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Analysing the effect of climate policies on poverty through employment channels

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Abstract

The recently proposed Green Deals and 'building back better' plans have affirmed the importance to make green transitions inclusive. This is particularly related to the labour market, which may witness significant changes. Empirically, this issue has until now received limited attention. The links between poverty and climate change are explored mainly through the lenses of climate change adaptation, or via the effects of rising energy prices on the purchasing power of poor households. We aim to address this gap by using results from a simulation of the global energy transition required to meet the 2-degree target, and compare this to a 6-degree baseline scenario. The simulation with a multi-regional input–output model finds that, overall, this transition results in a small net job increase of 0.3% globally, with cross-country heterogeneity. We complement this macro-level analysis with cross-country household data to draw implications of the effects on poverty through labour market outcomes. The few job losses will be concentrated in specific industries, while new jobs will be created in industries that currently witness relatively high in-work poverty rates, such as construction. We show that high in-work poverty in the industries of interest, and especially in middle-income countries, is often associated with low skills and an insufficient reach of social protection mechanisms. We conclude that green transitions must ensure that the jobs created are indeed decent including fair wages, adequate working conditions, sufficient social protection measures, and accessible to the vulnerable and poorest households.

1. Introduction

With the European Green Deal's principle of taking everyone along, the discussion about unequal impacts of climate policies has regained importance. The 'Just Transition Mechanism' focusses especially on Europe's coal regions (Henry *et al* 2020); but it is important to also identify other industries, occupations or household groups that might be in need of social protection and other cushion measures that offset negative implication of climate change response policies. Similar approaches have been advocated in other Green Deal proposals and in post COVID-19 'building back better' plans. There is, in summary, the need to address trade-offs between socio-economic and environmental Sustainable Development Goals (SDGs) (Malerba 2020). In this context, the current

article focuses on the potential effects of clean energy transitions (SDG13 and SDG7) on labour markets (SDG8), with implications for poverty (SDG1).

Alongside other impacts, such as increased price of consumer goods (Fullerton 2011, Bento 2013), a global energy transition may also significantly affect poverty through its distributional effects in the labour market. This relationship (energy transitions–jobs–poverty) needs to be analysed through four main channels. *A first channel, at the aggregate country-level, is the net change in the number of jobs.* On the one hand it can be argued that an overall increase in the number of jobs is a positive outcome, as more employment opportunities will be available. On the other hand, there is no certainty that more jobs will automatically decrease poverty. In fact, many workers live in poverty (defined hereafter as 'in-work

poverty') despite receiving earnings (Barrientos and Unnikrishnan 2018). It is therefore critical that the jobs created, if any, are stable and of good quality (as underlined by SDG 8.3), with decent wages and working hours. As a consequence, going beyond the aggregate net job creation, three other channels need to be explored to better understand whether overall positive net changes in the labour markets arising from a global energy transition could be beneficial for the lower income groups. *The second channel goes into more detail, and analyses which industries will be more affected by the energy transition.* In fact, looking at country aggregates does not show which industries are the ones witnessing higher increases, or the ones where in-work poverty is concentrated. It is argued that poverty can be reduced if net job creation allows the movements of workers from low to high-return industries, especially through structural transformations (Dercon 2014); for example, poverty is concentrated in the low-return agricultural industry (Sen *et al* 2020). In turn, it is also true that net aggregate job changes depend on the labour intensity of industries affected by the energy transitions (Montt *et al* 2018). *The third channel links the industries and jobs created by energy transitions to education and skills.* In-work poverty can be in fact the result of low-skilled jobs. Moreover, even if jobs increase in higher-return industries with high productivity, the poor may not be able to take advantage due to low human and physical capital (Dercon 2014). *A last (fourth) channel is the reach of social protection systems.* These policies are crucial not just to compensate workers losing their jobs, but also to ensure decent working conditions by increasing (minimum) wages and topping up earnings (Lohmann 2008). Social protection policies, especially active and passive labour ones, are also critical to re-train workers for new jobs. Therefore, better social protection can reduce (in-work) poverty.

Despite the need to address these key interactions across the aforementioned socio-economic and environmental SDGs, significant gaps exist. To begin with, research has explored the potential effects of climate change on economic outcomes and poverty (Hallegatte *et al* 2018), as well as the effects of climate change mitigation on economic growth (Fankhauser and Jotzo 2018). In parallel, increasing work has been analysing distributional implications of climate mitigation policies. This strand of research includes the analysis of the effects of rising energy prices (e.g. through higher environmental taxes or higher costs of renewables) on the purchasing power and welfare of poor households through incidence analysis (Dorband *et al* 2019) and through macroeconomic modelling (Rausch *et al* 2011, Williams *et al* 2015). These studies also consider how revenues from climate policies (carbon pricing) can be channelled through social protection mechanisms to compensate for higher prices. Finally, a limited number of studies focuses on the effects of green policies on jobs.
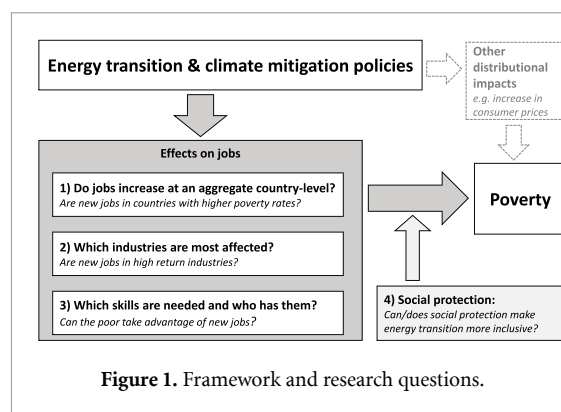

Figure 1. Framework and research questions.

