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THE GREEN SIDE OF PRODUCTIVITY: AN INTERNATIONAL CLASSIFICATION OF GREEN AND BROWN OCCUPATIONS

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ABSTRACT/RÉSUMÉ

The Green Side of Productivity:
An International Classification of Green and Brown Occupations

This paper describes the methodology used for crosswalking occupation-based measures of Green ("environmentally friendly") and Brown ("polluting") jobs from the Standard Occupational Classification (SOC) system to the International Standard Occupation Classification (ISCO) 08 at the most detailed (4-digit) level. The original, task-based Greenness scores by Vona et al. (2018) are provided at the 8-digit SOC level, and the industry-based Brownness measures are provided in 6-digit SOC. Crosswalking these measures requires several choices in terms of weighting and aggregating, which this paper describes in detail. The robustness of the resulting measures to the different weighting options and underlying assumption is tested using Linked Employer-Employee data from Portugal. An empirical application to the Productivity-Greenness link at the firm level shows the robustness of this link to different weighting choices, and confirms that all of the different measures derived are consistent in measuring the Greenness of jobs.

Keywords: Green transition, Green skills, Green occupations, Brown occupations, Occupation Classification, productivity.

JEL classification codes: J21, J24, L25.

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La Dimension Écologique de la Productivité :
Une Classification Internationale d'Occupations Vertes et Brunes

Cet article décrit la méthodologie utilisée pour établir une correspondance entre les emplois qualifiés de verts ("respectueux de l'environnement") et bruns ("polluants") dans le système de classification standard des professions (SOC) et la Classification internationale type des professions (CITP) 08 au niveau le plus détaillé (4-chiffres). Les scores mesurant si un emploi est vert (Vona et al. ,2018), sont basés sur les tâches réalisées, et sont fournis au niveau de la CPS à 8 chiffres. Les scores mesurant si un emploi est brun sont basées sur l'industrie et sont fournies au niveau de la CPS à 6 chiffres. Le croisement de ces mesures nécessite plusieurs choix en termes de pondération et d'agrégation, que cet article décrit en détail. La robustesse de la correspondance par rapport aux différentes options de pondération et aux hypothèses sous-jacentes est testée à l'aide de données couplées employeur-employé du Portugal. Une application empirique du lien Productivité-Environnement au niveau de l'entreprise montre la robustesse de ce lien aux différents choix de pondération et confirme que toutes les mesures dérivées sont bien adaptées pour mesurer la dimension environnementale des emplois.

Mots clés : Transition écologique, compétences vertes, emplois verts, emplois bruns, classification des professions, productivité.

Classification JEL : J21, J24, L25.

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The Green Side of Productivity: An International Classification of Green and Brown Occupations

By Nathalie Scholl, Sebastien Turban and Peter Gal[1]

1. Motivation

1. Assessing the consequences of the green transition on the business sector – that is, employees and the firms they work for - requires information on the environmental properties of jobs. This would then allow to assess how prepared a firm's workforce is for the green transition, and how this may impact business performance in the future. In two seminal papers, Vona et al. (2018[1]), (2019[2]) have proposed measures of "green" and "brown" occupations in the United States at a detailed (8-digit) level in the System of Occupational Classification (SOC). Their Greenness measure relies on an assessment of the environmental relevance of the tasks conducted within each occupation, provided by the Occupational Information Network (O*NET).

2. The purpose of this note is to leverage these measures and crosswalk them to the International Standard Classification of Occupations (ISCO) at the most granular (4-digit) level. This note details the various options to aggregate and crosswalk from 8-digit SOC to 4-digit ISCO, to ultimately classify jobs as Green (=environmentally friendly), Brown (=polluting), or Grey (=neutral). While the assumptions underlying Vona et al.'s (2018[1]) measures may be subject to discussion, the purpose of this note is to allow the application of these measures to an internationally comparable classification of occupations. As such, it is closely related to Bluedorn et al. (2022[3]),Elliott et al. (2021[4]), Valero et al. (2021[5]), and Tyros and Andrews (forthcoming[6]) who also derive an ISCO classification by crosswalking from SOC, with the SOC classification originating in a task-based approach from O*NET. Elliott et al. (2021[4]) use the binary classification of Green jobs provided by O*NET and crosswalk it to 4-digit ISCO, whereas Bluedorn et al.

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(2022[3]) as well as Tyros and Andrews (forthcoming[6]) rely on the same Vona et al. (2018[1]) continuous scores also used in this note, but aggregate to the less detailed 3-digit ISCO level.[2] Valero et al. (2021[5]) provide a mapping to UK SOC occupations, as well as a mapping to 4- and 3-digit ISCO, but without providing employment-weighted measures of the ISCO mapping to account for double-counting, as is done in this note.

3. Eventually, the methodology described in this note is applied to two opposed dimensions of an occupation's environmental properties at the 4-digit ISCO level. Different versions of a Greenness score measure the importance of tasks that are oriented towards environmental sustainability in a given occupation. By contrast, Brownness scores classify occupations according to how likely they are to be part of pollution-intensive activities. The residual category, comprising neutral (neither Green nor Brown) or ambiguous (both Green and Brown) occupations, is labelled Grey. The note is accompanied by a replication package in Stata and a dataset of the full set of ISCO_08 4-digit occupations, their classification into Green, Brown, and Grey, and different versions of Brown and Green intensity.

4. This note is organised as follows: First, the approach for crosswalking and computing 4-digit ISCO measures of Greenness and Brownness is detailed in Section 2. Green occupations and different versions of measuring Green intensity are explained first, before moving to Brown occupations. In both cases, various measures are derived that reflect different options for weighting and accounting for the nested structure of occupations in the different classifications. Finally, a few clarifications on Grey occupations are provided, focusing specifically on those occupations that are ambiguous (i.e., contain both Green and Brown elements). Section 3 then provides interpretations and summary statistics of the different measures of Greenness and Brownness, along with a discussion of their underlying assumptions and limitations. Section 4 applies the measures of Greenness and Brownness to Linked Employer-Employee data from Portugal, thus providing an example of how the different measures compare in a real-data context. Using the different measures of Greenness to test the positive relationship between productivity and Green jobs at the firm level confirms the validity of the productivity-Greenness link for all of the various Greenness measures, thus indicating that the different measures capture the same underlying structural characteristic. The last part of the note contains the resulting occupation tables of Green and Brown occupations.

2. Computing Indices of Greenness and Brownness of Occupations

5. This methodological note is part of the GFP's "Green Side of Productivity" project. The majority of countries taking part in this project uses a classification that maps directly into the International Labour Organization's International Standard Classification of Occupations (ISCO) from 2008 (ISCO_08). The objective of the exercise described in this paper is to arrive at a classification of Green, Brown, and Grey jobs in ISCO_08 at the 4-digit level, to provide measures of the environmental properties of occupations at a granular level, and which can easily be applied to a large number of countries.

6. Granularity allows applying these measures to micro data in a meaningful way, to allow for analyses at the worker or firm level. Using an internationally standardised classification helps improve comparability, and the very goal of ISCO is to "facilitate international comparison of international statistics" (International Labour Organization, 2012[7]). At its most detailed level, the ISCO classification breaks down occupations in 436 categories identified by a 4-digit code.

7. This note describes a methodology to classify those 436 occupations' environmental properties, by cross-walking the 8-digit SOC (2010 version)[3] continuous scores developed by Vona et al. (2018[1]). In

[2] There is a total of 130 3-digit ISCO occupations, compared to 436 occupations at the 4-digit level. Moving to the more detailed level thus adds information that is substantially more granular.

[3] Vona et al. (2018[1]) compute their measures of Greenness based on the 2012 version of the data.

the following, the author's original measure is described, which assesses environmental properties of occupations across two dimensions: the occupation's "Greenness", reflecting its new or enhanced role to promote environmental sustainability; and its "Brownness", reflecting the propensity of the occupation to be part of a pollution-intensive activity. The different steps involved in translating the very detailed SOC to the more aggregate ISCO classification for both these dimensions are detailed thereafter. The Annex contains tables of Green (Table A.2) and Brown (Table A.3) occupations in the ISCO_08 4-digit classification, providing the different versions of the measures of Greenness and Brownness derived in the following.

2.1. Greenness of Occupations

2.1.1. The original Vona et al. (2018[1]) measure of Green occupations

8. In a seminal paper, Vona et al. (2018[1]) develop a continuous measure of the Greenness of occupations at the 8-digit SOC level.[4] Their continuous measure of an occupation's greenness is based on counts of green and non-green specific tasks[5] in each occupation, exploiting detailed information from the O*NET database for the United States. Vona et al. (2018[1]) define Greenness as the share of green-specific tasks in the total specific tasks within each occupation. Green tasks are identified in the O*NET Green Task Development Project[6] by considering the new requirements linked to the green transition in existing occupations that are deemed to be significantly changed by the transition ("Green Enhanced Skills Occupations") or in new occupations that arise because of the transition ("New and Emerging Occupations"). [7]

9. Formally, consider the 8-digit SOC occupation $o8$ with specific tasks $t \in T^{o8}$. Let $1_{t \in Green}$ be a binary index equal to 1 if and only if task t is green according to O*NET. Then the greenness index of occupation $o8$ is:

$$Greenness_{o8} = \frac{\sum_{t \in T^{o8}} 1_{t \in Green}}{|T^{o8}|} \quad (1)$$

10. Those scores are the starting point for deriving Greenness scores at the ISCO 4-digit level described in the following. The translation of the original Vona et al. (2018[1]) measure into scores at the ISCO 4-digit level proceeds in two steps. First, the 8-digit SOC occupation scores are aggregated to the 6-digit SOC level. In a second step, the 6-digit SOC level scores are crosswalked to the 4-digit ISCO level, combining a pre-existing correspondence table with employment data by occupation.

[4] Vona et al. (2019[2]) provide another measure of an occupations' greenness which takes into account not only the count, but also the importance of tasks in an occupation. However, the green scores are almost identical to those in Vona et al. (2018[1]) and do not change the results in this note.

