October 2023

FONDAZIONE ENI ENRICO MATTEI

Working Paper

019.2023

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Summary

Developing and emerging economies face enormous challenges to reconcile economic development and job creation with decarbonization. An essential aspect of such "early-stage" decoupling of growth and carbon emissions is to develop a skill base that favours the diffusion of green productions and technologies. This paper sheds light on the role of the adjustments in the skill supply and of labour market institutions to pursue such early stage decoupling in developing and emerging economies. The paper begins by defining green growth strategies and the associated green skill requirement. To overcome measurement issues and data limitations, it then assesses the advantages and disadvantages of the task-based approach to green labour markets, emphasizing critical issues for developing countries as well as the opportunities to collect original data. Finally, it derives some policy recommendations to solve the coordination failure between investments in skills, particularly technical skills, and green technology adoption.

Keywords: skills, tasks, green economy, developing and emerging economies, structural change, green technological change, labour market institutions

JEL Classification: J24, Q56, O13, O14

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Skills and human capital for the low-carbon transition in developing and emerging economies*

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Abstract

Developing and emerging economies face enormous challenges to reconcile economic development and job creation with decarbonization. An essential aspect of such "early-stage" decoupling of growth and carbon emissions is to develop a skill base that favours the diffusion of green productions and technologies. This paper sheds light on the role of the adjustments in the skill supply and of labour market institutions to pursue such early stage decoupling in developing and emerging economies. The paper begins by defining green growth strategies and the associated green skill requirement. To overcome measurement issues and data limitations, it then assesses the advantages and disadvantages of the task-based approach to green labour markets, emphasizing critical issues for developing countries as well as the opportunities to collect original data. Finally, it derives some policy recommendations to solve the coordination failure between investments in skills, particularly technical skills, and green technology adoption.

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* I thank the World Bank for financial support and Carolyn Fisher for useful comments to an early draft of this essay.

1. Introduction.

There is no question that managing the trade-offs between poverty reduction, economic development and decarbonization is the main challenge of any global strategy to limit global warming below 1.5°C to 2°C. The Sustainable Development Goals of the United Nations recognize the importance of these three goals and of an early decoupling of economic growth and carbon emissions, but so far little have been achieved in this respect. In developed countries, managing distributional effects of climate policies is known to be particularly difficult as climate policies are often regressive along several dimensions (Fullerton, 2011; Vona, 2023). In developing countries, reconciling environmental preservation, equity and economic development is more difficult given the poor institutional quality and the lack of technological know-how and skills required to reduce the carbon footprint of industrial productions. This paper examines the labour market adjustment with an early decoupling of economic growth and carbon emissions, concentrating on measurement issues to assess emerging skill mismatches in developing countries. Labour is the main asset for most people in developing countries, thus understanding the labour market distributional effects of green growth on labour markets is particularly important in this context. Given the current GHG emission concentration, developing countries have no choice but embracing a growth path that avoid the initial surge of GHG emissions associated with industrialization, the so-called Environmental Kuznets Curve hypothesis (EKC henceforth, Grossman and Krueger, 1995). The costs and benefits of an early decoupling of economic growth and GHG emissions depend *inter alia* on the abundance of the skills required to attract and develop green productions in developing and emerging economies. Assessing the availability of such skills, in turn, requires a precise identification of the activities that can be considered green and of their skill content.

As usual in these types of analyses, it is important to understand the extent to which lessons learnt in the recent academic literature on green jobs and skills in developed countries apply to developing countries (Consoli et al., 2016; Vona et al., 2018; Vona

et al., 2019). I begin by highlighting the differences between developing and developed countries in both the functioning of labour markets (Fields, 2011) and the structural dynamics driving labour demand (McMillan and Rodrik, 2011; Rodrik, 2018). Of particular interest is to understand the role of labour market institutions and human capital scarcity in hampering economic development. In doing so, the paper builds on new facts on structural change dynamics (Rodrik, 2018).

Next, I apply these ideas to green jobs creation in developing countries. There is, however, a prerequisite to study this issue: a researcher needs to provide an operational definition of what is green in developing and emerging economies, and then of green jobs. The concept of green activities and jobs may have different and somehow contradictory meanings, especially in developing economies. The most obvious notions of "green" are associated with the productions of goods that are beneficial to the environment (solar PV, electric vehicles, batteries) or to reductions in the carbon content of industrial productions (metals, cement, electricity). Alternatively, green employment can be created through the preservation of the environment; for climate change mitigation, forests' preservation and sustainable forestry productions. The case of forestry highlights the fact that the initial conditions are green in developing economies, although the opportunity costs of preservation could be exceedingly high without policy interventions (Chichilinsky, 1994). Finally, developing countries will contribute to decarbonize the world by providing essential minerals and metals to low-carbon technologies, but such additional channel of green job creation is often associated with poor working conditions, health damage related to local pollutants and the destruction of ecosystems.

The latter example brings up directly another fundamental theme of this paper: green jobs are not necessarily "decent" or "good" jobs.[1] In developing countries, informal jobs

[1] The International Labor Organization defines "decent work" as productive work for women and men in conditions of freedom, equity, security and human dignity. It has been implemented considering various dimensions and indicators including basic rights, working conditions, wages, social protection and social dialogue (e.g., Ghai, 2003). The notion of "good job" is instead related to the pay scale and stability. Here it is important to emphasize also the exposure to pollution and toxic substances in the workplace.

are common in waste management, mining and construction, which are all sectors deeply concerned by the green transition. If informal jobs are associated with low health, security and contractual standards, green jobs could be less attractive than jobs in carbon-intensive manufacturing productions provided that the issue of informality is not addressed. In an extreme and probably unlikely scenario, green job creation may exacerbate labour market inequalities as long as working conditions in mines and construction are worse than those in the rest of the economy. As a result, in order to develop a set of indicators to monitor and evaluate the green transformation of labour markets in developing countries, a researcher would need to expand the set of criteria used for developed countries. In particular, she needs to consider a broader set of indicators, which incorporate working conditions in addition to skill and human capital metrics.

Finally, the paper takes stock from the literature on industrial policy in developing countries (e.g., Rodrik, 2004) and on the labour market impacts of the environmental policies for different occupational and skill groups (e.g., Vona et al., 2018; Marin and Vona, 2019) to give a few policy insights. Naturally, the policy discussion revolves around building the skill base for the green economy in developing countries. This entails solving coordination failures by matching the creation of green jobs by firms with the availability of green skills by workers. While the government plays a key role in coordinating the two sides of the markets, I discuss the role of international channels as well and of possible reforms of the WTO rules, also suggested by influential economists (Stiglitz, 2011; Nordhaus, 2015).