This literature finds that green transitions have a modest impact on overall jobs creation (Aldieri *et al* 2019), but with a bias towards high-skilled jobs (Vona *et al* 2018, Marin and Vona 2019). But most of this research focuses on a particular country, region or program. In summary, more and better research and evidence is critical to understand which industries and workers may be affected by energy transitions, to understand distributional implications going beyond treating individuals as consumers.

We aim to fill the gap and explore the potential cross-country implications of green (energy) transitions on poverty through the effect of the structural economy-wide transformation on employment by going beyond the net change in the overall number of jobs (following the four channels previously outlined). As represented in figure 1, we additionally explore the industries most affected, and profile the workers by looking also at skills and educational levels of the most relevant industries. We finally analyse how social protection programmes reach the income poor and industries that will be affected by energy transitions.

We also address previous methodological gaps and perform a cross-country analysis, merging data sources and including micro-data representing more than 1.7 billion workers. This allows us also to differentiate between different country groups. This analysis can be used to help design policy mixes that make climate change mitigation just, inclusive and pro-poor (Green and Gambhir 2020).

Filling the aforementioned research gaps implies overcoming methodological constraints and challenges. The global energy transition requires wide-reaching changes in the economic system. Both fossil energy supplying industries and renewable energy technology producers are affected by this transition, together with their upstream supply chains. These value chains link different industries and span across country borders (Groundstroem and Juhola 2019). An example: a reduction in coal use for electricity not only directly affects the coal supply chain, but also all other goods and services need to run coal power plants as well as the suppliers to the coal mines. In turn, renewable energy technologies, s.a. wind

and solar, need to be built and maintained, affecting entirely different global supply chains. Models based on multi-regional input–output data are able to capture not only direct, but also all indirect effects of such changes in supply chains across country borders (Los *et al* 2015). Section 2 explains how input–output analysis can be used to estimate these indirect effects on employment and how we combine information on employment outcomes with household data on poverty. Section 3 analyses the results of our quantitative analysis and reflects on cross-border impacts on related SDGs. Section 4 discusses how social protection policies can be designed to complement climate policies. Section 5 concludes.

2. Methods

We combine input–output analysis with micro-level information to explore the potential implications of employment outcomes of climate policies on poverty. We base the analysis on existing climate change mitigation scenarios for 2030 that provide data on employment by gender and skill level by industry for more than 40 countries and regions (Wiebe *et al* 2018). We then combine the scenario results on employment (by country and industry) of the business-as-usual (BAU) and the climate change mitigation scenario with household information from the Luxembourg Income Study database (LIS 2020) to assess the implications of the changes in the structure of jobs on poverty.

2.1. What-if scenarios in multi-regional input–output models
For our analysis we use the employment data of the simulation model results from Wiebe *et al* (2018). It includes two 'what-if' scenarios running from the base year 2014–2030 that were implemented in the multi-regional input–output system EXIOBASE (Stadler *et al* 2018) based on information from the IEA's Energy Technology Perspectives 2-degree and 6-degree scenarios (IEA 2015).