[5] The occupations in O*NET include both "specific" and "general" tasks. "General" tasks are common to all occupations, whereas "specific" tasks are unique to each occupation (Vona et al. (2019[2]).

[6] https://www.onetcenter.org/dl_files/GreenTask_Summary.pdf.

[7] https://www.onetcenter.org/dl_files/Green.pdf.

2.1.2. From 8-digit SOC to 4-digit ISCO

Step 1: Computing Greenness at the 6-digit SOC level

11. To arrive at a 6-digit measure of Greenness from the original 8-digit level scores, the Greenness score of occupations from Vona et al. (2018[1]) is aggregated across *all* nested 8-digit SOC categories within each 6-digit SOC. Ideally, one would like to aggregate the scores at the 8-digit level using a weighted average, informed by some measure of the relative size of each 8-digit occupation, such as employment (see below). In practice, no such information is available at this level of detail, so that the 8-digit scores are simply averaged. The implicit assumption underlying the simple average is that 8-digit occupations are uniformly distributed within each 6-digit occupation. Vona et al. (2018[1]) follow a similar approach in the analytical part of their paper, where they aggregate the scores for the 8-digit SOC available in O*NET into scores for each 6-digit SOC, noting that because of the absence of employment data at such detailed levels, "we assume that employees are uniformly distributed across eight-digit occupations within each six-digit SOC occupation." They suggest that "most of the green skill variation is at the six-digit level" so that this assumption should not have a significant impact on the different versions of the resulting indicators.

12. Formally, define $\Omega(o6)$ the set of 8-digit SOC occupations nested in the 6-digit occupation $o6$. The greenness of a 6-digit occupation can then be written as:[8]

$$Greenness_{o6} = \frac{1}{|\Omega(o6)|} \sum_{o8 \in \Omega(o6)} Greenness_{o8} \quad (2)$$

13. In addition to this measure based on the original, continuous Greenness score at the 8-digit level, a binary indicator that dichotomises occupations into Green and non-Green at the 8-digit level is constructed. This index simply indicates whether the occupation contains *any* green task (or, in other words, if its Greenness score is strictly positive). This indicator is averaged at the 6-digit SOC level in the same way, so that the resulting measure at the 6-digit SOC level then simply records the share of 8-digit Green occupations in the 6-digit level occupation. Note that henceforth, when referring to an occupation as "Green" (in any of the potential classifications), this means that the occupation contains at least one nested Green 8-digit SOC occupation, that is, entails *any* Green task.

14. Finally, in addition to these two continuous measures at the 6-digit SOC level, a third indicator is constructed by binarising the 6-digit SOC occupations in the same way as done for the 8-digit level. The resulting measure then classifies 6-digit occupations according to whether they contain any green task (equivalently, if their Greenness score as computed above is strictly positive).

15. This leaves three different measures of Greenness at the 6-digit SOC level that are crosswalked to the 4-digit ISCO level in the next step: the binary indicator just discussed, the average green score of its 8-digit constituents, and the share of green occupations among its 8-digit constituents.

[8] With the exception of four occupation groups, all occupations identified by Vona et al. (2018[1]) as involving green tasks are uniquely identified either at the 6- or at the 8-digit level. In the four cases where one 6-digit and one nested 8-digit occupation within this 6-digit occupation are both identified as Green, only the score for the 6-digit category is retained to compute the score at the 4-digit ISCO level in the second step. Those cases are: Transportation engineers being the only subcategory of Civil engineers (172051); Water/Wastewater Engineers being the only subcategory of Env. engineers (172081); Robotics Technicians being the only subcategory of Electro-Mechanical Technicians (173024); and Solar Sales Representatives and Assessors being the only subcategory of Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products (414011).

Step 2: Crosswalking 6-digit SOC measures to the 4-digit ISCO level

16. To translate the three measures of Greenness from the 6-digit SOC level to the 4-digit ISCO level, a pre-existing crosswalk to 4-digit ISCO provided by the US Bureau of Labor Statistics (BLS) is used.[9] This crosswalk is supplemented with employment data from the same source, which is available at the 6-digit SOC level.[10] This allows dropping the assumption of a uniform distribution of nested (lower-level) occupations into the higher (more aggregated) level that was made when aggregating from SOC 8-digit to SOC 6-digit. Instead, Greenness scores can be aggregated using employment weights, with different options for implementing the employment weighting in the context of the many-to-many mapping between SOC 6-digit an ISCO 4-digit, as detailed in the following. Note that this methodology applies to indicators of Brownness in the same way, as explained later in this section.

17. The main complication to be addressed during the crosswalking procedure is the many-to-many mapping between SOC and ISCO. The crosswalk provided between SOC 6-digit and ISCO 4-digit is not one-to-one: a 6-digit SOC code can map into multiple ISCO 4-digit codes, and, conversely, a 4-digit ISCO code typically consists of multiple 6-digit SOC codes. If the mapping was one-to-one, one could simply compute a Greenness score for a given 4-digit ISCO occupation by averaging the scores of its constituent 6-digit SOC occupations, using 6-digit SOC employment weights. However, if a 6-digit SOC occupation is matched with multiple 4-digit ISCO occupations, its score will be counted multiple times in the different 4-digit codes to which it belongs. The main question with this many-to-many mapping is thus how to allocate the same 6-digit SOC code to the multiple 4-digit ISCO codes it maps into.

18. To avoid double counting, one needs to make an assumption about the distribution of a given 6-digit SOC occupations' employment across the 4-digit ISCO to which it is matched. Two possibilities are considered here: (i.) an approach assuming a uniform distribution, which is proposed in the absence of supplementary data that may contain further information on how the 6-digit SOC codes map into ISCO 4-digit; or (ii.) an approach using employment weights, which is preferable when information on the distribution of employment across ISCO 4-digit occupations is available.

19. Approach (i.), labelled "uniform weighting" in the following, assumes that the employment of each 6-digit SOC occupation that maps into multiple ISCO 4-digit occupations is uniformly distributed across those occupations. This means splitting the employment of the constituent 6-digit SOC occupation score equally between the ISCO occupations. For example, if a SOC occupation maps into three different ISCO occupations, the SOC employment in each ISCO occupation is assumed to be one-third of the total SOC employment. Formally, if an ISCO occupation (X) contains two different SOC occupations (A and B), of which only occupation A maps into another ISCO category, employment for ISCO occupation X is then constructed as [1/2* Employment(SOC_A)+ Employment(SOC_B)].

20. Approach (ii.) is used when information on employment in the *destination* (ISCO 4-digit) classification is available, which allows deriving employment weights to allocate the 6-digit SOC occupation's employment into the different ISCO 4-digit categories. Following the methodology used by Dingel and Neiman (2020[8]), a 6-digit SOC occupation's employment is distributed across the different 4-digit ISCO occupations in proportion to the distribution of total employment in the 4-digit ISCO occupations. This provides, for a given SOC occupation, the employment weight to use in the aggregation to the 4-digit

[9] Downloadable at https://www.bls.gov/soc/soccrosswalks.htm.

[10] Employment weights are based on 2016-2018 average employment and can be downloaded at https://www.bls.gov/oes/tables.htm.The time period is chosen because of the purpose of the exercise: ISCO_08 4-digit occupation information is available from 2010 onwards in the Linked Employer-Employee datasets this classification is developed for. 2016-2018 represents a forward-looking mid-point for the analysis, with years for the early 2020's being added on an ongoing basis. Using employment data from earlier years changes the results very little: the employment-weighted scores using 2012 SOC employment weights display correlations with those using 2016-2018 weights that are very close to 1, with the lowest correlation being 0.9995.

ISCO. For example, if an ISCO category (X, 100 employees) contains two different SOC occupations (A and B), of which only occupation A maps into another ISCO category (Y, 200 employees), employment in ISCO occupation X is then constructed as [100/300* Employment(SOC_A)+ Employment(SOC_B)]. This approach is labelled "DN weighting" in the following.

21. Formally, let $\Theta(o6)$ be the set of 4-digit ISCO occupations to which the 6-digit SOC occupation $o6$ is matched in the BLS crosswalk, and $\Gamma(i4)$ be the set of 6-digit SOC occupations which are matched with the 4-digit ISCO occupation $i4$. Let L_{o6} be employment in the 6-digit SOC category $o6$, and E_{i4} be employment in the 4-digit ISCO occupation $i4$. In the uniform weighting approach, the share of L_{o6} which is allocated to any $i4 \in \Theta(o6)$ is $\omega_{o6}^{i4} = \frac{1}{|\Theta(o6)|}$. In the DN weighting approach, the share of L_{o6} which is allocated to any $i4 \in \Theta(o6)$ is $\omega_{o6}^{i4} = \frac{E_{i4}}{\sum_{i \in \Theta(o6)} E_i}$. In both cases, for a given 6-digit SOC occupation, the weights sum to 1. That is, the employment of this SOC occupation is fully allocated to the 4-digit ISCO occupations to which it is matched:

$$\sum_{i4 \in \Theta(o6)} \omega_{o6}^{i4} = 1 \tag{3}$$

22. The allocation above provides the 6-digit SOC occupations' employment share within each 4-digit ISCO occupation. Using these employment weights, it is possible to compute a Greenness score for a 4-digit ISCO occupation as an employment-weighted average of the 6-digit SOC occupation scores. Namely:

$$Greenness_{i4} = \sum_{o6 \in \Gamma(i4)} w_{o6}^{i4} \cdot Greenness_{o6} \tag{4}$$

where $w_{o6}^{i4} = \frac{\omega_{o6}^{i4} \cdot L_{o6}}{\sum_{o \in \Gamma(i4)} \omega_{o}^{i4} \cdot L_{o}}$ is the share of $i4$'s employment which is in $o6$.