The reminder of the paper is organized as follows. Section 2 sets the stage of the analysis by presenting the standard Kuznets paradigm and its failures to understand the relationship between structural change, labour demand and green growth. Section 3 examines the possible strategies that developing countries can use to decouple emissions and economic growth, and the role of skill development in each strategy. Section 4 illustrates the task-based framework to conceptualize and measure green jobs and skills, focusing on its applications and limitations for developing countries. Section 5 provides some policy insights to the design of skill and

labour market policies that can sustain green growth in developing countries. Section 6 concludes by suggesting avenues for future research and for data collection.

2. Structural change and labour demand.

Structural change is the process of sectoral labour reallocation induced by changes in fundamentals: preferences, technology and demographic factors. The "Kuznets paradigm" of structural change[2] is usually condensed in two emblematic stages: i. Reallocation from the informal jobs in the primary sectors, notably agriculture, to the formal jobs in secondary sectors, notably manufacturing; ii. Reallocation from manufacturing to tertiary sectors, notably services. In the first stage, because countries are distant from the technological frontier (Nelson and Phelps, 1966; Acemoglu and Zilibotti, 2001), the main engine of growth is labour reallocation from low-productivity agriculture to high-productivity manufacturing (McMillan and Rodrik, 2011). In the second stage, within-sector technological improvements become more important to sustain economic growth (Rodrik, 2018).

The common wisdom is that the first stage does not require substantial upskilling of the workforce. Since both agriculture and manufacturing draw heavily from an abundant pool of low-skilled labour, the aggregate cost of moving workers from the former to the latter sector is expected to be low. In contrast, the second Kuznetsian stage is associated with the development of technical, cognitive and scientific skills that are the engine of innovation and are enabled by large scale investments in education (Goldin and Katz, 2010). Without complementary adjustments in workforce skills, technological upgrading is unable to deliver the expected payoffs in terms of growth, job creation and productivity improvements (Acemoglu and Zilibotti, 2001).

Recently, the Kuznets' paradigm has been put into question by new empirical evidence on premature deindustrialization, and on the impacts of globalization and technological change in developing countries (McMillan and Rodrik, 2011; Rodrik,

[2] See https://blogs.worldbank.org/jobs/how-can-we-generate-more-good-jobs-developing-countries

2016; Rodrik, 2018). First, some developing countries, notably Latin American and African ones, were not able to sustain industrialization over time. In such countries, international competition accelerated the exit of unproductive plants more than the growth of productive ones, creating a mass of displaced workers that moved back to the informal sector. The premature deindustrialization contributed to slow down productivity growth as well as the creation of good jobs, i.e. well-paid and secure jobs.[3] Second, in last four decades technological change has been biased in favour of high-skilled workers and labour-saving nearly everywhere, including, although to a less extent (Blum, 2010), in developing countries. In conjunction with globalization, the skill-biased direction of technological change helps explain premature deindustrialization. Indeed, automation also weakened the comparative advantage of developing and emerging economies, which rests on their abundance of unskilled labour.

For environmental outcomes, a similar two-stage process is described in the above-mentioned EKC. In the first stage, emissions increase because manufacturing is more pollution-intensive relative to agriculture. In the second stage, emissions decline because the service sector is less pollution-intensive than manufacturing and technological change reduces emission intensity. An important aspect of the EKC is the endogenous shift in the preferences for environmental quality. In developing countries, the median household is poor and thus does not care much about environmental quality, which is not perceived as a basic need (Greenstone and Jack, 2015). In developed countries, the median household is usually rich (although this depends on the level of inequality, e.g., Magnani, 2000; Nicolli et al., 2022) and thus can start caring about the environment. This has an important implication: green growth will gain political support in developing countries only if sustained economic growth (the mean income increases) is combined with a balanced distribution of the dividends of growth (the median income increases as well, e.g. Vona, 2023).

[3] Note also that displaced workers lose their specific skills during periods of prolonged unemployment or when they change sector.

To make a concrete example of which type of structural change is compatible with green growth, let us concentrate on the most pressing problem of climate change where usually the first stage of the EKC is warranted while the second is not (Stern, 2017, Nicolli et al., 2022). The challenge here is that, if we want to limit global warming below at least 2°C, developing countries cannot follow the first stage of the EKC-path for GHG emissions.

For expositional convenience, three, not mutually exclusive, strategies can be envisaged to achieve an early decoupling of economic development and GHG emissions. The first is to accomplish the transition from agriculture to manufacturing importing best available technologies and production methods to reduce GHG emissions (*early green industrialization*). The second strategy is centered around the idea to compensate developing countries in order to remain specialized in primary productions, helping them to develop industries linked to preservation (*preservation-related industrial linkages*). The third strategy consists in by-passing the first-stage of the EKC paradigm altogether, directly moving to a service economy (*early terziarization*). Next section discusses the implications of these green strategies for labour demand and skill development.

3. Green growth strategies and skills.

This section first examines the ways through which workforce skills adjust in the three green growth strategies sketched above and then considers the role of labour market institutions in the adjustment process. The focus is on green growth strategies that either reinforce or create comparative advantages in tradable activities that reduce global GHG emissions. Tradable sectors are strategic to a country's development path by creating indirect jobs through local job multipliers and input-output linkages (e.g., Moretti, 2010).[4]

[4] A boost to green job creation will also come from the nontradable part of the economy, notably through infrastructure investments in electrification, building, transportation and environmental remediation. However, one should not expect large cross-country differences in the skill sets required to install a

Early green industrialization.

Laggards countries find it difficult to industrialize due to path dependency that is linked to fact that building competences and skills take time. Industrializing becomes more difficult for developing countries because manufacturing becomes more intensive of skilled labour (Kunst, 2019), which is initially scarce in these countries. Green industrialization is not an exception to this upskilling pattern. Marin and Vona (2019) show that an arguably exogenous increase in energy prices (a proxy for higher carbon prices)[5] induced a change in the skill composition of EU manufacturing productions away from manual workers and in favour of technicians and engineers.[6] Evidence for the US confirms the bias of green activities (tradable and non) towards technical skills (Vona et al., 2018) and higher on-the-job training requirements (Consoli et al., 2016; Popp et al., 2021). A study on the British Columbia carbon tax finds that higher costs are passed to unskilled workers in terms of lower earnings (Yip, 2018).