The model is a demand-driven input–output model (Leontief 1970), $\mathbf{x} = (\mathbf{I} - \mathbf{A})\mathbf{y}$, where $\mathbf{y}$ represents final demand by industry and country, $\mathbf{A}$ is the global intermediate coefficient matrix, $\mathbf{I}$ an identity matrix of appropriate size, and $\mathbf{x}$ is output by industry and country. The 6-degree scenario, or BAU, reflects climate change mitigation actions taken primarily in European and Asian countries, while the 2-degree scenario corresponds to global climate change mitigation action (GLOB). In the BAU scenario in 2030 about 55% of the energy carriers used in Europe are low carbon, while the global average is only 35%. In the GLOB scenario, 55% of the energy carriers globally are expected to be low carbon (nuclear, biomass, geothermal, wind, solar and ocean). Please see Wiebe *et al* (2018) as well as its supplementary information for more information.
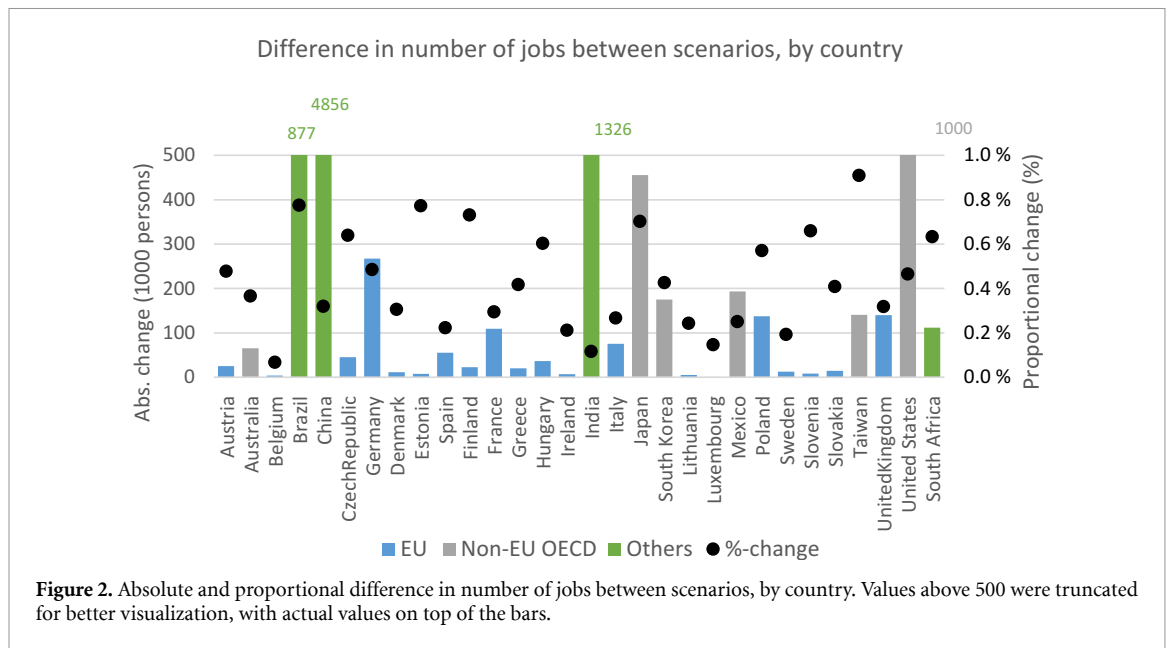
2.2. Using input–output analysis for identifying global effects on employment
Employment data from labour force and household surveys follow the same industry classification system as economic data that is collected for the System of National Accounts and input–output tables, making it possible to estimate the effects of changes in monetary output on employment in each industry (Stadler *et al* 2018, Horvát *et al* 2020). Using an extended input–output model, employment outcomes can be determined as $\mathbf{E} = \widehat{\mathbf{e}}(\mathbf{I} - \mathbf{A})\mathbf{y}$, where $\widehat{\mathbf{e}}$ is the number employees per unit of industry output by industry and country, and $\mathbf{E}$ is the absolute number of employees by industry and country. Note that for the scenarios, $\widehat{\mathbf{e}}$ was assumed the be same, i.e. there are no differences in labour productivity between the scenarios. Thus, all differences in $\mathbf{E}$ can be traced back to the differences in final demand $\mathbf{y}$ (the changes in demand for energy, construction, investment in renewable energy technologies) and economic structure $\mathbf{A}$ between the two scenarios.

The model allows for analysing direct and indirect, but not induced effects of these exogenous changes (Leontief 1970, Miller and Blair 2009). It does not include a dynamic labour market model with adjusting wages or qualifications. Rather, the results of the 'what-if' scenario analysis indicate the initial shock to the labour market in form of the number of employees necessary in each country and industry in the climate mitigation scenario, given today's structure of wages and skill levels. These are not projections of what the future labour market will look like. It instead gives an indication for which industries and in which countries the demand for workers might rise or fall, identifying possible hotspots for labour market imbalances. In the next section we outline the micro-data used to examine the change in the share of employment that experiences in-work poverty or lack of social protection based on the prevailing wages and policies across economies

2.3. Linking MRIO employment data to household survey data
We match the data on employment outcomes of the aforementioned scenarios with household survey data from the Luxembourg Income Study (LIS) database. We use the most recent available survey-year for each country. LIS is the most comprehensive data repository that aggregates and standardises household information, especially in relation to income sources and other labour information (Ferreira *et al* 2015, Bradbury *et al* 2019). Despite some limitations arising from the aggregation and standardization of household data for many countries, this source gives the opportunity to do a first analysis of this kind through detailed labour force information across countries and industries. For the main analysis we use a restricted group of countries ($n = 30$) with information

Figure 2. Absolute and proportional difference in number of jobs between scenarios, by country. Values above 500 were truncated for better visualization, with actual values on top of the bars.

from both LIS and the EXIOBASE scenarios. This group of countries corresponds to 55% of the global population, including the majority of high-income countries, as well as India, China, South Africa, Mexico and Brazil which represent 55% of the total population of middle-income countries (MICs; see supplementary material (available online at stacks.iop.org/ERL/16/035013/mmedia)). More interestingly for the scope of the paper, we end up with weighted data for more than 1.7 billion workers. One limitation is that we do not include low-income countries due to data unavailability. In terms of industries, the LIS dataset includes information on the standard 21-category ISIC Revision 4 classification; therefore, we allocate the 163 industries from EXIOBASE to the ISIC Rev. 4 industrial composition. As a final methodological remark, to estimate poverty using this household survey data, we employ a poverty line equal to 50% of the median equivalised income. Relative poverty lines are commonly used in advanced economies and are appropriate or this case as our sample comprises mainly high-income countries. To analyse heterogeneity when presenting the results, alongside considering the overall sample, we divide the countries in three groups: 'EU' countries (19); 'other OECD' countries (6; non-EU); and 'MICs' (5).