23. Average scores by ISCO occupation can also be computed by calculating the simple average of all 6-digit SOC occupations' scores and ignoring double-counting. This approach is labelled "frequency-weighting" here, as opposed to the "employment-weighting" approach. It can be appropriate when the unit of interest is the occupation itself, rather than the economic unit (worker or firm) active in that occupation. The frequency-weighting approach can be expressed as:

$$Greenness_{i4} = \frac{1}{\Gamma(i4)} \cdot \sum_{o6 \in \Gamma(i4)} Greenness_{o6} \tag{5}$$

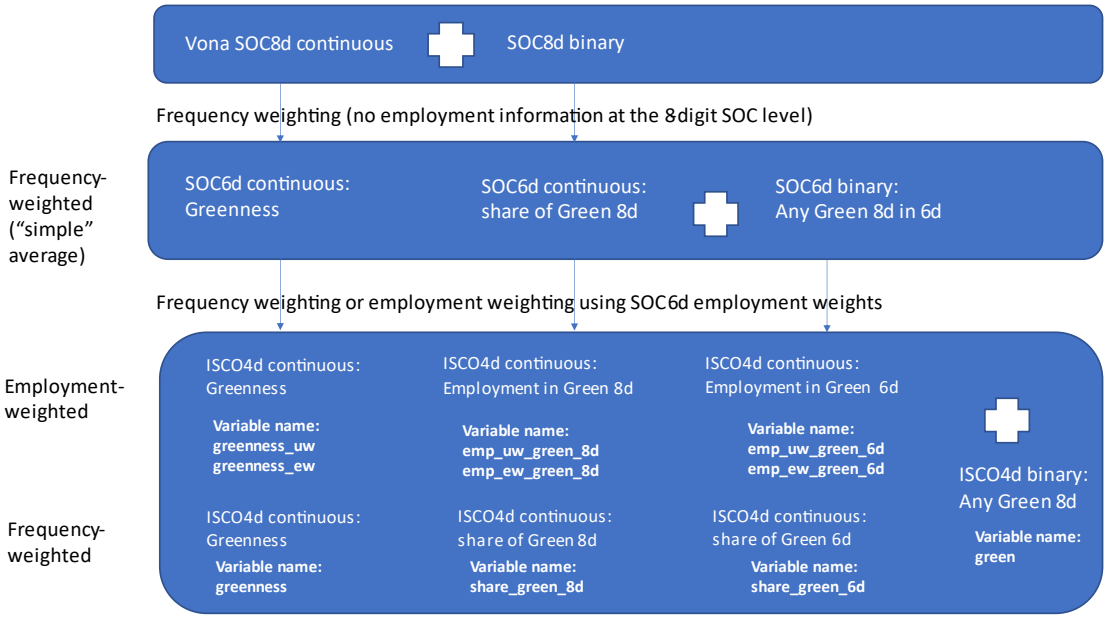
24. These two principal weighting approaches – "frequency-weighting" and "employment-weighting" can be applied to the three measures derived at the 6-digit SOC level, resulting in a total of 6 continuous measures at the ISCO 4-digit level.[11] Box 1 and 2 provide an example of how this is done in detail.

25. Finally, a binary measure that dichotomises the continuous green scores is added at the ISCO 4-digit level. Analogous to the binary measures constructed at the 8- and 6-digit SOC level, it indicates ISCO 4-digit occupations with any green content (a strictly positive green score). A schematic representation of

[11] The "employment-weighting" can in turn be done via "uniform-weighting" or "DN-weighting" to compute 6-digit SOC employment weights to aggregate scores for a given 4-digit ISCO occupation, as described above. As illustrated in Section 4 using data from Portugal, empirically, the two options yield very similar results.

the construction of scores and the resulting measures is shown in Figure 1. and provides an example of the different steps involved in aggregating an occupation with many-to-many mapping and weighting. Section 3 contains an overview of all the different Greenness measures derived, with summary statistics provided in Table 2.

Figure 1. Computing green scores at the 4-digit ISCO level



Note: This flowchart demonstrates the multi-level structure of occupations, going from the most detailed (8-digit) SOC level at the top of the chart to the most aggregated (4-digit) ISCO level at the bottom. Moving down from one level to the next implies an aggregation step, symbolised by the vertical arrows, and requires a weighting choice. Because there is only one option for weighting from the top (8-digit SOC) level to the middle (6-digit SOC) level due to the unavailability of employment information, each 8-digit measure results in only one 6-digit measure. Moving from the middle (6-digit SOC) level to the bottom (4-digit ISCO) level entails two different options for weighting, implying that for every 6-digit measure, there are two versions of its aggregated 4-digit counterpart. The variable names of the resulting measures are printed in bold and correspond to the variable names in the accompanying dataset, as well as to the terminology used throughout the remainder of this paper.
Source: OECD.

Box 1. Constructing Greenness measures at different levels: Example 1

Frequency- vs. employment-weighting when mapping "Incinerator and water treatment plant operators" (ISCO code 3132)

An example for a 4-digit ISCO category that contains both Green and non-Green SOC occupations is "Incinerator and water treatment plant operators" (ISCO code 3132). The occupation contains a total of four SOC 6-digit occupations, one of which is Green. Using **frequency weighting** (that is, ignoring the size of the 6-digit occupations), the share of Green 6-digit occupations is 0.25 (variable **share_green_6d**). The **employment-weighted** version of the index (variable **emp_uw_green_6d**) is much lower (0.018), reflecting the fact that employment in the Green SOC 6-digit occupation (Plant and System Operators: 6,100 employees mapped into ISCO 3132) is much lower than employment in the non-Green ones (First-Line Supervisors of Production and Operating Workers; Water and Wastewater Treatment Plant, and System Operators; Pump Operators: 329,713 employees mapped into ISCO 3132).

Because the continuous Greenness score of the Green 8-digit SOC occupation mapping into the Green 6-digit occupation is equal to 1 (i.e., 100% of the 8-digit occupation's specific tasks are Green), and the Green 6-digit SOC occupation contains three other (non-Green) 8-digit categories, the frequency-weighted Greenness-score at the 4-digit ISCO level (variable **greenness**) is equal to 0.0625 (=1/4*1/4). This reflects that ¼ of the 8-digit occupations in the only Green 6-digit SOC occupation is Green, and that the Green 6-digit SOC occupation in turn represents ¼ of 6-digit occupations mapped into the ISCO 4-digit occupation.

The employment-weighted continuous Greenness score at the 4-digit ISCO level (variable **greenness_uw**) has a value of 0.0045 (applying the same 6-digit SOC employment weight). The share of Green 8-digit categories in overall mapped 8-digit categories (variable **share_green_8d**) is 1/7 (around 0.14), and the employment-weighted version is 0.0045 (variable **emp_uw_green_8d**). This is equal to the employment-weighted continuous Greenness score in this case, because the continuous Greenness score is equal to one at the 8-digit level.

Box 2. Constructing Greenness measures at different levels: Example 2

Many-to-many mapping of "Managers" (SOC code 119199)

The following example uses the case of "managers" to illustrate the nested structure of SOC occupations and the many-to-many mapping into ISCO 4-digit. Table 1 shows the different steps involved in aggregating and cross-walking from the 8-digit SOC to the 4-digit ISCO level. It contains three panels, each showing one aggregation step. It starts from the most detailed occupation level (8 - digit SOC) in Panel A, with numbers aggregated at the 6-digit SOC in Panel B, and the translation to 4-digit ISCO in Panel C.

The first panel of Table 1 shows all of the nine 8-digit SOC occupations that map into the 6-digit occupation "managers" (SOC code 119199). For the four Green 8-digit occupations, the Greenness score, as well as the Vona et al. (2018[1]) original task-counts are included in the table, to show how the original measure was constructed. As four out of the nine 8-digit occupations are Green, the share of Green occupations at the 6-digit SOC level is 4/9 = 0.44, and the average Greenness score is 0.183.

The next panel, at the 6-digit SOC level, shows the mapping of the occupation into the 4-digit ISCO category 1114 ("Senior officials of special-interest organizations"). The SOC 6-digit occupation "managers" (SOC code 119199) maps into seven other ISCO categories (column N_ISCO_4d). In turn, the ISCO occupation 1114 contains two other SOC 6-digit categories, which also map into several other ISCO 4-digit occupations. At the 6-digit SOC level, employment data is available and is shown in column "emp". The employment-weighted version of the Greenness score at the ISCO level requires allocating the employment of each of the constituent 6-digit SOC to the destination ISCO occupations. With uniform weighting, the SOC 6-digit employment is simply split equally between the ISCO occupations it maps into: The 432,210 employees are thus divided by seven, and the adjusted employment number that maps into the ISCO 4-digit occupation of interest is 432,210/7 = 61744, shown in column "adj. emp". Employment from the other two constituent 6-digit SOC occupations is split in the same manner, so that the new employment total in the ISCO category can be calculated by adding up these adjusted employment numbers, which are also the basis for the computed shares in column "emp. weight". These employment shares constitute the weights applied when averaging the Greenness score of the underlying 6-digit SOC occupations. The last two columns of the table show the share of Green occupations and the average greenness at the 6-digit SOC level for SOC occupation 119199.

Panel C displays the final resulting measures at the ISCO 4-digit level. The simplest indicators measure the share of 8 or 6-digit SOC occupations in the ISCO occupation. The numbers of Green and total 8-digit SOC occupations nested in the ISCO occupation are provided in the table, yielding a share of 5/11=0.455, or 45.5% of Green 8-digit occupations. Since two out of the three constituent SOC 6-digit occupations are Green, the share at the 6-digit level is equal to 2/3, or 66.7%.

Next, Green employment at the 8- and 6-digit level is constructed. The share of Green 8-digit employment (**emp_uw_green_8d**) is computed by adding up the employment-weighted shares of Green 8-digit occupations (subject to rounding), shown in the penultimate column of Panel B, which yields a total of 0.859, or 85.9% of Green employment in the underlying 8-digit SOC occupations. In 6-digit occupations, 94.4% of employment is Green (**emp_uw_green_6d**). This is due to the small employment share of the non-Green SOC 6-digit occupation, which accounts for only 5.6% of employment after adjusting for the multiple mappings.