Importantly, workers with middle-to-high technical skills are scarce in developing countries and the incidence of on-the-job training arrangements is much lower than in OECD countries. For instance, a recent report mentions that the workers who receive training in Latin American countries is, on average, just 15% that is much lower than the OECD average of 56% (Alaimo et al., 2015). As for other coordination failures that characterize economic development, public investment in technical skills may not suffice to trigger an early green industrialization, unless not combined with policies to attract companies willing to invest in on-the-job training. Popp et al.

PV system, to repair an electric vehicle or to insulate a building. Some infrastructural investments are also essential to build a comparative advantage in tradable productions; hence they can be seen as complementary to the investments in human capital in green industrial productions.

[5] See Marin and Vona (2021) for a detailed discussion of the conditions under which energy price changes can be used to simulate the effects of an increase in carbon pricing.

[6] Borissov et al. (2019) incorporate some of these ideas into a theoretical analysis of the interplay of human capital investment and climate polices in a growth model where the clean technology is high-skill intensive.

(2021) reveal the importance of coordinating green investments in both physical and human capital by showing that the job creation effect of a green fiscal push was significantly higher in regions with the appropriate green skills.[7]

Another issue is that the comparative advantage in green productions (e.g. bicycles, PV panels, LED bulbs, wind turbines, railways, etc.) is highly persistent and concentrated in wealthy countries with long-standing industrial expertise such as Denmark and Germany (Bontadini and Vona, 2020). While some emerging economies, notably China and India, were able to attract key green productions, such as batteries and PV panels (Sawhney and Kahn, 2012), it may be more difficult for other developing countries to follow the same path.

Rather than focusing on high-tech green goods decarbonizing traditional manufacturing can be easier to achieve for developing countries, provided that there is a substantial gap in energy (and pollution) efficiency in developing countries. While energy costs are often a small fraction of total cost for the average industry, overall efficiency, and not only energy efficiency, is much lower in developing countries for several reasons, including the lack of the appropriate workforce skills and know-how. Foreign companies play a key role in creating an efficient manufacturing sector (Verhoogen, 2021). Empirical research shows that, in developing countries, energy and carbon intensity are significantly lower among exporters and multinational companies (e.g., Eskeland et al., 2003; Barrows and Ollivier, 2018; Brucal et al., 2018) and that these companies also pay higher than average wages (e.g., Verhoogen, 2008; Amiti and Davis, 2012). A few recent studies highlight the importance of human capital for environmental performance of companies in developing countries (Cole et al., 2008; Blackman and Kildegaard, 2010; Lan and Munro, 2013; Lan et al., 2017). For instance, Cole et al. (2008) show that a higher energy efficiency is positively

[7] However, green spending did not appear to have a larger job multiplier than non-green spending on average, although this paper was unable to distinguish between green spending in tradable and nontradable sectors. Other studies find larger green job multipliers, but are less credible in addressing endogeneity issues (Vona et al., 2019, Batini et al., 2021). More research is needed to assess the size of green job multipliers relative to credible counterfactuals, and the role played by investments in skills.

associated with the previous training and experience in foreign owned companies. However, there is also a dark side of FDI as multinational companies are inclined to transfer the old and most polluting technologies in developing countries also to escape environmental regulation (see for a survey, Cole et al., 2017). Although more evidence is needed to understand the role of know-how transfer from multinational companies, these findings suggest that investments of foreign companies can have either positive or negative impact on the carbon footprint of manufacturing in developing countries. The costs and benefits of green industrialization depends also on initial conditions. One can consider three groups: emerging economies, developing economies without fossil fuel resources and developing economies with fossil fuel resources. For the latter group, the opportunity cost of green industrialization is expected to be exceedingly high in any plausible scenarios. Obviously, the policies required to diversify resource-intensive economies go beyond the domain of skill and labour market policies (see, e.g., Stiglitz, 2005; Van der Ploeg, 2011). It suffices here to say that the incentives to invest in human capital are lower in countries abundant of natural resources, thus the potential skill base for the low-carbon economy will be also weakened. For the group of emerging economies, two contrasting forces are at work. On the one hand, the existing industrial know-how makes green industrialization easier (e.g., Sawhney and Kahn, 2012). On the other hand, emerging countries face higher sunk costs than those encountered by the developing countries, especially if industrialization was based on the intensive use of coal. Indeed, industrial restructuring raises enormous challenges for regions and workers that are highly specialized in coal-intensive industries and often lack the set of competences to be employed in green industries. These issues have been studied by the recent work on the just transition (Vona, 2019; Weber, 2020; Carley and Konisky, 2020; Pai et al., 2020).[8] An important finding of the just transition literature is that the skill set of "brown workers" is quite similar to the skill set of "green workers" (Vona et al., 2018;

[8] A recent comprehensive report highlights the labour market challenges faced by developing and emerging economies to phasing out from coal (Ruppert Bulmer et al., 2021). I refer the reader to this report for a better understanding of the challenges to achieve a just transition for coal workers.

Popp et al., 2021). While this is good news for the distributional effect of the energy transition, it also implies that the competition for such skills will be higher in emerging countries that have already established a comparative advantage in polluting industries.

Preservation-related industry linkages.

Preserving the environment looks the default strategy, at least in terms of reskilling requirement. However, it has the lowest political appeal as it is not associated to a growth-enhancing industrialization push. Implementing this strategy requires exploring new policy tools and redirecting international aids to projects such as payments for ecosystem service (PES) that remunerate local communities for forests' preservation (e.g., Jayachandran et al., 2017). For instance, scaling up PES financing would have a positive effect on global GHG concentration and moderate costs in terms of reskilling requirement.[9]

To make this strategy more appealing, policymakers can take stock from the literature on the remedies for the natural resource curse (Stiglitz, 2005). According to this literature, governments leverage the opportunities opened by the abundance of a natural resource (i.e., forests) using industrial policies directed to sectors that are linked to that resource (David and Wright, 1997). For forests, there are obvious linkages related to tourism and exploitation of biodiversity by pharmaceutical companies. Promoting a greener and more technologically advanced agriculture is another example of this strategy. Other linkages are less obvious: industry development in the wood and furniture industry is a distinct possibility following the Swedish and Chilean examples, but the challenge is to make such industry environmentally friendly. To create new intra-industry linkages, governments have to identify the skill needs of the candidate industrial sector so as to design sector-specific training policies.