3. Results

### 3.1. Do climate policies increase jobs overall, especially in countries with high poverty rates?

We start by assessing the first channel of interest outlined in the introduction, namely the net change in jobs. We then see if countries with the largest changes are the ones with higher rates of poverty to understand the country-level poverty implications of employment changes. Globally, employment is 0.3%

higher in the GLOB scenario than in the BAU scenario, but there are differences across the 30 countries in the sample. Figure 2 shows that in absolute terms, MICs represent a high share of the net job increase, also because they are populous countries. When considering EU countries, Germany is the one with the highest absolute net increase in jobs. But OECD countries such as Japan and the US witness a higher absolute increase. From a proportional point of view, there is no systematic difference between EU, other OECD and MICs countries.

Comparing these findings with poverty numbers, countries witnessing higher proportional job increases are not necessarily the ones with higher poverty rates. Focusing on MICs, given their high poverty rates, we find contrasting results. On one side, Brazil (0.8%) and South Africa (0.6%), witness relatively high proportional increases in jobs. This is important, as these countries also have relatively high poverty rates. On the other hand, China and especially India show low proportional growth in jobs (0.3% and 0.1% respectively), despite having the highest absolute increase in jobs of 4.9 and 1.3 million respectively. This becomes even more striking when considering that India still has around 280 million people in absolute extreme poverty at a per capita income of US$1.9 a day (Castaneda Aguilar *et al* 2019, World Bank 2020). This underlines that for many countries the net increase in jobs is very small when compared to the number of individuals and workers in poverty: job creation from an energy transition alone is not sufficient to significantly contribute to poverty alleviation at a country and global level. It is therefore critical to make this job transition pro-poor.

3.2. Which industries are the most affected?

To comprehensively understand if the changes and net increase in jobs could ultimately decrease poverty,

Figure 3. Absolute change in jobs and % working poor, by industry.
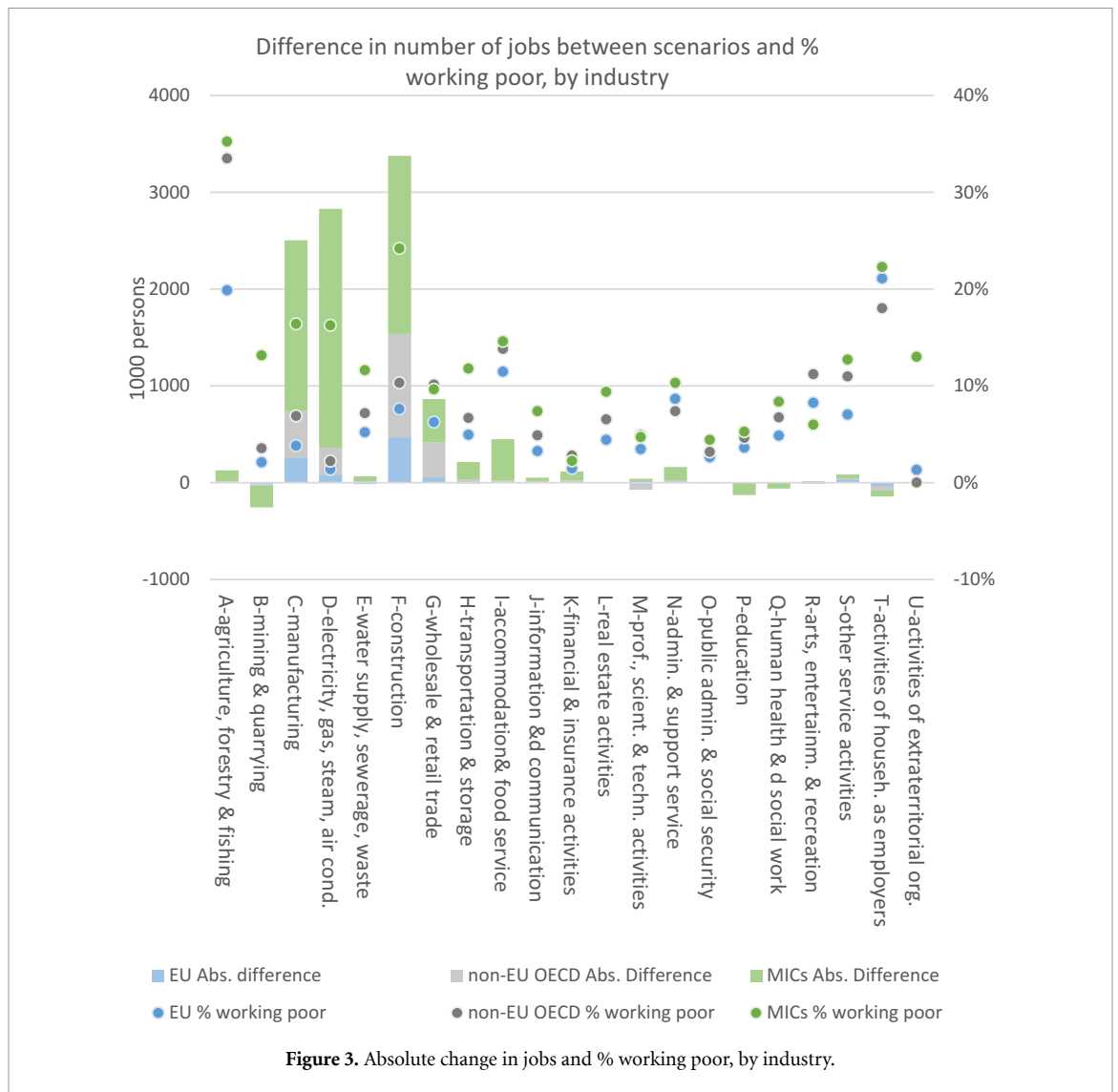
we now focus on the second channel of interest, namely which industries are most impacted. We first assess the implications of job creations as they are significantly larger than job losses. Overall, job increases will be concentrated in few industries: manufacturing, electricity and construction represent 85% of the net job increase. In particular, construction is expected to have almost 3.4 million more jobs for our sample of countries (see figure 3), with significant increases also in EU and other OECD countries. On the other hand, nearly the totality of new net jobs in electricity is estimated in MICs. While construction cannot be further decomposed in neither EXIOBASE nor LIS, we also see that the half of the increase in manufacturing comes from the manufacture of electrical machinery; while, as expected, jobs in electricity come from the production of electricity from renewable sources.