The last two columns of Panel C contain the frequency-weighted and employment-weighted Greenness scores. The frequency-weighted Greenness score (**Greenness**) is the simple average of the three 6-digit Greenness scores (0.183+0.06+0)/3 = 0.081. The employment-weighted score (**Greenness_uw**) consists in the weighted average of the Greenness scores at the 6-digit level (weighted components shown in the last columns of Panel B) and is equal to (0.0280+0.0475+0)/3 = 0.025.

Table 1. Example of cross-walking managerial occupations

Panel A: SOC 8-digit level

SOC 8d	ONETSOC2010Title	Green-ness 8d	Total specific tasks	Green specific tasks	SOC_6 d	share green	greenness _6d
119199.01	Regulatory Affairs Managers	0.15	27	4	119199	0.44	0.1833
119199.02	Compliance Managers	0.2	30	6	119199	0.44	0.1833
119199.03	Investment Fund Managers	0		0	119199	0.44	0.1833
119199.04	Supply Chain Managers	0.3	30	9	119199	0.44	0.1833
119199.07	Security Managers	0		0	119199	0.44	0.1833
119199.08	Loss Prevention Managers	0		0	119199	0.44	0.1833
119199.09	Wind Energy Operations Managers	0		0	119199	0.44	0.1833
119199.10	Wind Energy Project Managers	0		0	119199	0.44	0.1833
119199.11	Brownfield Redevelopment Specialists and Site Managers	1	22	22	119199	0.44	0.1833

Panel B: SOC 6-digit level

SOC _6d	SOC 6d Title	ISCO _4d	N_ ISCO	emp.	adj. emp	emp. weight	share green	green-ness_6d	w. emp.	w. green-ness
119199	Managers, All Other	1114	7	432,210	61,744	0.153	0.44	0.183	0.067	0.0280
111021	General and Operations Managers	1114	7	2,230,280	318,611	0.791	1	0.06	0.791	0.0475
112031	Public Relations and Fundraising Managers	1114	3	67,910	22,637	0.056	0	0	0	0

Panel C: ISCO 4-digit level

ISCO_4d	ISCO08TitleEN	N Green SOC8d	N SOC8d	share_ green_8d	share_ green_6d	emp_uw_ green_8d	emp_uw_ green_6d	Green-ness	Green-ness_uw
1114	Senior officials of special-interest organizations	5	11	0.455	0.667	0.859	0.944	0.081	0.025

Source: OECD.

2.2. Brownness of Occupations

2.2.1. The original Vona et al. (2018[1]) measure of Brown occupations

26. The measure of Brownness of occupations provided by Vona et al. (2018[1]) differs from their measures of Greenness in several ways. The first difference is that their approach to identify Brown (i.e., polluting) activities originates in industries, rather than detailed occupation descriptions. Second, the measure of Brownness is binary rather than continuous, thus not providing information on how much of the occupation involves activities that are Brown. And third, the occupation measure is provided at the 6-digit SOC level, rather than the more detailed 8-digit SOC classification.

27. Vona et al. (2018[1]) translate the information on polluting activities available at the 4-digit NAICS (North American Industry Classification System) to occupations through a two-step procedure. First, they identify polluting industries using information on industries' emissions of six different air pollutants, and labelling industries as brown when they are in the 95th percentile of pollution intensity for at least 3 pollutants. The authors identify 62 Brown industries (out of just over 1000 4-digit NAICS) in this way. In a second step, they map 6-digit SOC occupations into industries and classify occupations as Brown or non-Brown based on the observed employment of occupations in polluting relative to non-polluting industries. The threshold chosen to classify an occupation as Brown is that the share of this occupation's employment in polluting industries is at least seven times higher than the same share for all occupations.[12]

2.2.2. Cross-walking 6-digit SOC to 4-digit ISCO

28. The indicator measure of Brown occupations at the 6-digit level is crosswalked to the 4 - digit ISCO destination classification using the same pre-existing correspondence table and procedure as done in step two of the computation of green scores. Brown occupations at the 6-digit SOC level that fit into multiple ISCO 4-digit categories are mapped under the same assumptions underlying the different options for weighting Green occupations: (1) frequency weighting, double-counting all SOC 6-digit occupations that map into multiple ISCO categories; or (2) employment weighting, where 6-digit SOC employment shares are either distributed evenly across 4-digit ISCO (uniform weighting), or allocated proportionally to the relative employment observed in the 4-digit ISCO occupations into which they map (Dingel-Neiman (DN) weighting). Importantly, DN weighting is only possible when employment information for ISCO 4-digit occupations is available.

29. Since there is only a single measure to be cross-walked from the 6-digit SOC, this leaves three final measures of Brownness at the ISCO 4-digit level: two continuous measures resulting from the crosswalk (a frequency-weighted and an employment-weighted share of Brown), and a simple binary indicator. The procedure yields a total of 50 Brown occupations at the 4-digit ISCO level, and the resulting measures are summarised and discussed in Table 2 in Section 3 below.

2.3. Grey Occupations

30. Grey occupations are those that are a) neither Green nor Brown, or b) both Green and Brown. Category a) comprises most occupations in the economy (291 occupations out of 438), and category b) consists in 13 occupations that are re-coded to Grey because they contain both Green and Brown SOC occupational categories.[13] Table 4 summarises the Greenness and Brownness indicators for those occupations. The final classification contains 83 Green (19%), 50 Brown (11.4%) and 304 Grey (69.6%) occupations.

[12] While the choices in identifying Brown industries, as well as the probability cut-off value of 7 for mapping occupations into those industries, are somewhat arbitrary, replicating the mapping step using French data yields a set of occupations that can reasonably be considered "Brown" when the share of mapped brown occupations is held constant but the probability threshold is set at a lower value (which is necessary due to the overall smaller number of both industries and occupational categories in the French data).

[13] These are detailed in Annex Table A.4. These 13 occupations correspond to roughly 3% of 4-digit ISCO occupation categories, and account for 3% of employment in the Portuguese data used in the empirical application in Section 4 of this paper.

3. Description and Interpretation

31. The measures computed in the previous section vary in their interpretation and the assumptions behind them. The simplest measure, based on a binarisation at the most aggregate level, is straightforward in its interpretation, but lacks the information required to assess how green an occupation really is, or how many of the originally Green (or Brown) occupations are represented in the final ISCO occupation and what share of employment they account for. The data provided along with this note does not make a choice of which indicator would be best, as this will also depend on the actual question at stake. In addition, providing multiple indicators can help in analytical applications to test how robust a result is depending on the definition of what a "green job" or "brown job" is. The following sections will discuss in detail the different measures and their interpretation, providing summary statistics, interpretations, and comparisons of the different measures derived starting with Green before moving to Brown and Grey occupations.

3.1. Measures of Greenness

32. Table 2 provides summary statistics of the different measures of Greenness derived in Section 2, showing first the six main indicators (the indicator measure at the 4-digit ISCO level is not shown because the table focuses on Green occupations only, and the measure is equal to one for all 83 Green ISCO occupations by definition). The employment-weighted measures that are included in the main measures are using uniform weighting to crosswalk SOC occupations into ISCO occupations, and the "DN weighted" versions of the employment-weighted indices are shown separately in the last three rows. The DN version, which requires information on the size of occupations at the ISCO level, is constructed using ISCO 4-digit employment weights from Portugal (see Section 4 for more details on the Portuguese data).

33. Starting with the first two measures that refer to the SOC occupations mapped into the ISCO occupation, **share_green_8d** and **share_green_6d** are simple averages of dichotomous indices at the 6-digit or 8-digit SOC levels and reflect the share of green occupations within a 4 - digit ISCO category. These measures are informative when the occupation is the unit of interest, rather than the individual active in the occupation.

34. **share_green_8d** indicates the share of green SOC 8-digit occupations mapped into ISCO_4d. On average across all 83 Green occupations, 58.5% of all underlying 8-digit occupations mapped into ISCO 4-digit are Green. Half of the Green 4-digit ISCO occupations have at least 50% underlying Green 8-digit occupations, and the ISCO occupation with the lowest share of underlying Green 8-digit occupations contains one Green out of nine total 8-digit occupations.

35. The interpretation of the **share_green_6d** is analogous to that at the 8-digit level and indicates the share of green SOC6d occupations mapped into ISCO_4d. By construction, this measure is equal or larger than the share of 8-digit occupations. While the 8-digit measure is clearly more informative about the extent to which underlying mapped occupations are Green, the 6-digit measure might be useful to compare Green with Brown occupation measures, as the latter are only available at the 6-digit level. Therefore, they also rely on a rather coarse measure of what constitutes a green/brown occupation, but they do not rely on assumptions on the crosswalk between the ISCO and the SOC classifications.

Table 2. Descriptive statistics of the different indicators of Greenness

Variable	*Obs*	*Mean*	*Std. Dev.*	*P25*	*P50*	*P75*	*Min*	*Max*
share_green_8d	83	0.582	0.295	0.333	0.500	1	0.111	1
share_green_6d	83	0.705	0.295	0.500	0.667	1	0.125	1
emp_uw_green_8d	83	0.630	0.320	0.415	0.597	1	0.007	1
emp_uw_green_6d	83	0.779	0.291	0.580	0.968	1	0.007	1
greenness	83	0.201	0.215	0.055	0.115	0.280	0.011	1
greenness_uw	83	0.147	0.205	0.025	0.060	0.183	0.001	1
emp_ew_green_8d	83	0.584	0.343	0.304	0.523	1	0	1
emp_ew_green_6d	83	0.717	0.350	0.370	0.947	1	0	1
greenness_ew	83	0.141	0.207	0.022	0.060	0.183	0	1

Note: This table does not contain the 13 occupations classified as both Green and Brown. share_green_8d refers to the share of green SOC8d occupations mapped into ISCO_4d. emp_uw_green_8d refers to the employment share of green SOC8d occupations mapped into ISCO_4d using uniform weighting. share_green_6d refers to the share of green SOC6d occupations mapped into ISCO_4d. emp_uw_green_6d refers to the employment share of green SOC6d occupations mapped into ISCO_4d using uniform weighting. greenness refers to the frequency-weighted Greenness score, measuring the average green-intensity of the underlying SOC8d occupations. greenness_uw refers to the uniformly weighted Greenness score, measuring the green-intensity of employment. emp_ew_green_8d refers to the employment share of green SOC8d occupations mapped into ISCO_4d using DN weighting and ISCO4-digit employment weights from Portugal. emp_ew_green_6d refers to the employment share of green SOC6d occupations mapped into ISCO_4d using ISCO4-digit employment weights from Portugal. greenness_ew refers to the DN-weighted Greenness score using ISCO4-digit employment weights from Portugal, measuring the green-intensity of employment. Figure 1 provides an overview of the construction of the measures.
Source: OECD.