[9] For instance, the ILO reports that the skills needed for occupations related to forest preservation are already available in Bangladesh, but further skill development programs will be required to expand their supply (Mondal et al., 2011).

Early terziarization.

The last option is to transition directly to a service economy. Note that the service sector is highly polarized in terms of skill requirement and tradability. High-skilled service sectors such as finance, law and engineering consulting are high-skill intensive and tradable, while other service sectors such as cleaning, preparing food and waste management are low-skilled intensive and non-tradable. Because developing countries lack high-skilled workers, by-passing industrialization is tantamount to moving directly to a low-skilled service economy, which will have limited capacity to sustain economic growth. Tourism linked to biodiversity preservation is an exception of a low-to-middle skilled service sector that is potentially green, but it is difficult to think that this sector can be the engine of sustained long-term growth.

Another important part of the low-skilled service sector is represented by waste management, which is unskilled, labour-intensive, pollution-intensive and partly tradable. In a well-known vicious circle, developed countries export waste, including toxic and illegal waste, to developing countries with the associated damages in terms of health, destruction of ecosystems and biodiversity. For waste associated with low-carbon technologies, Tanaka et al. (2021) show that the diffusion of electric vehicles in the US increase in the export of used batteries to Mexico where the production of battery-recycling plants is highly polluting and thus deteriorates the health conditions of people living near the plants. Rather than the upskilling of the workforce to deal with recycling activities, on which there is however some preliminary evidence (Burger et al., 2019), the most pressing issue is ensuring high environmental standards along the entire value chain of waste management. Also recycling activities open up interesting opportunities to create new industry linkages. Notably, developing countries could exploit the potential linkage between recycling of rare minerals and the manufacturing of green productions using recycled products. It is worth emphasizing here another fundamental difference between developed and developing countries. The job quality in sectors such as waste management, forestry

and mining of critical minerals for the energy transition is low in most developing countries: wages are low, work accident frequent, exposure to toxic substance high and child labour widely used. In other words, the second fundamental difference between developed and developing countries is that, in the former, all green jobs are good jobs, while, in the latter, a large share of green jobs are likely to be bad jobs.

Changes in labour market institutions.

In discussing the early decoupling of economic growth and emissions, I focused so far on the complementarity between reskilling investments and a targeted green growth strategy. An equally important issue is to promote changes in labour market institutions that allow to reconcile green growth with the creation of decent jobs.

Field (2011) reviews the characteristics of labour markets in developing countries. Salient characteristics are the high incidence of informal contractual arrangements with the associated labour market dualism,[10] the diffusion of self-employment, job instability, and no (or weak) employment protection legislation. The incidence of informality[11] is likely to be high in some green sectors, such as waste management, construction and mining, making it difficult to achieve both an improvement in working and environmental conditions. For instance, the incidence of labour informality in mining ranges between 36% in Bolivia to 50% in Columbia and 61% in Costa Rica (OECD, 2022).[12] Weak institutions, including weak labour market institutions and the absence of a welfare state, may even lead to a deterioration of the natural environment. Chichilinsky (1994) shows that, in absence well-established property rights on common resources and of a well-established welfare system,

[10] In the formal sector wages and productivity are typically much higher than average and jobs are secure. In the informal sector, wages and productivity are much lower than average and jobs insecurity is the norm. This can be explained by various theoretical mechanisms (Field, 2011), including barriers to occupational mobility (i.e., certified skills) and search and matching (i.e. only matches with high productivity becomes formal as formal jobs are costlier in terms of social security contributions).

[11] The informal sector is defined as enterprises that do not keep written accounts or are not registered in tax institutions.

[12] Informality is much lower in the utility sector, which is also potentially green, but this sector represents a very small share of total employment compared to construction, mining and waste management together.

unemployed workers are forced to go back to the informal sector where they are likely to over-exploit common pool resources (i.e. forests). This is consistent with the fact that the informal sector serves as an insurance for workers displaced by structural transformations.

Importantly, labour market dualism has serious implications for skill formation and on-the-job training. First, displaced workers end up employed in the informal sector rather than in state-sponsored retraining programs. Using firm-level data for several developing countries, Almeida and Aterido (2011) show that a strict employment protection legislation increases the firm incentive to invest in on-the-job training as predicted by theoretical models (Acemoglu and Pischke, 1999). Second, the fact that workers in the informal sectors do not possess certifications for their skills pushes the economy towards an equilibrium where private companies are discouraged to invest in workforce training. Third and related to this, dualism is self-sustaining as less skilled workers usually receive much less training (e.g., Almeida and Faria, 2014; Alaimo et al., 2015).

Institutional change is endogenous to economic development and sustained economic growth improves labour market conditions reinforcing the workers' bargaining power and thus workers' rights, i.e., various employment protection legislations. Knowing this, workers in developing countries are willing to prioritize economic growth over the preservation of the environment. More specifically, if the socioeconomic benefits of green growth are more forward looking than those of non-green growth, the latter has higher political acceptability than the former (unless the former is not associated with immediate improvements of working conditions). This argument is particularly relevant for green growth strategies based on preservation and early terziarization, as both the forestry and the waste management sectors are characterized by a high incidence of informal arrangements. In a nutshell, without a parallel promotion of employment protection legislation, there are little chances that workers will prefer to be employed in preserving a forest rather that in the oil sector.

Summary.

In developed countries, the main challenge of green growth is to restructure existing sectors by upgrading technologies and infrastructures. In developing and emerging economies, a green growth strategy has the main goal of by-passing the first phase of the EKC paradigm where emissions and growth are coupled. The type of labour market adjustment, and especially the adjustments in the skill base, is strongly interwoven with the strategy chosen. However, a common theme of all green strategies is to reconcile growth with improved working conditions, thus enhancing political acceptability. If green jobs are concentrated in the informal sector, unsecure and less paid than non-green jobs, the public support for them will be low regardless of the international support that they will receive.

As we will see in the next section, these conceptual issues bear relevance for the building of indicators that allows to monitor the progress of developing countries along a green growth path.

4. Identifying green jobs and skills.

Once a green growth strategy is chosen, the next step is to build a set of indicators to assess, monitor and implement it. The concepts of green jobs and skills have been developed for this purpose. Recent research makes progress to give a rigorous and precise definition to these concepts using the task-based approach to labour markets (Vona et al., 2018; Vona, 2021).[13]

The general idea of the task model is to infer the occupational involvement (or exposure) to a structural transformation (i.e., automation, green technologies, globalization etc.) using a description of what workers do in the workplace. This description is organized into tasks as natural in most workplaces.