Why are jobs increases concentrated in those particular sectors? Producing and installing renewable energy technologies is more labour and skill intense then building fossil fuel power stations (Mathews and Tan 2014), and these technologies are produced

by the manufacturing sector and installed by the construction industry. Further, generation of electricity from renewable energy technologies requires more jobs for O&M than fossil fuel power (Lehr *et al* 2008, 2012).

Finally, it is worth noticing that in some countries, such as Austria, as well as Brazil, other sectors witness the highest increase. In these two countries, the wholesale and retail trade (including the sale of automobiles), in fact, is the industry with highest net increase in jobs.

Turning now to job losses, they will be concentrated in few industries, such as the mining sector. The decrease in demand for fossil fuel produced electricity naturally has a negative effect on the mining and quarrying industry. But in absolute terms, the number of job losses is small.

Comparing these changes with in-work poverty (figure 3), construction (21%), manufacturing (14%) and electricity (13%) are some of the industries with highest overall poverty rates, below just to agriculture (35%). As a comparison, in the public administration industry, the in-work poverty rate is around 4%.

Figure 4. Education level, by industry.
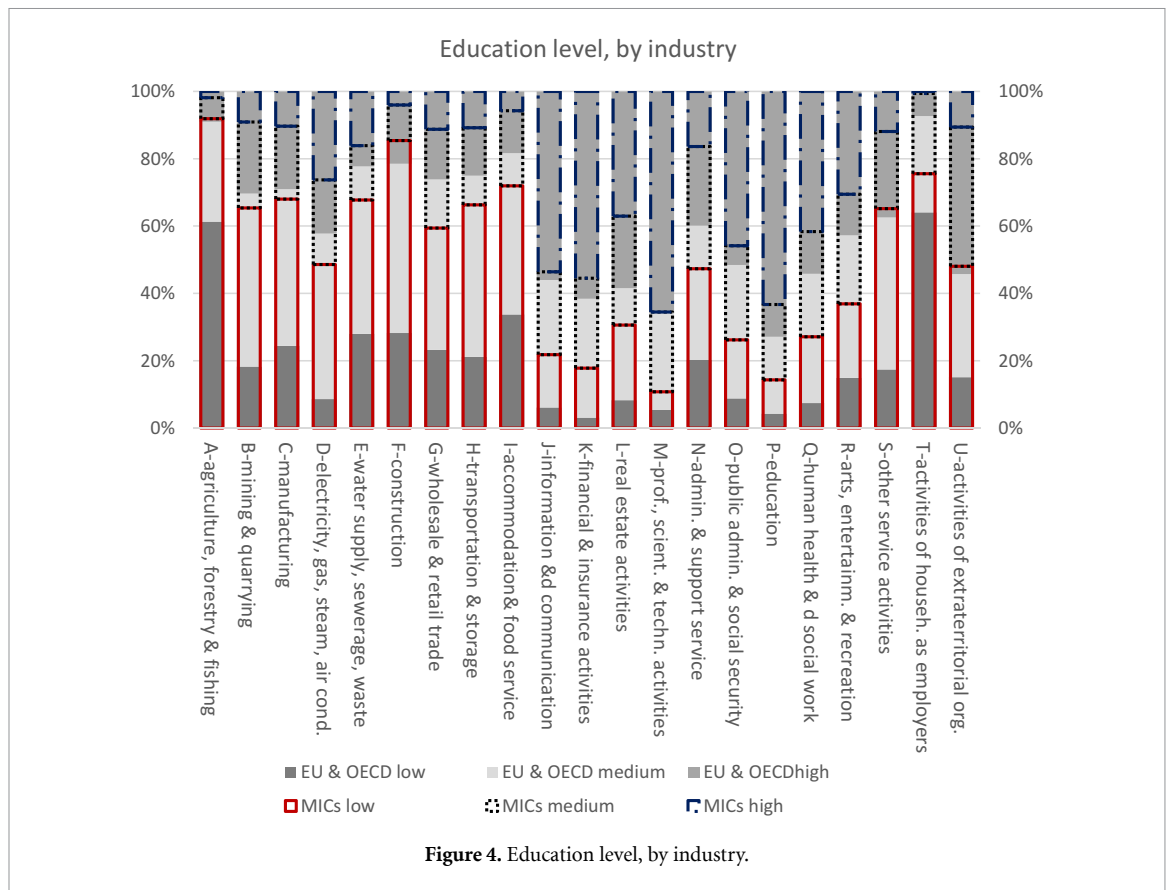
Moreover, in almost every sector the in-work poverty rate is higher in MICs compared to other OECD and especially EU countries; for example, 24% of construction workers are poor in MICs, compared to 8% in EU countries. Therefore, job creation is foreseen to happen in industries that have relatively high in-work poverty, as energy transition do not significantly spur structural transformations.