36. The next two measures, **emp_uw_green_8d** and **emp_uw_green_6d**, use information on the employment in the SOC occupations underlying an ISCO occupation. The focus here is on the individual, and the measures aim to capture the employment size of the underlying occupation categories to ultimately provide a quantitative assessment of Green *employment*, rather than Green occupations. The numbers are less straightforward to interpret, and their construction requires more choices and assumptions – specifically, about the distribution of 6-digit SOC employment within a 4-digit ISCO occupation, and the relative size of 6-digit SOC occupations.

37. **emp_uw_green_8d** is an employment-weighted aggregation of the binary index at the 8-digit SOC level, assuming a uniform distribution of the employment SOC 6-digit whenever they map into multiple 4-digit ISCO. The measure can be interpreted as the share of green *employment* (instead of green *occupations*) within a 4-digit ISCO occupation. On average, 63.4% of the employment in a Green ISCO occupation is active in a Green 8-digit occupation, i.e., an occupation involving at least one Green task. Equivalently, **emp_uw_green_6d** is an employment-weighted aggregation of the binary index at the 6-digit SOC level and is, as such, equal or larger than the 8-digit version as it traces back to the binarisation at the cruder, 6-digit level. 78.1% of employees in a Green ISCO occupation are active in a 6-digit SOC occupation involving at least one Green task.

38. Finally, the two measures, **greenness** and **greenness_uw**, are based on the continuous green scores from Vona et al. (2018[1]) and can be interpreted as measures of "green intensity". These measures provide a more precise measure of the Greenness of employment or occupations, by indicating *how Green* the employment or the occupation is.

39. When the original Greenness scores are combined in a simple average, the resulting variable (**greenness**) estimates the average green intensity of jobs within a 4-digit ISCO occupation. The variable **greenness** thus allows a more refined assessment of the Green content of each 4-digit ISCO occupation. The average of 0.20 indicates that the average Green intensity – that is, the share of Green-specific tasks across the mapped 8-digit occupations - is 20%.

40. When the original Greenness scores are combined in a weighted average, the resulting measure estimates the Green-intensity of *employment*, that is, the average share of Green tasks done by workers in each occupation. The variable **greenness_uw** indicates a lower share of 14.7% of green tasks when the employment size of occupations is taken into account, under the assumption of uniform weighting. As

shown in the last row of Table 2, when employment weighting is done using DN ISCO 4-digit employment weights from Portugal, the resulting number is slightly lower, at 14.1%.

41. Comparing the remaining two DN employment-weighted indices with their uniformly weighted versions, the DN weighted employment **emp_ew_green_6d** is a more substantial 7.3 percentage points lower than the uniform version. This measure indicates that when exploiting the relative size of ISCO 4-digit occupations in Portugal, on average 70.8% of employees in a Green ISCO occupation are active in a 6-digit SOC occupation involving at least one Green task (compared to 78.1% with uniform weighting, i.e., when no information on relative ISCO occupation sizes is used). A similar pattern emerges when comparing the same indicators at the 8-digit level: with a mean of 57.7%, **emp_ew_green_8d** is also lower than its uniformly weighted version, at 63.4%.

42. More generally, when comparing the DN- and uniformly weighted measures, the consistently lower scores on the DN measures indicate that Green ISCO 4-digit occupations containing SOC 6-digit occupations with multiple mappings are, on average, larger than non-Green 4-digit occupations containing SOC 6-digit occupations with multiple mappings. This result critically hinges on the employment distribution across 4-digit occupations in Portugal, and may change in the context of a different economy with a different industrial structure.[14]

43. Comparing the different measures, the simplest, dichotomous score are easy to interpret and require few assumptions, but do not provide an account of the extent of Greenness within occupations. The more complex measures that aim at capturing the size of occupations and the employment within them more closely estimate the Greenness of occupations, but they rely on additional assumptions that arise from the choices that are inevitable during the aggregation procedures from the detailed 8-digit SOC to the ISCO 4-digit level.

44. Comparing the worker-centred (i.e., employment-weighted) to the occupation-centred (i.e., frequency-weighted) measures, whenever employment measures yield higher average numbers than those relying on occupation counts, more individuals work in green SOC occupations than in non-green occupations in the underlying employment data. Note that this result might be different if SOC employment weights were taken not from the United States but a different economy, and that the result also hinges upon the employment weighting procedure applied in the many-to-many mapping from SOC to ISCO: When DN- rather than uniform weighting is used, the means of the employment-weighted averages are remarkably close to the frequency-weighted versions. That said, the standard deviations and quantiles differ more than with uniform weighting. This suggests that the differences between the measures may be larger at the tails of the distributions and for smaller occupations. Thus, if one is interested in economy-wide average levels of Greenness, picking one measure or the other may not make a big difference. However, when the focus is on specific occupations or sectors of the economy, a more careful assessment of the underlying assumptions of the different measures and their application is required, and testing robustness of outcomes to different versions of the Greenness measures can be helpful.

45. Given the differences not only in the means, but also the dispersion of the different measures, the following analyses provides a more complete picture of their distribution and the correlation between them. Figure 2 shows the distribution of the nine possible scores (including both the uniform and the DN method of computing the employment weighted average), as well as the scatterplots and Kendall correlation coefficients for all pairwise combinations of the scores.

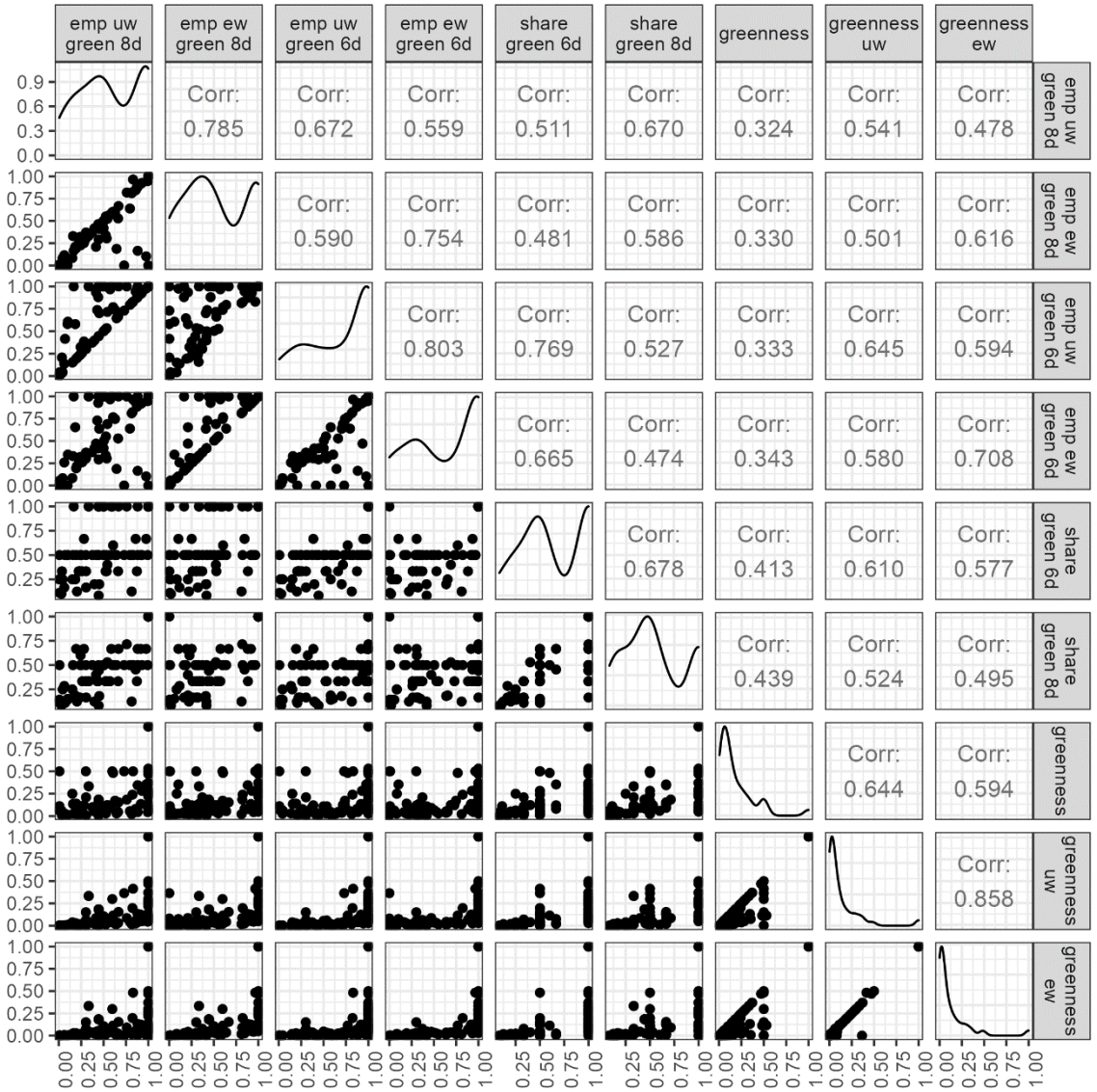
46. Although the different scores have clearly different levels, they are strongly correlated. The weakest correlations are those involving the Greenness intensity measure based on the continuous scores

[14] This suggests that, even though the uniform- and DN-weighted versions of the employment-weighted measures are rather similar overall, for a country-specific application, it may be useful to use country-specific employment weights at the 4-digit level to calculate the DN-employment-weighted measure. Alternatively, if the same set of measures is to be applied to a set of comparable countries, average detailed (4-digit) employment across the set of countries could be used.

from Vona et al. (2018[1]) and computed without considering the employment size of the SOC occupations (**greenness**). This measure tends to be (relatively) weakly correlated in particular with the measures of Green employment in the SOC occupations, with rank correlations below 40%. The fact that the Greenness scores display the lowest pairwise correlations with the other measures may not surprising, given that these scores measure the Green intensity of occupations whereas all other measures derive their variation only from the size of occupation groups.

