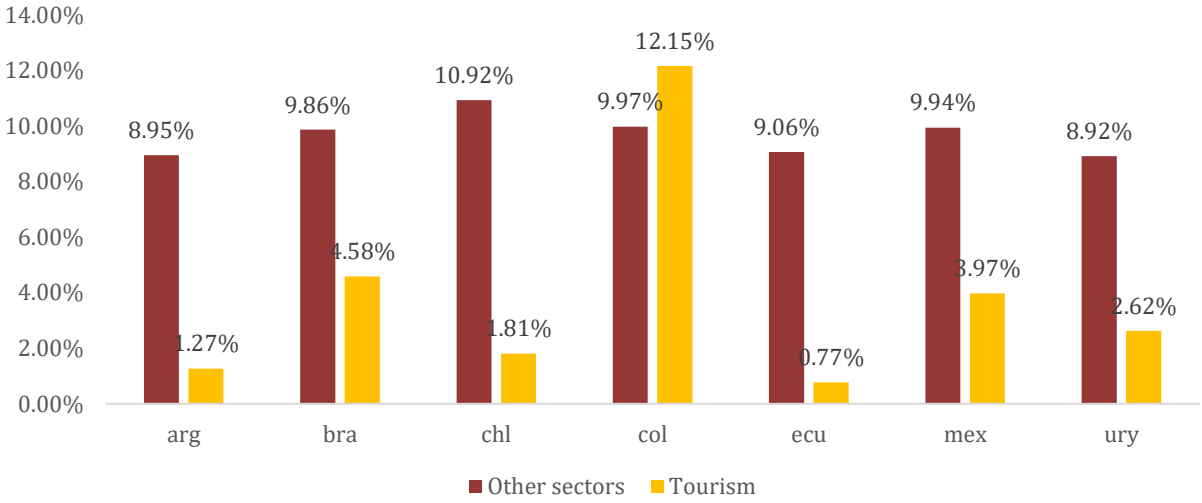
Figure 1: The green employment share

[7] Brown jobs are identified for the US SOC occupation classification, hence for the rest of the countries where crosswalks are used Bo can also take fractional values, indicating that only a share of the occupation is brown.



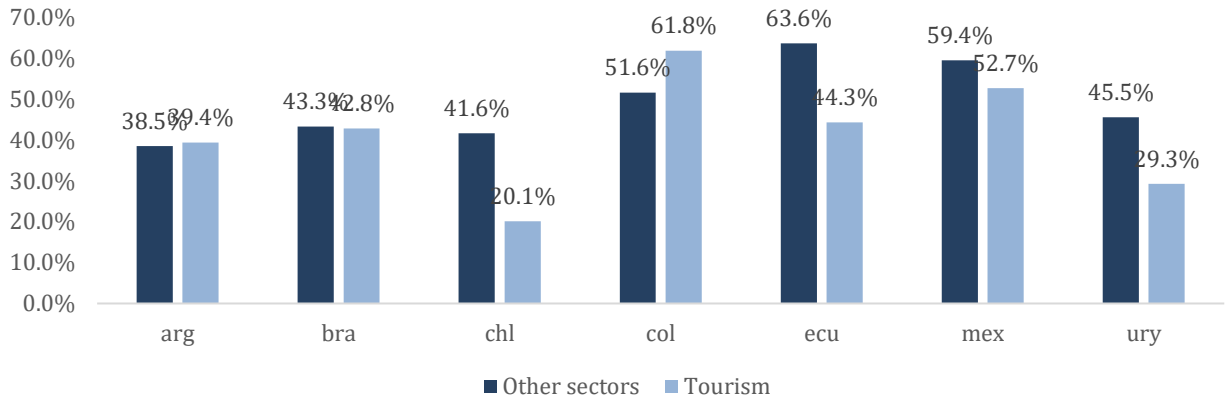
Source: Own elaboration based on household surveys.

Figure 2: The brown employment share



Source: Own elaboration based on household surveys.