3.3. Skills and education level

We now explore the possible reasons driving the relatively high in-work poverty rates (channel 3) in the industries of interest. In terms of wages, the industries that will be positively impacted the most (in terms of number of jobs created) have relatively low hourly wage levels (see supplementary material). These low wages, and the consequent high in-work poverty, may be driven by the low level of skills and human capital, as well as by the job type. Figure 4 indicates (using a broader categorization of the International Standard Classification of Education (ISCED), see supplementary material), in fact, that the construction and manufacturing (to a lesser extent) industries have a high proportion of workers with a low education level especially in MICs. On a positive note, jobs increase in the EU will be in industries with dominant medium skills; this matches overall improvements in the education levels (European Commission 2018). For example, in construction low education workers represent 85% in MICs, compared to 28% in EU

and other OECD countries combined. In addition, the education level is important not just in terms of wage returns but also in terms of transitions to new (and higher skilled) jobs.

In addition to lower education levels, the industries that will witness higher job creation are the ones with fewer professionals and managers. The status of employment and job type are crucial also in terms of poverty and vulnerability. Using a broad classification based on the ISCO-10 job categorization, figure 5 shows that professionals and managers represent 17% of workers in the electricity industry, 13% in manufacturing, and 11% in construction. While shares of professionals are similar in the manufacturing and constructions sectors, considering the electricity industry the share is up to 29% in EU and OECD countries compared to 14% in MICs (see supplementary material for more information). The difference between country groupings is even larger when comparing the shares of other skilled and unskilled workers. For example, in the manufacturing industry, 53% of workers are unskilled in MICs, compared to 15% in EU and other OECD.

Finally, in terms of the status in employment (based on the international ILO classification, ICSE—International Classification of Status in Employment), especially the construction and manufacturing industries witness high levels of non-regular employees; while agriculture has the largest share of self-employed (see supplementary material).
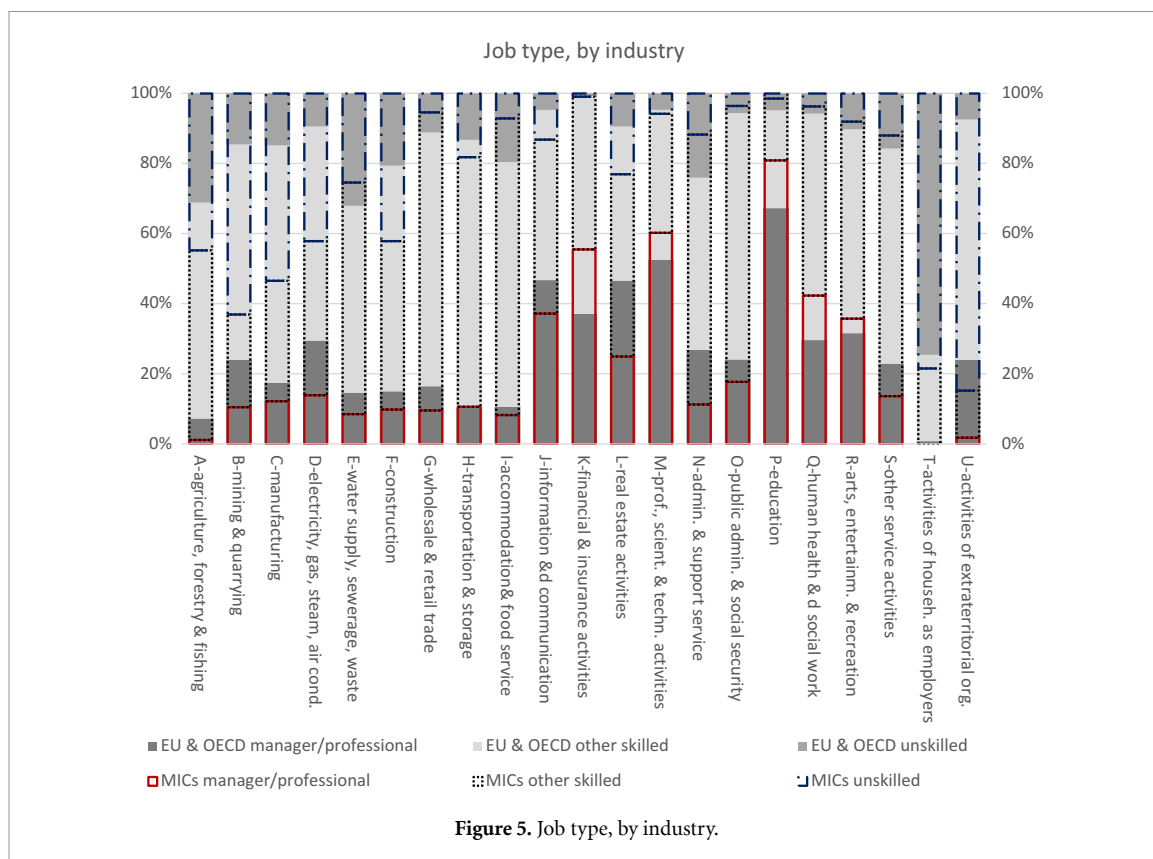
Figure 5. Job type, by industry.