47. The methodology used to compute the employment-weighted average does not seem to matter significantly, as the employment-weighted measure computed with uniform weighting has a rank correlation of around 80% with the same measure computed with DN weighting. This confirms that the patterns from the summary statistics in Table 2 also hold when taking into account the full distribution of scores.

Figure 2. Correlations of measures of Greenness



Note: The graphs on the diagonal show a smoothed distribution of the corresponding score. The numbers in the top right matrix display the Kendall correlation coefficients. The scatterplots in the bottom left compare the score as computed with the measure written on the right (on the y-axis) to the score as computed with the measure written on top (on the x-axis). Each dot is a green occupation at the 4-digit ISCO level (including occupations which are both green and brown).

3.2. Measures of Brownness

48. Table 3 provides summary statistics of the different measures of Brownness (again omitting the indicator measure at the 4-digit ISCO level, as the measure is equal to one for all 50 Brown ISCO occupations by definition). The DN version of the Brown employment-weighted indices are constructed using the same ISCO 4-digit employment weights from Portugal as for the Greenness measures (see Section 4 for more details on the data).

Table 3. Descriptives of the different indicators of Brownness

Variable	*Obs*	*Mean*	*Std.*	*P25*	*P50*	*P75*	*Min*	*Max*
share_brown_6d	50	0.704	0.310	0.5	0.751	1	0.143	1
emp_uw_brown_6d	50	0.676	0.389	0.243	0.919	1	0.010	1
emp_ew_brown_6d	50	0.674	0.383	0.342	0.899	1	0.017	1

Note: This table does not contain the 13 occupations classified as both Green and Brown. share_brown_6d refers to the share of brown SOC6d occupations mapped into ISCO_4d. **emp_uw_brown_6d** refers to the employment share of brown SOC6d occupations mapped into ISCO_4d using uniform weighting. **emp_ew_brown_6d** refers to the employment share of brown SOC6d occupations mapped into ISCO_4d using ISCO4-digit employment weights from Portugal.
Source: OECD.

49. The share of Brown 6-digit SOC occupations in each brown 4-digit ISCO category (**share_brown_6d**) is 70.4% on average, and the share of employees in Brown occupations in 6-digit SOC occupations is just slightly smaller, at 67.6% with uniform weighting (**emp_uw_brown_6d**), or 67.4%, when DN-weighting is used (**emp_ew_brown_6d**). As with Green occupations, dispersion is higher for the employment-weighted numbers.

50. If a consistent approach of measuring Greenness and Brownness is desired where the resulting numbers are directly comparable, the employment- or frequency-weighted SOC6d indicators are the best available option. Summary statistics suggest that the measures for Green and Brown are symmetrical: in general, the numbers for the Brownness of occupations are of a similar magnitude as the numbers for Greenness when comparing the equivalent measures at the 6-digit SOC level – around 60-70% of mapped 6-digit SOC occupations and employment are Brown (resp, Green) within each Brown (resp. Green) ISCO 4-digit.

3.3. Grey occupations

51. Summary statistics of the 13 occupations that are re-coded to Grey because they contain both Green and Brown SOC occupational categories are provided in Table 4. The table contains both the Greenness and the Brownness measures. Depending on the purpose of the application of the Greenness and/or Brownness measures provided in this note, these 13 occupations can be added to either category, treated as a separate category, or retained as Grey.

52. The summary statistics suggest that the ISCO 4-digit occupations containing both Green and Brown 6-digit SOC categories are substantially less Green on average, with green scores at least 50% lower across all types of measures (frequency- and employment-weighted, irrespective of the weighting procedure applied). Not a single measure contains 100% Green occupations or employment, and every quartile is lower than for the unambiguous Green occupations.

53. The Brownness measures are also lower on average, but the difference is much less pronounced – roughly around 10 percentage points across the three measures. There are also still occupations that are 100% brown, indicating that some of the underlying mapped 6-digit SOC occupations are both Green and Brown, rather than there being fully Green and fully Brown occupations mapped into the same ISCO 4-digit occupation.

Table 4. Summary statistics of the occupations that are both Green and Brown

stats	mean	sd	p25	p50	P75	min	max
share_green_8d	0.252	0.190	0.125	0.167	0.333	0.083	0.667
emp_uw_green_8d	0.225	0.236	0.028	0.203	0.281	0.005	0.872
share_green_6d	0.282	0.181	0.125	0.250	0.333	0.083	0.667
emp_uw_green_6d	0.237	0.236	0.044	0.203	0.305	0.007	0.872
greenness	0.074	0.068	0.021	0.063	0.111	0.006	0.250
greenness_uw	0.013	0.020	0.003	0.004	0.009	0.001	0.070
emp_ew_green_8d	0.244	0.242	0.019	0.251	0.321	0.006	0.883
emp_ew_green_6d	0.253	0.238	0.056	0.303	0.321	0.007	0.883
greenness_ew	0.012	0.019	0.002	0.005	0.018	0.001	0.071
share_brown_6d	0.553	0.313	0.333	0.500	1	0.100	1
emp_uw_brown_6d	0.586	0.396	0.089	0.628	1	0.028	1
emp_ew_brown_6d	0.557	0.393	0.117	0.670	1	0.016	1

Note: This table is based on the 13 occupations that are both Green and Brown. Refer to Table 2 notes for a detailed description of the indicators of Greenness. Refer to Table 3 notes for a detailed description of the indicators of Brownness.
Source: OECD.

3.4. Further information provided at the ISCO 4-digit level

54. Besides the indicators of Greenness and Brownness developed thus far, the dataset that is provided contains a few more variables that provide additional information relevant to the different levels of aggregation. Further variables provided are:

- **N_SOC8d**: The number of original 8-digit occupations mapped into the ISCO occupation
- **N_green_SOC8d**: The number of *Green* 8-digit occupations mapped into the ISCO occupation (note that both variables are subject to double-counting, and the continuous, weighted "share_Green_8d" is a better indicator of the prevalence of 8-digit Green occupations per 4-digit ISCO category)
- **N_SOC6d**: The number of 6-digit occupations mapped into the ISCO occupation
- **N_green_SOC6d**: The number of *Green* 6-digit occupations mapped into the ISCO occupation (note that both variables are subject to double-counting, and the continuous, weighted "share_Green_6d" is a better indicator of the prevalence of 6-digit Green occupations per 4-digit ISCO category)
- **N_green_SOC6d**: The number of *Brown* 6-digit occupations mapped into the ISCO occupation

4. Application and Discussion

55. This section applies the different measures of Greenness and Brownness derived in this paper to Linked Employer-Employee data from Portugal. The Portuguese "Quadros de Pessoal" data covers the full population of firms and their employees in the private economy (excluding the public sector). It provides rich information on both the worker- and the firm side, including ISCO 4-digit occupation information from 2010 onwards. The last year of available data is 2017, allowing to also investigate trends over time. This data is thus ideally suited to illustrate the different measures developed in this paper, and to discuss differences that may arise between them when applied to real data.

Table 5. Example: economy-wide figures for the different indices of Greenness and Brownness

Portugal, 2011 and 2017

year	share_green_8d	emp_ew_green_8d	emp_uw_green_8d	share_green_6d	emp_ew_green_6d	emp_uw_green_6d	green	greenness	greenness_ew	greenness_uw
2011	9.5	11.0	11.2	11.1	13.0	13.1	19.0	2.9	1.7	1.7
2017	8.7	10.1	10.3	10.2	12.0	12.1	17.9	2.6	1.5	1.5
				share_brown_6d	emp_ew_brown_6d	emp_uw_brown_6d	brown			
2011				6.9	5.3	5.3	11.6			
2017				6.4	5.0	5.0	10.8			

Note: All indicators have been multiplied by 100, to ease interpretation.
Source: OECD.

56. Table 5 illustrates the different measures of Greenness and Brownness, using Linked Employer-Employee data from Portugal and comparing the economy-wide numbers in 2017 to those in 2011.[15] Besides revealing the time trends in Greenness and Brownness, this exercise also helps assess whether using uniform- or employment-weighted mapping from SOC to ISCO makes a difference in practice.

57. Starting with the simplest measures, the binary indicators of green and brown indicate that in 2017, 17.9% of workers were employed in a 4-digit ISCO occupation that is classified as Green (i.e., contains any Green task), and 10.8% of employees were employed in an ISCO-occupation that is classified as Brown. Comparing these numbers to 2011, both Green and Brown employment has fallen by just over 1 percentage point.

58. Moving to more fine-grained levels of the binary indicators, in 2017, 10.2% of employees work in 6-digit SOC occupations classified as Green (down from 11.1% in 2011), and 8.7% of employees work in 8-digit SOC occupations classified as Green (down from 9.5% in 2011). For Brown occupations, the most detailed available level is 6-digit SOC, and 6.4% of workers are active in a 6-digit occupation classified as Brown (down from 9.6% in 2010). For both Green and Brown occupations, when moving from the binarisation at the cruder 4-digit ISCO to the more detailed 6-digit SOC level, the numbers drop by just under 40%. This suggests that within each green ISCO occupation, a significant share of SOC occupations do not entail green tasks.