Theoretically, tasks enter in a production function, while factors of production compete to be assigned to a specific task (Acemoglu and Autor, 2011). For instance, information and communication technologies replace middle skill workers in

[13] This section extends the background paper of Vona (2021) where the task approach and its applications to study green jobs and skills are presented in details. For more examples and details, I refer the reader to this paper.

performing routine cognitive tasks (Autor et al., 2003). The distinction between tasks, on the one hand, and production factors, on the other, allows for a richer representation of production. For instance, it allows to have skill mismatches at a very granular level. If wind energy engineers have a comparative advantage to test and design wind turbine equipment, a scarcity of such engineers (or of the skills they possess) reduces the efficiency of wind turbine production.

Empirically, the task model becomes the horserace to study the impact of structural transformations in the labour market thanks to the development of new datasets containing detailed information on the task and skill content of occupations. Not by chance, these datasets were developed by policymakers in the US to track potential skill mismatches in the labour market after the great recession of 1929 (Gray, 2013).

Defining what is green.

The first step of a suitable strategy to identify a green job is to define "what is green" (Vona, 2021). The previous discussion on green growth strategies gives insights on how this issue is context-specific and depends on the country's strategic objectives.

Two main notions of what is green have emerged in previous literature (e.g., Bontadini and Vona, 2020): i. a process definition, emphasizing the pollution content of production and thus jobs; ii. an output definition, emphasizing the potential of a product or a service to mitigate harmful impacts on the environment. The surveys collecting the production of green goods and services use the second definition, i.e. the Green Goods and Services Survey of the Bureau of Labor Statistics in the US (Becker and Shadbegian, 2009; Elliott and Lindely, 2017) and the Eurostat definitions of green products (Eurostat, 2016; Bontadini and Vona, 2020). In contrast, the surveys assessing the pollution content of productions are tied to the first definition (i.e., Sato, 2014; Marin and Vona, 2021).

Both types of data are collected at the firm- or sector-level, capturing two different aspects of green technological change (Bontadini and Vona, 2020). On the one hand, the output-based definition concentrates on the production of green technologies, but it is silent on the environmental impacts over the product life-cycle. An electric

vehicle has the potential to be green, but it becomes green only when electricity is consistently produced with low-carbon sources. On the other hand, the process-based approach concentrates on these life-cycle aspects, but it is silent on the green technology used. Using the process-based approach, it impossible to know if a company has a low-carbon footprint because it is more efficient in using all inputs or because it is adopting a particular low-carbon technology.

A task-based measure of green jobs.

A drawback of the data collected in both cases is that a researcher is unable to capture heterogeneity in worker's exposure to green activities. In contrast, datasets containing information on the task content of jobs allow to identify the extent to which each job is exposed to the greening of the economy, regardless of the way in which being green is defined. This feature is very important for assessing the labour market effects of technological change that are highly heterogeneous across workers and depend on the mismatches between the set of skills possessed by workers and those required on the job.

In light of its importance for research on green jobs, I focus here on the US Occupational Information Network (O*NET). From 2000 on, O*NET employs occupational experts and surveys on incumbent workers to collect data on the task and skill content of approximately 900 occupations. Skills are defined for all occupations with a 1-5 importance score, while tasks are text descriptions unique to each occupation.

O*NET has a special section devoted to green jobs and tasks: the 'Green Economy Program', which is inspired by the output definition of what is green (see Dierdorff et al., 2009; 2011; Peters et al., 2011). The Green Economy Program provides two important pieces of information. First, some occupations (around 100) are labeled as green. This includes both occupations that are obviously green, such as Solar Sales Representatives, Recycling Coordinators, Hazardous Material Removers, Environmental Engineers and Fuel Cell Technicians, but also occupations that could be green depending on the particular technology used, such as Software Developers,

Customer Service Representatives, Chemical Plant and System Operators, Roofers and Urban and Regional Planners. Recent research shows that this occupation-based, "binary", approach largely overstates the share of green employment. Indeed, a binary definition of green jobs misleadingly considers as fully green jobs that are generic or engaged in green production for a fraction of their time (Vona et al., 2018, 2019; Vona, 2021).

Fortunately, O*NET also contains information on the green task content of occupations. For instance, we know that a Roofer perform both green tasks (i.e. install solar roofing systems) and non-green tasks (i.e., inspect problem of roofs to determine repair procedures). Vona et al. (2018, 2019) propose to use the share of green task over total task as continuous proxy of occupational greenness. This indicator has two possible interpretations (Vona, 2021). First, occupational greenness captures the amount of time spent on green activities and technologies in the average job post within a given occupation. Second, it captures the share of job posts that are engaged in green productions within a given occupation. It is thus possible to the greenness indicator to measure the share of green employment, by reweighting occupational employment shares by their greenness.[14] Vona et al. (2019) find a share of green employment of approximately 2-3%. This estimate is in line with that of the Green Goods and Services Survey for the US (Elliott and Lindely, 2017) or with the measure of green production based on the PRODCOM dataset for Europe (Bontadini and Vona, 2020).

A continuous measure of occupational greenness has several advantages: rather than considering as fully green occupations that are not, it gives a nuanced assessment of the occupational involvement into green activities. As a result, the greenness indicator allows to accurately track the evolution of green employment over time and across regions. Importantly for developing countries and the discussion of section 3,

[14] Green tasks are retrieved only for green occupations by O*NET. Thus, the greenness index is 0 for about 800/900 SOC 8-digit occupations, and it is between 0-1 for the remaining 100 8-digit occupations that O*NET defines as green.

this definition could be easily adapted to different notions of what is green or even to identify brown tasks using the O*NET task descriptor.