## 3.4. Reach of current social protection measures

As a final step, we now analyse if high in-work poverty in affected industries can be linked to the performance of social protection systems (channel 4). The importance of social protection is also advocated by proposed Green Deals (Mastini *et al* 2021), which underline its importance in mitigating the effects on the most vulnerable. While the focus is on job guarantees, other critical social protection policies related to labour markets include the need to upskill workers, link them to jobs and job search processes, also actively including job seekers. Despite its potential importance, less than half of the global population is covered by any social protection instrument, while just one third is covered by a system of instruments (ILO 2017). Focusing on labour markets, many workers do not participate in contributory social insurance mechanisms (including sick leave, paternity/maternity benefits, unemployment benefits). This negative picture is driven by the poor performance in lower income countries, especially due to the size of the informal economy.

On a positive note, the expansion of non-contributory social protection programs (social assistance) in the last two decades (Niño-zarazúa 2019) could be critical in complementing the low coverage of contributory social protection, especially in lower income countries. In fact, the targeting of these programs does not exclude informal workers, but it is linked to the poverty situation of the household. Therefore, workers not reached by contributory

social protection programs can be helped by non-contributory ones.

Following a large literature, the performance of social protection is mainly analysed through an incidence analysis. We compute poverty rates pre-transfers and taxes, and we compare them to the actual ones using disposable income (post-transfers and taxes). This gives a measure of the redistributive impact of social transfer programs (Lohmann 2008). The reduction of in-work poverty is low in the industries of interest compared to other industries, and especially in MICs (see figure 6; data is not available for China). For EU countries, in the electricity industry the tax and transfer systems seems to reduce poverty significantly. Finally, the poverty reducing effect of social protection in other OECD countries is closer to the one in MICs rather than EU members. Therefore, the role of social protection can be significantly strengthened in all non-EU countries.

The main reason for this current low poverty reduction effect of social protection can be attributed to informality. In fact, among the smaller sample of countries with available information (see supplementary material) the three industries that will witness the highest increases in jobs (in absolute terms), are the ones with higher informality rates: construction has an informality rate of 60% (still below the one witnessed by agriculture, 73%); this compares to the low informality rate (9%) of the electricity industry. The data also show that, as a consequence

Figure 6. In-work poverty reduction from welfare state, by industry and country group.
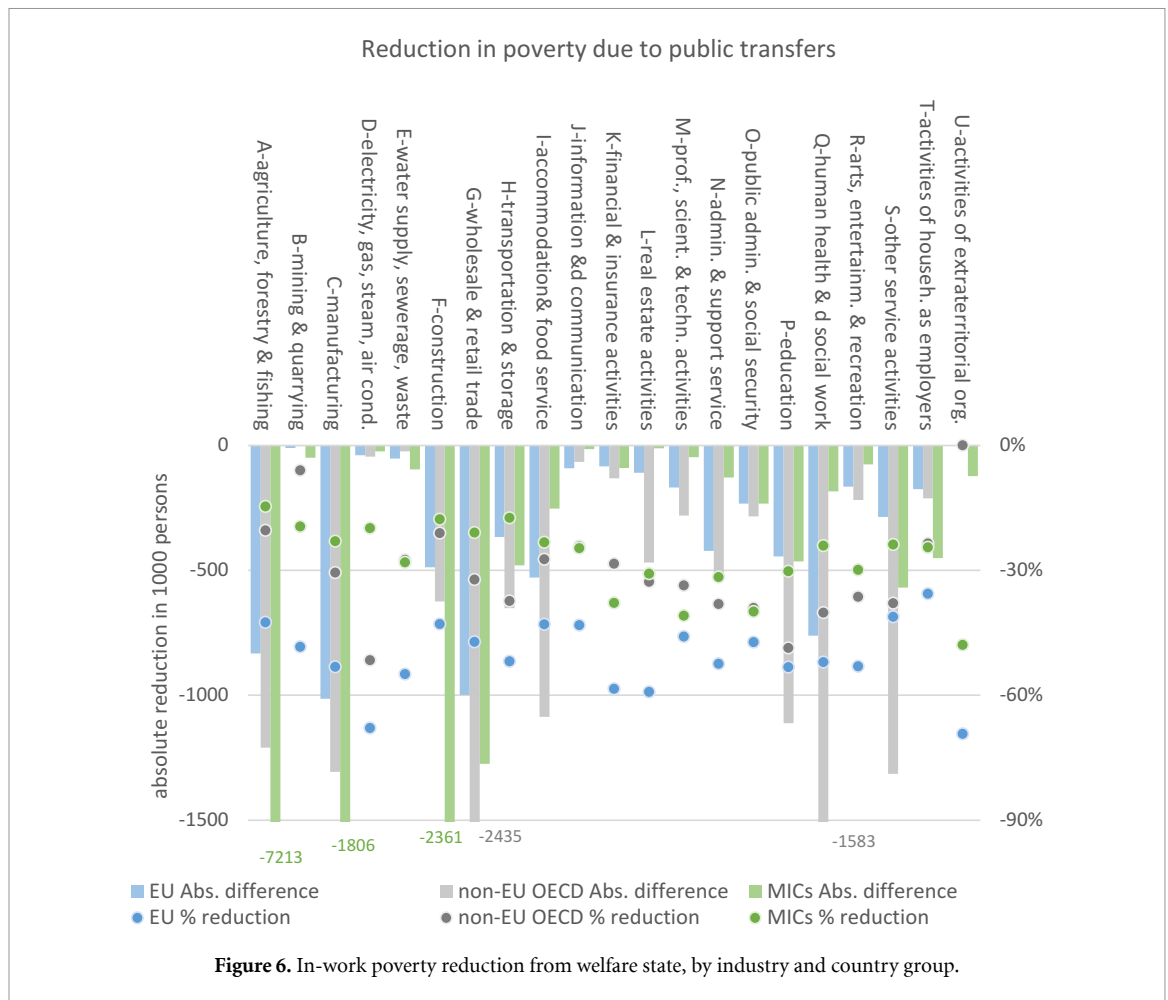
of informality, a very small share of workers reports contributing to private insurances.