59. Moving to measures of Green employment, in 2017, around 12% of employment is Green at the 6-digit SOC level (12.1% using uniform weighting, and 12.0% using DN weighting) and just over 10% of employment is Green at the more precise 8-digit SOC level (10.3% with uniform weighting, and 10.1% using DN weighting). These numbers indicate that empirically, using uniform or employment weighting makes very little difference, at least at this economy-wide level of aggregation. The same holds true for Brown employment, which is 5% for both the uniformly weighted and the employment-weighted version at the 6-digit level, which is the most detailed available level for Brownness.

60. Comparing the time trends in the Green employment measures, the same patterns emerge as for the binarised measures, with numbers dropping by around 1 percentage point across the different

[15] This example therefore uses the year 2011 as the start year because the 2010 numbers display some irregularities that are likely to occur due to a major data break in 2009, which results in implausibly high and erratic changes in the time series.

measures. A downward trend is also discernible for employment in Brown occupations, albeit less pronounced.

61. The fact that Green employment is not increasing over time and remains at a rather small share of overall employment is in line with the findings in Bluedorn et al. (2022[3]) for a set of 34 mostly advanced economies, and Vona et al. (2019[2]) for the United States. The relatively low level of greenness, and a stable trend in the greenness of jobs, could confirm that the level of labour reallocation which will be required by the green transition will not lead to a significant change in the overall level of turnover in labour markets (OECD, 2017[9]). However, it is also likely that this trend partly reflects some of the limitations of Greenness measures based on a fixed set of tasks by occupation in picking up changes in the task content of occupations over time, as discussed further below.

62. Lastly, the Green intensity of employment is provided by the "Greenness" indicators, originating from Vona et al.'s (2018[1]) continuous Greenness scores. By construction, these measures yield much lower numbers of Greenness of the economy. The average green intensity of 8-digit SOC occupations is 3%, and the intensity of Green employment is 1.5% for both the uniformly weighted, and the DN-weighted version of the measure.

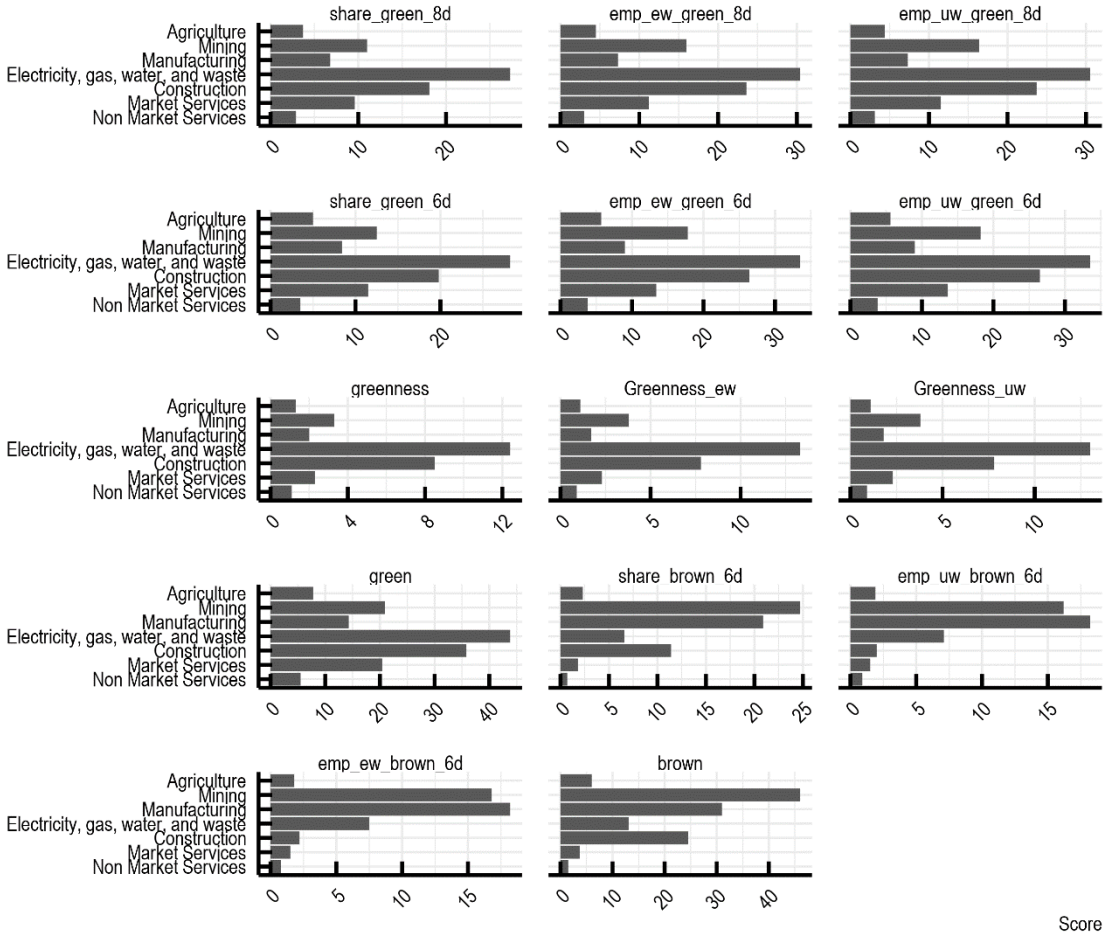
63. Analysing Greenness and Brownness at a more disaggregate industry level, Figure 3 shows the different measures for seven macro-sectors of the economy. Because occupations can vary widely between sectors, differences between the various Greenness and Brownness measures may be more pronounced than for the entire economy.

64. As expected, both Greenness and Brownness differ widely across sectors. Utilities (electricity, gas, water, and waste) is by far the most Green of the seven macro-sectors, regardless of the measure of Greenness: The different measures of Green employment and employment in Green occupations yield relatively similar numbers of around 30%. Green intensity is also highest, with around 13% of tasks being Green in this sector.

65. Construction has the second-highest levels of Greenness, across all measures. However, in the sector, the differences between measures are relatively more pronounced, with employment-centred measures (emp_ew_green, emp_uw_green) being over five percentage points higher than those based on binary occupations (share_green). Greenness intensity is around 8%, which is around 1/3 of the most granular, and most precise (8-digit) employment measure. Compared to Utilities, the average Green intensity of Green occupations is thus lower in Construction. The next two macro-sectors with the highest green scores are Mining and Non-Financial Services. While both have just over 20% Green occupations at the 4-digit ISCO level, there are large differences in Green employment:16% of employment is Green in Mining, whereas only 11% of employment is Green in Non-Financial Services. Green intensity is also clearly higher in Mining. The binary measures thus miss important variation in Greenness, even for binarisation at finer levels of the occupation classification (8- or 6-digit levels). The Greenness of Construction is clearly understated looking at the share of Green 8-digit occupations as opposed to Green employment, which is 5 percentage points higher. This suggests that the greener occupations in Construction tend to be larger than the average occupation.

Figure 3. Measures of Greenness and Brownness across macro-sectors

Portugal, 2017



Note: All indicators have been multiplied by 100, to ease interpretation. Annex Table A.1 shows the exact numbers across macro-sectors. Macro-sectors consist in grouping STAN A38 2-digit industries as follows: Agriculture: industries 01-03; Mining: industries 05-09; Manufacturing: industries 10-33; Electricity, gas, water, and waste: industries 35-39; Construction: industries 41-43; Market Services: industries 45-82; Non-Market Services: 84-99. The list of STAN 38 industries**Error! Hyperlink reference not valid.** is available on the STAN website: http://oe.cd/stan
Source: OECD.

66. For Brown occupations, the relative differences between employment- and occupation-centred measures are also very pronounced when comparing macro-sectors. The three sectors with the highest levels of Brownness are Mining, Construction and Manufacturing. Comparing the share of Brown 6-digit occupations to the employment in those occupations, Manufacturing turns out to be the sector with the highest levels of Brown employment, despite having a 15% lower share of 4-digit ISCO occupations, and a 3.8% lower share of Brown 6-digit occupations compared to Mining (which is the sector with the second-highest Brown employment). In Construction, although around one quarter of ISCO 4-digit occupations are Brown, levels of Brown employment are only 2%. This is comparable to Brown employment in Agriculture which contains 6% Brown ISCO-occupations that represent less than 2% of employment.

67. These results demonstrate the importance of consulting different measures of Greenness and Brownness, as results can vary significantly depending on the measure considered. Looking only at a

single measure can not only hide important level differences between sectors, but also affect their ranking, especially for Brownness.[16]

68. While the binarised measures can yield very different results compared to the employment-weighted measures, the two versions of the employment-weighted indices continue to be very similar when looking at macro-sectors. Using an employment-weighted index with uniform weights can thus be appropriate when employment weights at the disaggregated ISCO level are not available for a given application of the indices. This result is reassuring also when the same index is to be applied in a cross-country context, where adjusting employment weights by country might complicate the comparability of results.

69. Occupation-centred measures based on binary indicators can be important when the aim is to understand the occupational *structure* of the economic unit (economy, sector, industry, firm) under consideration. Taking into account the size of occupations is important, however, when the aim is to assess the overall Greenness of a unit or compare levels of Greenness between units.

70. Despite these conceptual differences, an application of the different measures of Greenness to the positive link between firm productivity and the Greenness of its workforce (Box 3) yields very similar patterns, thus indicating that the different measures indeed capture the same underlying characteristic of the Greenness of jobs.

71. There are further limits to the validity of the measures across space and time. All measures entail a trade-off in terms of comparability and accuracy, both between countries and over time. Not only can the structure of occupations (i.e., *between*-occupation variation) differ between countries, but the content of occupations – i.e., the tasks *within* them – may also be different in different countries. The same holds true when making comparisons over long periods of time, as the Green Transition is likely to bring about significant change. A given occupation may become Greener over time (limiting *within*-occupation comparability), or new Green occupations may emerge that are not captured by the SOC or ISCO occupation classifications (limiting *between*-occupation comparability over time).[17] This may also help explain the apparent flat (Bluedorn et al. (2022[3])), or only marginally increasing (Vona et al. (2019[2])) or decreasing (this paper) share of Green employment when looking at time trends over 6-8 years.