However, the O*NET dataset has also important limitations, especially for the imputation of green tasks. First, O*NET-type of data on the green task content of occupations are available for the US only.[15] Using crosswalks between the US occupation classification (SOC) and the EU one (ISCO), the US task content of occupations is often imputed to that of EU occupations in papers studying the impact of computers and digital technologies on the European labour market (e.g., Goos et al., 2014). A similar imputation has been done for green tasks by Elliott et al. (2021) in the Netherlands. In the former case, however, measurement issues become very relevant for the small size of green occupations and the lack of granularity of occupational data outside the US.[16]

Second, for this imputation to be valid the key assumption is that the task content of occupations, and thus the technology and organization of work, is the same in the US and in the rest of the world. Several papers conduct rigorous tests of this assumption for developing and emerging economies, conditional on data quality and availability (Dicarlo et al., 2016; Lewandowski et al., 2019; Lo Bello et al., 2019). For 11 low- and middle-income countries, Dicarlo et al. (2016) and Lo Bello et al. (2019) validate the common practice of imputing routine and non-routine task intensity scores of O*NET to other countries using a new survey of the World bank called the Skills toward Employment and Productivity (STEP), which has been built following same principles of O*NET (see Dicarlo et al., 2016, for details). The main takeaway of these cross-validations is that, comparing similar 1-digit occupations, the skill content of jobs in developing countries is very different from that of the US. The authors observe that similarity increases with income per capita, suggesting that this assumption is

[15] Germany and Italy have developed similar datasets, but they do not contain information on the task content of occupations.

[16] The imputation of the US greenness to EU data presents other problems related to the level of granularity available in the EU Labor Force Survey. The key problem is that occupations with positive greenness represent a small fraction of total employment, thus aggregating them without knowing their precise employment shares leads to large measurement errors. Vona (2021) discusses this issue in details.

less valid for developing countries than for Europe. This is consistent with the fact that EU countries shares with the US similar organizational practices and technological expertise.

Third, while digital technologies are general purpose and share a set of common principles, green technologies are more idiosyncratic and specific depending on definition of what is green, the sectors of use and the fact that they are rapidly evolving. To a certain extent, a researcher could overcome this limitation by grouping the O*NET green tasks into specific sub-sectors.[17] However, in spite of the richness of the O*NET data, this will be asking too much to such data. Indeed, several green jobs and thus tasks are defined for 8-digit occupations for which the Bureau of Labor Statistics does not even report the employment shares (see Vona, 2021, for details).

Finally, O*NET task scores are country averages, so they are unable to capture the sectoral and regional heterogeneity in exposure to shocks related to the green economy. This assumption is quite common in the study of other structural shocks (i.e. Autor and Dorn, 2013), but still represent an important limitation of O*NET.

Identifying green skills.

The task-based approach is particularly useful to provide a rigorous definition of another elusive concept for the green economy, that of green skills (e.g., Cedefop, 2010, 2019; ILO-Cedefop, 2011). Having a workforce with the set of skills required to perform green tasks efficiently (i.e. green skills) is essential to build a comparative advantage in green productions because reallocation costs are proportional to the skill distance between origin and destination occupations (e.g., Kambourov and Manovskii, 2009; Gathmann and Schönberg, 2010). If green jobs are similar in terms of skill set to non-green jobs, at least within a certain occupational category (e.g., construction workers), there is no need to worry too much about the cost of retraining workers for such jobs. If instead skill sets are very different, retraining policies

[17] O*NET divides the green occupations into the following sectors: agriculture and forestry, energy efficiency, manufacturing, renewable energy generation, environmental protection, government regulation, green construction, recycling, R&D and consulting, transportation.

become an essential ingredient of a successful green policy package. Also, the size of reallocation costs affects the distributional and aggregated effect of climate policies (e.g. Castellanos and Heutel, 2019).

Overall, the task-based approach is the ideal setup to tackle the most important question to understand the labour market implications of the green transition: how much would cost to retrain workers for green occupations?

Vona et al. (2018) use the task-based approach to reveal the skills that have a comparative advantage in performing a green task. In doing so, the authors regress skill scores of O*NET on the greenness indicator and controlling for occupational dummies in order to compare similar occupations. A positive and significant coefficient for the greenness indicator reveals that a particular skill is green. Using principal component analysis, the authors aggregate green skills into four groups: i) Engineering and Technical, ii) Operation Management, iii) Monitoring, and iv) Science. Interestingly, the most important green skill, i.e. Engineering and Technical skills, is uncorrelated with the usual index of routine-task intensity used to measure the exposure of an occupation to computers and digital technologies. Moreover, relative to the benchmark of all other occupations in the same broad SOC group (at 2-digit level), green and brown jobs[18] are quite similar in terms of green skills, but different in terms of on-the-job training requirement (Consoli et al., 2016; Popp et al., 2021). This implies that the cost of retraining workers displaced by climate policies for green jobs will be mostly in terms of on-the-job training, which, as already discussed, is under-supplied by companies in developing countries.

The use of these green skill indicators contributes to explain the impact of environmental and climate policies in multiple contexts. Vona et al. (2018) estimate changes in the demand of green skills induced by an amendment in the US Clean Air Act. The authors find that the demand for workers with green skills, especially engineering and technical skills, increases in metropolitan areas exposed to a more

[18] To define brown occupations, a researcher has to resort to a process definition that considers brown an occupation primarily employed in polluting industries or firms. Vona et al. (2018) consider brown an occupation that has a probability of being found in polluting sectors higher than a certain threshold.

stringent environmental regulation relative to a credible counterfactual. Popp et al. (2021) show that green skills are important to mediate the economic effect of a fiscal push to the green economy. This research finds that the net job creation of the green part of the US American Recovery and Reinvestment Act (ARRA) was much larger in US commuting zones with a larger fraction of workers with the appropriate green skills, which also received a larger fraction of green spending and were growing relatively faster before the 2008 financial crisis. Marin and Vona (2019, 2021) show that an arguably exogenous increase in energy prices induced a change in the skill composition of EU and France manufacturing production away from manual workers and in favour of technicians and engineers. Saussay et al. (2022) use job vacancy data for the US to conduct a similar analysis for the subset of low-carbon jobs, finding larger skill gaps between low-carbon and non-low-carbon job ads for technical skills than for other skill metrics (e.g., IT skills, social skills).[19]

In sum, technical and engineering skills appear as a defining feature of green technologies, organizational practices, and production methods. These skills are both high- and mid-level skills required in several stages of technology, including design, construction and installation. While the skill content of green jobs can be different in developing countries, it is hard to believe technical skills will not be important for a green industrialization strategy. While more research is needed to corroborate this key finding for developing countries, next section gives some suggestions on how to assess trends in green jobs and skills without O*NET data.

Overcoming data limitations in developing countries.

Is the task-based approach a suitable measurement framework to understand the labour market implications of the low-carbon transition in developing and emerging economies? The answer is a cautious yes because his framework is flexible enough to accommodate for different definitions of what is green and green growth strategies.