Figure 3: The highly-auto employment share

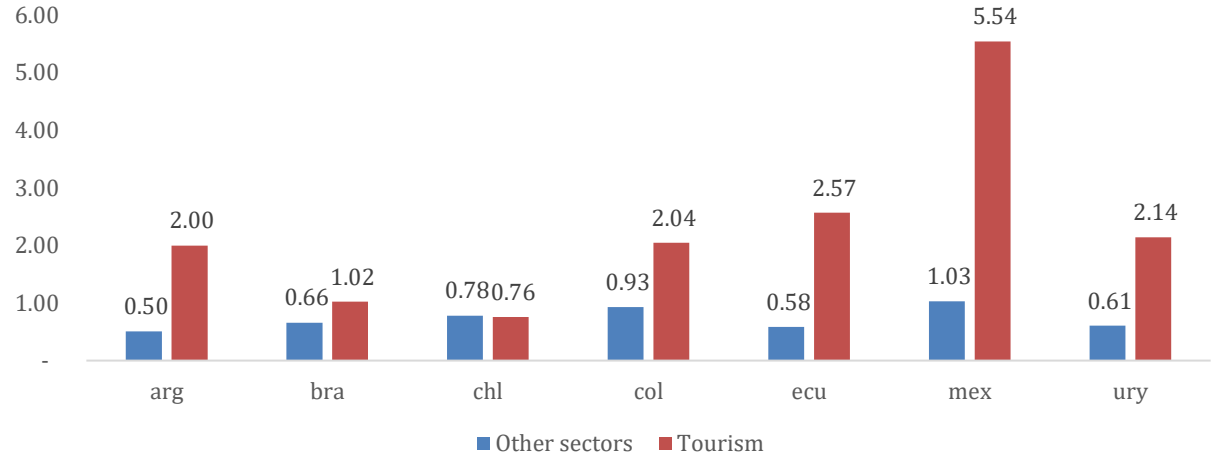


Source: Own elaboration based on household surveys.

The Green Transition Index

As we discussed, brown job workers have a similar green skill level to the one required by green jobs, within their broad occupation group. Hence, the existence of green vacancies in broad occupations with brown jobs indicates low transition costs during the decarbonization of the economy. The GTI across our sample countries, presented in Figure 4, quantifies this by estimating whether green jobs exist in occupation groups where brown jobs are present as well. Our results so far indicate that these groups will also be the ones creating the most green vacancies. Thus, it indicates which countries have a higher potential to reallocate brown workers to green jobs within broad occupation categories and, thus, have lower transition costs.

Figure 4: The Green Transition Index



Note: This figure shows the average GTI in the tourism industry and other sectors. *Source*: Own elaboration based on household surveys.

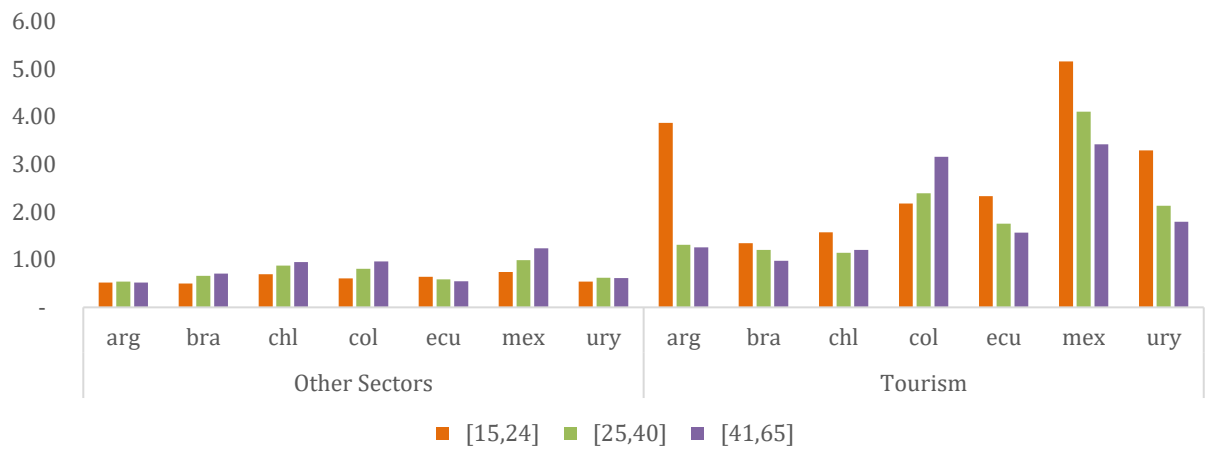
The results highlight important cross-country differences in the potential to reallocate workers from brown to green jobs within the tourism sector compared to the rest of the economy. In almost all the countries considered, the GTI is consistently higher in tourism than in other sectors, suggesting that tourism occupations combine a relatively high degree of "greenness" with the presence of brown jobs, which facilitates reallocation.