4. Discussion—the need for social protection to complement climate policies

The analysis indicates that the role of social protection in complementing climate policies in relation to labour markets and poverty is twofold. First, it needs to address job losses, which are few and concentrated in specific industries. In the supplementary material we show that the main decreases come from sectors related to coal mining or in electricity production from coal. In that case, structural programs with a focus on re-training and unemployment benefits are crucial; this has been analysed by few existing studies (Oei *et al* 2020). Second, and even more challenging especially in lower income countries, there is the need to build universal social protection systems (ILO 2017) to make new (and current) jobs of higher quality (SDG 8), as well as inclusive. This requires different social protection mechanisms such as minimum wage regulations and active labour market policies. Social assistance and income support for (in-work) poverty is also important as decreasing purchasing power and inflation from

energy transitions will negatively impact low-income households, which are highly vulnerable to changes in food and energy prices (Albanesi 2007, Kaplan and Schulhofer-wohl 2017). In addition comprehensive systems of social protection are critical to reach workers that fall through the cracks of the systems, such as the 'missing middle': informal workers that do not qualify for social insurance nor social assistance (IPC-IG and UNICEF ROSA, 2020).

While it may seem challenging especially for countries with underdeveloped social protection systems, some positive examples solutions and implications can be gathered by the current experience with the response to the COVID-19 crisis, which shows that such policies can be rapidly and effectively introduced at least temporarily. Since the start of the pandemic, 212 countries have planned, introduced or adapted social protection and jobs programs in response to COVID-19. This includes 1179 programs and 1.88 billion beneficiaries supported via COVID-19-related introductions, expansions, and adaptations of social assistance programs (Gentilini *et al* 2020). From the workers' perspective it is especially critical to underline that, alongside social assistance, also social insurance and labour market policies are being widely used. The latter includes mainly wage subsidies, the former paid sick leave and

unemployment insurance. And as a further positive sign, MICs are among the most active regarding the expansion of these social protection measures, while some encouraging signs also are witnessed in low-income countries. Finally, research has shown that adequate financing of social protection can come from revenue recycling from climate policies (Malerba *et al* 2021).

5. Conclusion

This study is the first attempt to link macro-level data on energy transitions to micro-level data on workers at a cross-country level. This is especially relevant given the current push for Green Deals and 'building back better' plans, which require a better understanding of the potential distributional implications of climate policies in the labour market, and the role of social protection (Galvin and Healy 2020, Mastini *et al* 2021). The novelty lies in the profiling of the workers and industries that will be impacted by energy transitions across countries, using household data from several countries. This allows to identify differences in in-work poverty between industries. The findings, based on descriptive statistics, have underlined that energy transitions are not automatically pro-poor and inclusive; new jobs need to be made decent and accessible to low-income households, also through improved social protection systems. This is especially true in MICs.

Four issues can be advanced as avenues for further research. First, it is important to consider the reallocation of workers within and between industries. In this respect, for example, social protection (especially active labour market policies) can be critical, to link workers to new jobs and to re-train them. Second, the data in our study focusses on high-income countries and MICs due to data constraints. A similar analysis in lower income countries is thus needed, due to their different structural characteristics. In addition, it is paramount to analyse countries with higher poverty rates and that may also witness a decrease in jobs from energy transitions due to their reliance on 'dirty' natural resources for their economies (such as oil-producing countries in the Middle East and Africa). Third, the analysis can be supplemented by applying labour market models that can add information on wage dynamics given labour supply. Here specific focus should be put on skill level, occupation and roles, and transfer possibilities between industries. Fourth, it needs to be seen the long-term effects of the significant expansion of social protection as a response for COVID-19, made it possible through political will; and which valuable lessons need to be considered in the context of energy transitions and Green Deals where social and environmental goals need to be jointly met (Engström *et al* 2020, Hepburn *et al* 2020).

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