[19] Interestingly, the authors find that, while low-carbon ads are more skill intensive than similar ads, they do not offer higher wages. Therefore, investments in skills seem relatively less lucrative in green jobs than in the rest of the economy.

Moreover, the procedure to identify green skills described above could be easily extended to contexts where task data are slightly different or unavailable.

Additional data collection would be required to implement the task approach circumventing limitations listed above. The expertise built within the Skills toward Employment and Productivity (STEP) project can be fruitfully applied to collect additional data on green tasks. The easiest way of doing this is to add questions on green tasks, taking stock from the green economy program of O*NET and the specific green growth strategies described above. Because of the time required for an extensive data collection, data can be also collected in a bottom-up fashion from specific policy experiments. This would be coherent with the O*NET type of data; that is: improve information flows between the demand and the supply sides of the labour markets (Gray, 2013). For instance, data on the skill requirements in specific green occupations and technologies can be collected for the various projects financed by international organizations, such as the Clean Development Mechanism, payment for eco-system services and industrial projects to build solar farms or reconvert coal power plants. It goes without saying that setting common criteria for bottom-up data collection will make it possible to use such data to conduct credible policy evaluations and cross-country comparisons.

Another data effort is targeting multinational companies that invest in developing countries. Tracking the skill needs of such companies is a first step to improve the social and environmental impact of foreign direct investments. Global data on multinational companies are increasingly available, but it is unclear the extent to which best managerial and human resource practices are adopted in all locations and the role played by skill availability in slowing down their diffusion. Some developing countries have excellent data on firm-level emissions and energy intensity (e.g., Brucal et al., 2018; Barrows and Ollivier, 2018) that are amenable to be merged with data on skills to identify the association between emission intensity and skill requirement, using a method similar to that proposed by Vona et al. (2018). More generally, any firm- or sector-level dataset with information on production, export, patents or emissions can be used, first, to identify green activities (e.g., the inverse of

the pollution intensity or exports of green products) and, then, to assess the skill requirement of these activities, provided that data on the occupational structure of firms or sectors are readily available.

The implementation of the task approach using job vacancy data is yet another promising avenue to build skill contents that varies also within specific occupations. In particular, two job ads belonging to the same occupation can be compared in terms of skill content. This feature of job vacancy data is interesting to understand whether green and non-green job ads require different skill sets within a narrow occupation. Lightcase (former Burning Glass Technologies) is the main player in the field of data-intensive measures of skills based on job vacancies and is extending its approach in several countries, including developing ones. Saussay et al. (2022) use these data to extend the analyses of Vona et al. (2018) focusing on climate-friendly green jobs. Using natural language processing techniques as in Atalay et al. (2020), the authors identify the climate-friendly green job vacancies and then a set of occupation-specific green skills. However, self-selection is an obvious issue with job ad data that is related to the fact that not all jobs are advertised online. Such issue is likely to be amplified in developing and emerging economies where the use of online job posting is limited, most jobs are in the informal sector and found through informal contacts. Still, such data will provide insights on the skill content of green jobs in the formal sector of developing economies.

The final and more general issue is related to the association between green jobs and good jobs. Previous section raises the concern that the incidence of informal arrangements, and so insecure and low-paid jobs, may be higher in some green activities, such as waste management. However, adopting greener productions represents an opportunity to encourage the diffusion of formal and more stable work arrangements in waste management, mining and construction. To evaluate the progress in this direction, indicators tracking the growth of green employment and potential skill mismatches need to be combined with indicators measuring the quality of new green jobs in terms of wages, job security and exposure to pollutants and toxic substances in the workplace. The goal of using multiple criteria is to avoid cases of

rare earth mining jobs that may be low-carbon in a global perspective, but are detrimental to working and health conditions in developing countries damaging the local wellbeing. Based on these ideas, next section discusses some policy insights for the development of green competences in developing and emerging economies.

5. Policy insights for green competence building.

This section lays out policy insights that can be used to enhance the creation of green jobs in developing and emerging economies. It is inspired by four strands of policy research on: i. industrial policies in developing countries (Rodrik, 2004) and distressed communities (Bartik, 2020); ii. policies and institutional setups for the creation of good jobs (Hall and Soskice, 2001; Rodrik and Sabel, 2019; Rodrik and Stantcheva, 2021); iii. the just transition (Carley and Konisky, 2020; Vona, 2023; Ruppert Bulmer et al., 2021); iv. green jobs and skills (Vona et al., 2018; Popp et al., 2021). Due to space constraints, I cannot give justice to these strands of policy analyses. The purpose here is to connect and hybridize some ideas developed by literatures for the case of green skills in developing economies.

To recap the issues at the stake, the key challenge for developing countries is to build a base of technical and engineering skills that allow them to move directly to a green industrialization path, possibly exploiting pre-existing industry linkages with natural resource preservation. Such skills are scarce in developing countries either because there is no industrial expertise or because workers with such skills are employed in polluting industries, which are not dissimilar in terms of skill requirement but usually pay higher wages. Building up technical and engineering skills, especially middle-skilled ones, not only depends on good public education and local training programs, but also on on-the-job training which in turn requires the cooperation between industrial associations, unions and local governments (Hall and Soskice, 2001), which is another scarce asset in developing countries. However, social actors are actually weak in several developing countries, thus the process of capacity building is more difficult. Finally, the worker's preferences for green jobs crucially

depend on job quality, including the incidence of informality and the exposure to pollutants. It is by no means clear that green jobs in developing countries will be necessarily good jobs. Therefore, complementary institutional changes in labour regulation are essential to make green growth feasible, attractive and beneficial for people in developing countries.

The first policy issue is to coordinate industrial policies and skill development policies. If firms do not supply an adequate quantity of green jobs, there is no reason to invest in green skills, and viceversa. This principle has not been followed by policymakers in developed countries that, in spite of the empirical evidence for the US (Popp et al., 2021), neglected the complementary of investing in green skills for the success of the green stimulus packages under discussion around the World. Indeed, as shown in the OECD dataset on the green recovery, only 2.1% measures under discussion within green stimulus packages concerns workforce retraining for green jobs.[20]

A focal point of government interventions is to tackle both the "environmental externality" and the "good job externality" –as a higher incidence of good jobs in a local community is associated with lower crime, lower use of drugs, better health, etc. (Rodrik and Sabel, 2019). This can be achieved in several ways, but a stick and carrot approach seem particularly promising here. Practically, companies polluting above a pre-specified benchmark can be penalized, while companies creating more good job than average could be rewarded.