The relative advantage of tourism is most pronounced in Mexico and Ecuador, where GTI values in the sector are more than four times higher than in the rest of the economy. This indicates that, as decarbonisation advances, these countries may experience lower transition costs in reallocating brown job workers within tourism. Argentina, Colombia, and Uruguay also display a similar pattern, with GTI values for tourism roughly two to three times higher than in other sectors. By contrast, Chile and Brazil stand out as exceptions: in both countries, the GTI for tourism is comparable or even slightly lower than for other sectors, implying limited reallocation potential in the industry. This finding is consistent with the OECD framework, which stresses that the scope for green transition depends not only on the stock of green skills but also on the alignment between green and brown employment within broad occupations.

Compared to the OECD sample analysed by Tyros et al. (2023), where GTI values typically range between 0.5 and 1.5, the levels observed for tourism in Latin American countries are remarkably high. This contrast indicates that the tourism sector in the region exhibits a much greater potential for within-occupation reallocation from brown to green jobs than the OECD average.

The results disaggregated by age groups reveal important heterogeneities in the GTI across Latin American countries. In line with the OECD framework, where younger cohorts are often better positioned to adapt to new green tasks due to skill flexibility, the tourism sector in the region shows a clear age gradient. In most countries (Argentina, Colombia, Ecuador, Mexico, and Uruguay), workers aged 15–24 exhibit substantially higher GTI values than older groups, suggesting that younger workers in tourism have a particularly high potential to reallocate from brown to green jobs. Mexico stands out, with very high GTI levels for youth, reinforcing the role of tourism as a sector with strong transition capacity. By contrast, in Chile and Brazil, differences across age groups are less marked, and the relative advantage of younger workers is more limited.

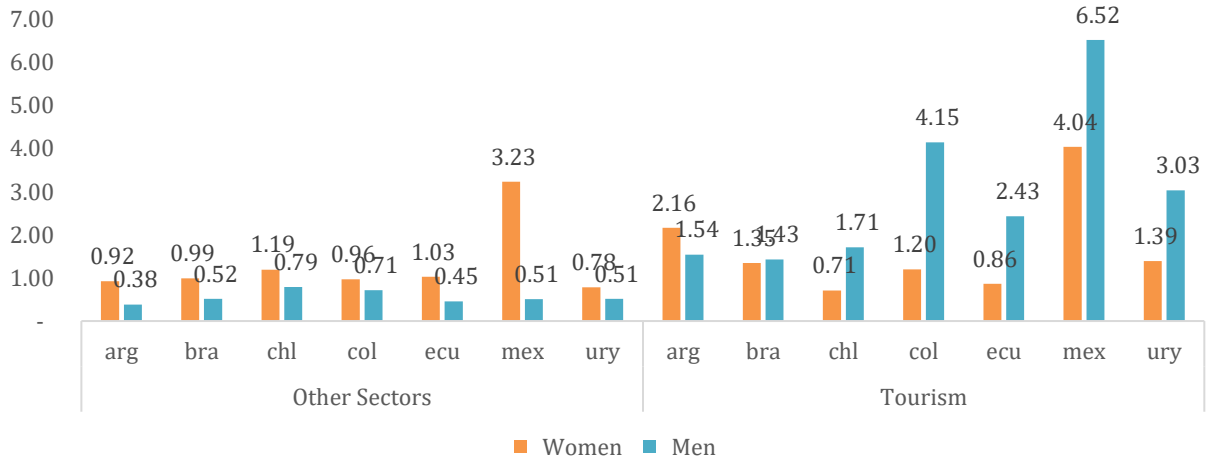
Figure 5: The Green Transition Index by age group



Note: This figure shows the average GTI in the tourism industry and other sectors by group age. *Source*: Own elaboration based on household surveys.

The gender-disaggregated results show asymmetries between women and men. In the tourism sector, GTI levels for men are significantly higher in several countries (notably Mexico, Ecuador, and Uruguay), indicating that male workers have greater potential for within-occupation reallocation from brown to green jobs. However, women also exhibit relatively high GTI values in Argentina and Colombia, pointing to a more balanced transition potential in those contexts. This suggests that, while both men and women in the region are engaged in occupations with reallocation potential, structural gender differences in tourism employment patterns (e.g., occupational segregation, concentration of women in service-related roles) may amplify or reduce transition opportunities. In particular, the exceptionally high male GTI values observed in Mexico highlight the need for targeted policies to ensure that women are not left behind in the green transition of the tourism sector.

Figure 6: The Green Transition Index by gender

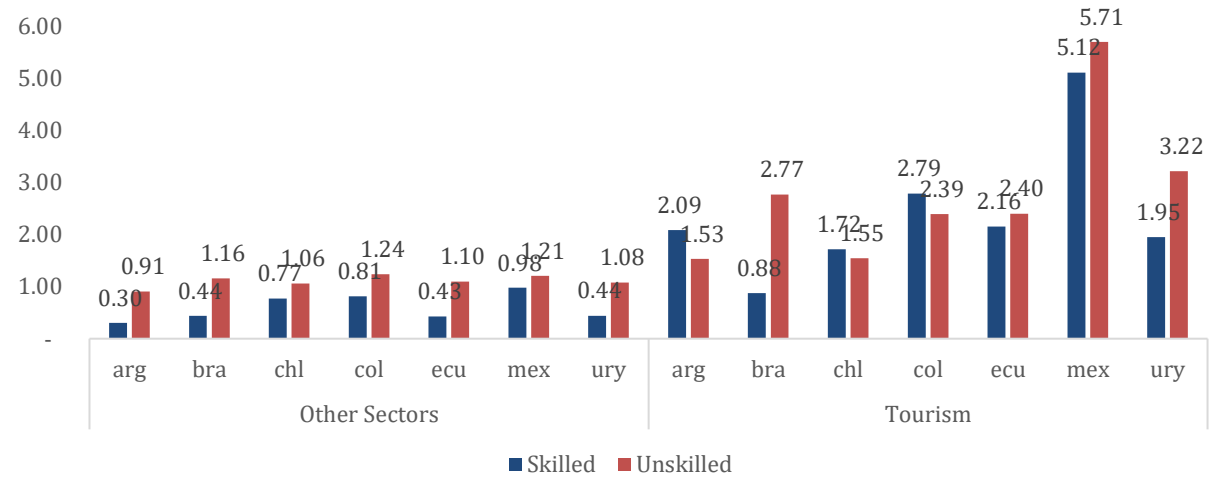


Note: This figure shows the average GTI in the tourism industry and other sectors by sex. *Source*: Own elaboration based on household surveys.

The results by education level show that unskilled workers (those with at most completed secondary education) often display higher Green Transition Index (GTI) values than skilled workers (those with some tertiary education), particularly within the tourism sector. This pattern is most evident in Brazil, Argentina, and Mexico, where unskilled workers in tourism exhibit GTI values well above those of skilled workers. For instance, in Mexico, the GTI reaches 5.71 for unskilled workers compared to 5.12 for skilled workers, highlighting that tourism provides an unusually high potential for reallocation among less educated workers.

By contrast, in Colombia, Ecuador, and Uruguay, the GTI levels for skilled and unskilled workers are more balanced, with skilled workers even surpassing unskilled in some cases (e.g., Colombia and Ecuador). This suggests that the reallocative potential of the green transition in tourism is not exclusively driven by low-educated workers, but rather reflects country-specific occupational structures.