The bottom line to solve coordination failures is that specific initiatives on both sides of the markets are required to complement public investment in training and education. On the supply of skills, the ILO (2019) recommends the diffusion of green skill certification schemes for various jobs and imposing them to all employers involved in green projects. These certification schemes mitigate informational problems that reduce the incentives of private companies to further invest in green skills. New institutional arrangements can be envisaged to build the green

[20] See: https://www.oecd.org/coronavirus/policy-responses/the-oecd-green-recovery-database-47ae0f0d/

competences required by local actors. For instance, the expertise of environmental protection agency could help educational and training institutions to identify green skill gaps in specific situations. It is however important that such bottom-up approaches are guided by a measurement framework inspired by the task-based approach that allows to identify skill gaps across occupations and thus design effective retraining programs.

Regarding the content of reskilling programs, recent research for the US finds that sectoral training programs are significantly more effective than general training programs (Rodrik and Stantcheva, 2021). As I already noticed, key prerequisite for sector-specific training is cooperation among private and public actors to identify the skill requirements, the financing arrangements and the target population of participants. O*NET type of data and the task-based approach could help in building valuable information to continuously upgrade and evaluate training programs. However, developing countries often lack the capabilities, both from the government (i.e. bureaucratic competences) and the private sector side, required for the success of such initiatives. Clearly, the issue of building government competences should be properly addressed on a case-by-case basis.

On the demand side, openness to international competition has been seen as the key channel for quality upgrading in developing countries (Verhoogen, 2021), which allows exporting companies to combine higher than average wages and emission efficiency. However, evidence on the beneficial effects of trade openness is more mixed than previously thought. Exporting often creates fewer good jobs than expected (Cali et al., 2016), positive spillovers for the local economy are not so evident and excessive competition from foreign companies pushes back workers to the informal sectors (McMillan and Rodrik, 2011). Moreover, foreign companies systematically invest in highly polluting sectors without putting much effort to transfer best available green technologies (Dean et al., 2009; Sawhney and Rastogi, 2019).[21] Finally, the current

[21] Foreign companies could also lobby the governments of developing countries to relax environmental standards (Cole et al., 2006).

structure of world tariffs is extremely biased in favour of fossil fuel activities over cleaner productions (Shapiro, 2021).

Taken this evidence together, it is clear that, without global environmental rules, the interaction between foreign investors and politicians of developing countries is stuck in a vicious path from an environmental point of view. There is, however, plenty of room for changing the rules, especially at the WTO and for FDI. A minimal approach would be to recognize the exceptional threat of climate change, allowing an asymmetric change in global tariffs that penalize carbon intensive countries (Nordhaus, 2015). A more ambitious approach would be to incorporate labour and environmental standards within a broader reform of the WTO rules, at least, at least for FDI and well-established exporting companies, and would have the aim to reconcile good jobs and global reductions of GHG emissions (for a broader discussion, see Rodrik, 2004). Greening trade policies is expected to boost the demand for green jobs, matching it with public investments in training and reskilling. In an unfavourable environment for global cooperation as the current one, these ideas can be implemented on a smaller scale, on voluntary basis and in specific context where institutional capabilities are already there. For instance, it would be relatively easy to impose green and social conditionality rules to international aids or to combine green technology transfer with retraining requirements, especially for companies involved in well-established programs such as the Clean Development Mechanism.

Two final issues are worth to be discussed here. First, policymakers have to navigate the tradeoff between creating stronger labour market institutions and preventing excessive labour market rigidities that may slow down labour reallocation and could even increase informality in response to adverse labour market shocks (e.g., Almeida et al., 2022). In line with the Varieties of Capitalism literature (Hall and Soskice, 2001), there is plenty of room for experimentation and each country could find its own institutional setup to solve this tradeoff. In northern Europe, for instance, flexsecurity schemes combine generous unemployment benefits with targeted retraining policies (e.g., Viebrock and Clasen, 2009). In Anglo-Saxon countries, governments privilege market mechanisms and information flows. Second, policies

improving labour market conditions for green jobs enhances the political acceptability of sustainable development in general. Altering the preferences for green and brown jobs play a key role in this respect. A survey experiment in India shows that individuals recognize the harmful effects of working in coal mines, but also reveals that the pay scale is the main determinant of occupational preferences (Blankenship et al., 2022). As done under the US American Recovery and Reinvestment Act (ARRA), governments in developing countries can require to pay higher than average wages to companies receiving green subsidies, possibly adding incentives such as cuts in payroll taxes. Again, the availability of good data to identify virtuous companies is essential for the success of targeted green growth policies.

6. Concluding Remarks.

This paper focuses on the labour market and skill policies to accelerate the green transition in developing countries. Three main policy insights emerge combining the recent literatures on green skills and on structural change and labour markets in developing countries. First, an early green industrialization is impossible without a carefully designed coordination of the demand and the supply side of green labour markets. Second, such coordination is eased by the availability of good indicators and conceptual definition of what is green, which can be built using the principles of the task-based model. Third, targeting green jobs is not enough if such jobs are informal, offer lower wages than similar jobs and are exposed to health risks.

I conclude the survey by bringing the attention on possible directions of future research, beyond those already discussed in Section 4 concerning the collection of new data and the extension of STEP skill survey.

Above all, evidence for the US raises the concern that green jobs require more skills than similar jobs, but are not necessarily paid more than them (Popp et al., 2021; Saussay et al., 2022). This preliminary evidence needs to be corroborated in other contexts, particularly for developing countries and using individual-level data such as the International Income Distribution database of the World Bank. Existing data

can be also used to improve the measurement of the green skill base of specific countries. While measurement of green jobs is problematic without granular occupational data and information on the green task content of occupations, there is now enough evidence on the skills that are important for the green transition, so quantifying the availability of such skills in different countries would be very useful (e.g., using the employment shares of occupations intensive of such skills). Systematic evaluations of training requirement in occupations with high green potential can be conducted using individual-level data that are readily available in several developing and emerging economies countries.

Finally, matching data on emission intensity with data on the skill composition of the workforce would allow to assess the skill requirement of cleaner companies (or sectors). Quite surprisingly, these assessments have not been conducted in the literature, even if data on the emission intensity of companies are increasingly available also for developing countries. A parallel line of research can explore the relationship between human capital policies and the adoption of cleaner technologies, on which there is, to the best of my knowledge, only limited evidence.

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