Figure 7: The Green Transition Index by skill



Note: This figure shows the average GTI in the tourism industry and other sectors by skill. *Source*: Own elaboration based on household surveys.

Finally, to better understand the GTI in the tourism industry in countries we study the main factors correlated with this index, specially the relationship with the probability of automatization. The regression analysis presented above should be regarded as a preliminary exercise, subject to the usual considerations of the case.

We estimate the following regression model:

$$GTI_{ict} = \alpha + \beta \cdot X_{ic} + \gamma_c + \delta_t + \varepsilon_{ict}$$

where GTI_{ict} denotes the Green Transition Index for individual worker j in the tourism industry in country c, according to the index at time t; x_{jc} is a vector of worker-level covariates including the probability of automatization of the occupation, age, gender, and a

set of education dummies (incomplete/complete primary, secondary, and tertiary education); γ_c are regionally fixed effects and δ_t are year-fixed effects.

For other sectors, the probability of automatization has a strong and negative association with GTI (–0.088, p<0.01), implying that workers in highly automatable occupations face considerably lower prospects of reallocation from brown to green jobs within the same broad occupational group. Age (–0.042) and gender (–0.104 for men) are also negative and significant, confirming that younger and female workers are more likely to be located in occupations with higher reallocation potential. Education effects are mixed: incomplete secondary education has a positive effect (+0.025), whereas higher levels of completed secondary and tertiary education reduce GTI, suggesting that unskilled workers may be best positioned for green reallocation.

By contrast, in the tourism sector, the effects are smaller in magnitude and in some cases negligible. The probability of automatization remains negative (–0.016, p<0.01) but the effect is much weaker than in other sectors, suggesting that automation risk plays a less central role in shaping tourism's reallocation potential. Similarly, the age coefficient is essentially zero, indicating that the advantage of younger workers identified in other sectors is absent in tourism. Gender effects are also very small (–0.008), pointing to a more balanced distribution of reallocation potential between men and women. Educational attainment has limited influence, with only incomplete and complete tertiary education showing significant negative effects.

Table 2: Mail correlates of the GTI

Variables	Other Sectors (1)	Tourism (2)
Probability of automatization	-0.088***	-0.016***
	(0.002)	(0.001)
Age	-0.042***	-0.000***
	(0.000)	(0.000)
Male	-0.104***	-0.008***
	(0.001)	(0.000)
Incomplete primary educ	0.002	-0.006
	(0.003)	(0.003)
Complete primary educ	-0.002	-0.000
	(0.004)	(0.003)
Incomplete secondary educ	0.025***	-0.007
	(0.004)	(0.003)
Complete secondary educ	-0.013***	-0.008
	(0.003)	(0.003)
Incomplete tertiary educ	-0.015***	-0.014***
	(0.003)	(0.003)

Complete tertiary educ	-0.011***	-0.013***
	(0.003)	(0.003)
Constant		9.146***
	(0.002)	(0.003)
Observations	6857295	477933
Pseudo R-squared	0.270	0.987

Note: This table shows the estimated correlations with the GTI in the tourism industry and other sectors. The dependent variable in all regressions is GTI. Column 1 shows the results for the all sectors in the economy, except tourism, estimate for all countries, while Column 2 present the estimations for the tourism sector. The base category in educational attainment is no attendance. Data cover the period 2011-2024 and tourism workers are identified as those who report any of the following two-digit sectors at their main job (1) accommodation service, (2) restaurants, (3) travel agencies, and (4) entertainment, culture and sports services. All regressions include year, and region fixed effect, and standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5% and 1% levels. *Source*: Own elaboration based on household surveys.

Discussion

Given the constant threats to climate stability, several countries are recognizing the importance of greening the economy and have been developing strategies to foster the implementation of green technologies, the creation of sustainable industries, the reduction in current pollution, among other goals. At the same time, the last few decades have seen a particularly fast incorporation of greatly disruptive technologies in diverse sectors of the economy, including automation, robotics and artificial intelligence. We provided a first approximation of the proportion of green and digital jobs in the tourism sector in the seven largest economies of Latin America (Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, and Uruguay). We relied on the occupational approach and defined the green potential of jobs as the ability of an occupation to perform green tasks by using US occupational data from O*NET. We also compute the highly-automatized occupations. In addition, we studied the potential of workers to relocate from brown to green jobs by the so called Green Transition Index (GTI).

The analysis shows that the share of green jobs in tourism is relatively low, ranging from 6% in Ecuador and 8.5% in Mexico to about 14% in Argentina and Uruguay, compared to 18–26% in other sectors. However, the Green Transition Index (GTI) indicates that tourism has unusually high reallocative potential, reaching 5.54 in Mexico and 2.57 in Ecuador, well above OECD benchmarks. Regression results further confirm a strong negative correlation between GTI and the probability of automatization (–0.088 in other sectors and –0.016 in tourism), suggesting that jobs most exposed to automation are less likely to benefit from the green transition. Overall, the evidence suggests that tourism could act as a key driver of the green transition in Latin America, particularly in Mexico and Ecuador, where the sector appears structurally well-positioned to absorb workers from declining brown occupations.

At the same time, the heterogeneity observed across countries underscores the importance of national policies to foster green skills and support labour mobility, as emphasized in the OECD study.

According to the literature, the green and digital transition in tourism entails different actions with considerable implications for labor markets. Some green transition policies imply infrastructure transformations such as sustainable mobility or circularity of tourism services (for example, passenger transport companies developing greenhouse gas reduction plans, or improving sanitation to reduce water stress and increase water efficiency). Still, some others include readaptation of occupations, changes in some tasks and skills, creation of new types of jobs (for example, including the visitor perspective in sustainable mobility plans of cities and regions, reducing and separating overall waste of tourism services, engaging in capacity-building programs for small and medium enterprises to develop in environmentally friendly practices and schemes, etc.).

Digital transition in tourism requires substantial upgrades to infrastructure (for example, developing interoperable platforms for sharing visitor and destination data among small and medium enterprises, deploying artificial intelligence–driven digital replicas of destinations for predictive planning, enhancing online portals to provide validated information on sustainable, accessible, and specialized tourism options). At the same time, employment and labor trends are shifting as new specialist roles emerge -data analysts, digital experience designers, immersive technology developers- and existing staff engage in reskilling programs focused on interactive content creation and data management, while peer-learning networks and collaboration platforms support ongoing knowledge sharing, customer-service excellence, and continuous adaptation to evolving digital demands.

To sum up, the tourism sector in Latin America has the potential to adapt to greener forms of production, taking into account the digital aspects, according to a twin transition. Our results can be viewed as a help to assess the actual state of this industry in terms of green and digital employment.

The limitations of our study are related to the approach used. Essentially, our measurements of occupational greenness are calculated with data from the United States, given that the countries considered do not have descriptions of work content and skills at the occupational level. In addition, further research could be focused on studying the effects of several environmental policies that Latin America is currently undertaking.

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Appendix

Table 1: Description of Household Surveys

Country	Household Survey	Acronym	Years	Coverage
Argentina	Permanent Household Survey (Encuesta Permanente de Hogares)	EPH	2011-2024	urban
Brazil	National Survey by Household Sample (Pesquisa Nacional por Amostra de Domicílios Contínua)	PNADC	2011-2024	national
Chile	National Socioeconomic Survey (Encuesta de Caracterización Socioeconómica Nacional)	CASEN	2011-2024	national
Colombia	Large Integrated Household Survey (Gran Encuesta Integrada de Hogares)	GEIH	2011-2024	national
Ecuador	National Employment, Unemployment, and Underemployment Survey (Encuesta Nacional de Empleo, Desempleo y Subempleo)	ENEMDU	2011-2024	national
Mexico	National Survey of Occupation and Employment (Encuesta Nacional de Ocupación y Empleo)	ENOE	2011-2024	national
Uruguay	Continuous Household Survey (Encuesta Continua de Hogares)	ECH	2011-2024	national