[16] This may be due to the fact that there are fewer Brown than Green occupations; and also because the sectoral dimension is more relevant to Brown than Green occupations, given that the Brown classification originates in industries.

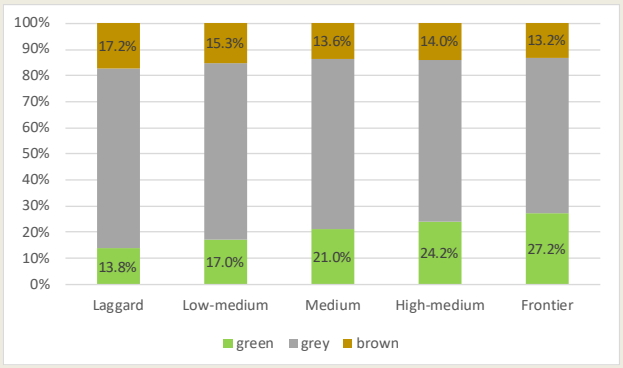
[17] Changes in the occupational structure over short periods of time do not seem to matter for the Greenness measures developed in this paper, as discussed in footnote 8.

Box 3. Robustness of the Greenness-productivity link to different measures of Greenness

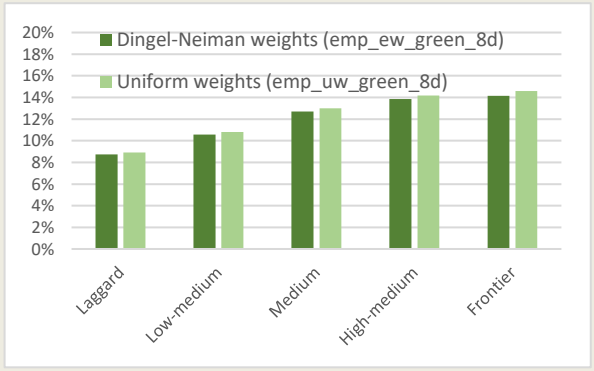
Thanks to the classification crosswalk developed in this paper and applied specifically to Portuguese Linked Employer-Employee (also used in the empirical application in Section 4), panel A of Figure 4 shows that productive firms tend to rely more on Green occupations, and less on Brown ones. The calculations rely on the binarisation at the 4-digit ISCO_08 level, which is the broadest of the available measures and defines a Green job as an occupation containing any Green task, thus likely overstating Greenness of the underlying workforce. Panels B and C show that the same pattern emerges for each of the different Greenness measures derived throughout this paper, thus underscoring the robustness of the productivity-Greenness link, as well as providing evidence for the validity of the different measures of Greenness.

Figure 4. Productivity-Green jobs link using different measures of Greenness

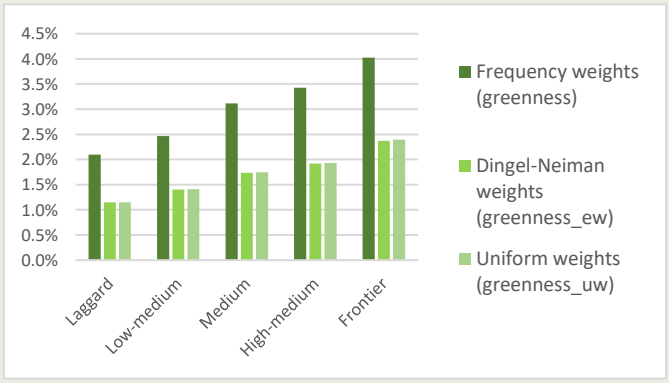
Panel A: Binarised at the ISCO 4-digit level



Panel B: Green employment



Panel C: Greenness



Note: In Panel A, Green jobs are ISCO 4-digit occupations that contain any green task. Panel B, uses Green measures that reflect the relative (employment) size of the underlying Green 6-digit SOC occupations in each ISCO 4-digit occupation. Panel C additionally takes into account the Green-intensity of Green occupations.
Productivity is measured as value added-based labour productivity within the average 2-digit industry (market sector) and year. Patterns are robust to using different measures of productivity, such as gross output-based measures. Laggard firms are defined as the bottom 10%; Low-medium as the 10-40%; Medium as the 40-60%; High-medium as the 60-90%; and Frontier as the top 10% of the productivity distribution.
Source: OECD.

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Annex A. Additional Tables

Table A.1. Measures of Greenness and Brownness across macro-sectors

Portugal, 2017

Macro-sector	share_ green_8d	emp_ew_ green_8d	emp_uw_ green_8d	share_ green_6d	emp_ew_ green_6d	emp_uw_ green_6d	green	greenness	Greenness _ew	Greenness _uw
Agriculture	3.7	4.5	4.4	5.0	5.7	5.6	7.8	1.3	0.7	0.6
Mining	11.0	16.0	16.4	12.5	17.8	18.2	20.9	3.3	2.5	2.5
Manufacturing	6.8	7.3	7.3	8.4	9.0	9.0	14.3	2.0	1.1	1.1
Electricity, gas, water, and waste	27.3	30.4	30.5	28.2	33.5	33.5	43.8	12.4	10.1	10.0
Construction	18.1	23.6	23.7	19.8	26.4	26.5	35.8	8.5	4.2	4.2
Market Services	9.6	11.2	11.5	11.5	13.4	13.6	20.4	2.3	1.4	1.4
Non Market Services	2.9	3.0	3.1	3.5	3.8	3.8	5.5	1.1	0.5	0.5
				share_ brown_6d	emp_ew_ brown_6d	emp_uw_ brown_6d	brown			
Agriculture				2.3	1.9	1.8	6.0			
Mining				24.7	16.2	16.8	46.0			
Manufacturing				20.9	18.2	18.2	31.0			
Electricity, gas, water, and waste				6.6	7.1	7.5	13.1			
Construction				11.4	2.0	2.2	24.5			
Market Services				1.8	1.5	1.5	3.7			
Non Market Services				0.7	0.9	0.8	1.5			

Note: All indicators have been multiplied by 100, to ease interpretation. Macro-sectors consist in grouping STAN A38 2-digit industries as follows: Agriculture: industries 01-03; Mining: industries 05-09; Manufacturing: industries 10-33; Electricity, gas, water, and waste: industries 35-39; Construction: industries 41-43; Market Services: industries 45-82; Non-Market Services: 84-99. The list of STAN 38 industries is available on the STAN website: http://oe.cd/stan.
Source: OECD.

Table A.2. ISCO 4-digit measures of Greenness

ISCO code	ISCO title	emp_uw_ green_8d	emp_ew_ green_8d	emp_uw_ green_6d	emp_ew_ green_6d	share_ green_6d	share_ green_8d	greenness	Green-ness_uw	Green-ness_ew
1112	Senior government officials	0.976	0.102	0.976	0.102	0.667	0.667	0.353	0.075	0.008
1113	Traditional chiefs and heads of villages	0.730	0.000	0.730	0.000	0.500	0.500	0.500	0.365	0.000
1114	Senior officials of special-interest organizations	0.859	0.845	0.944	0.934	0.667	0.455	0.081	0.025	0.025
1120	Managing directors and chief executives	1.000	1.000	1.000	1.000	1.000	1.000	0.530	0.115	0.116
1213	Policy and planning managers	0.444	0.444	1.000	1.000	1.000	0.444	0.183	0.183	0.183
1219	Business services and administration managers not elsewhere classified	0.061	0.115	0.137	0.259	0.167	0.286	0.031	0.004	0.008
1221	Sales and marketing managers	0.374	0.374	0.374	0.374	0.500	0.500	0.100	0.037	0.037
1223	Research and development managers	0.881	0.881	1.000	1.000	1.000	0.667	0.345	0.132	0.132
1321	Manufacturing managers	0.333	0.333	1.000	1.000	1.000	0.333	0.333	0.333	0.333
1322	Mining managers	0.444	0.444	1.000	1.000	1.000	0.444	0.183	0.183	0.183
1323	Construction managers	1.000	1.000	1.000	1.000	1.000	1.000	0.280	0.280	0.280
1324	Supply, distribution and related managers	1.000	1.000	1.000	1.000	1.000	1.000	0.237	0.237	0.237
1343	Aged care services managers	0.645	0.187	0.645	0.187	0.500	0.500	0.030	0.019	0.006
1346	Financial and insurance services branch managers	0.526	0.551	0.526	0.551	0.500	0.333	0.030	0.016	0.017
1349	Professional services managers not elsewhere classified	0.444	0.444	1.000	1.000	1.000	0.444	0.183	0.183	0.183
1420	Retail and wholesale trade managers	1.000	1.000	1.000	1.000	1.000	1.000	0.060	0.060	0.060
1431	Sports, recreation and cultural centre managers	0.415	0.209	0.934	0.470	0.500	0.400	0.092	0.086	0.043
1439	Services managers not elsewhere classified	0.444	0.444	1.000	1.000	1.000	0.444	0.183	0.183	0.183
2112	Meteorologists	1.000	1.000	1.000	1.000	1.000	1.000	0.500	0.500	0.500
2114	Geologists and geophysicists	0.882	0.882	0.882	0.882	0.667	0.667	0.187	0.097	0.097
2132	Farming, forestry and fisheries advisers	0.304	0.370	0.304	0.370	0.333	0.333	0.210	0.064	0.078
2133	Environmental protection professionals	0.597	0.597	1.000	1.000	1.000	0.500	0.500	0.299	0.299
2142	Civil engineers	1.000	1.000	1.000	1.000	1.000	1.000	0.470	0.470	0.470
2143	Environmental engineers	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2144	Mechanical engineers	0.573	0.573	0.968	0.968	0.500	0.333	0.115	0.040	0.040

2149	Engineering professionals not elsewhere classified	0.542	0.523	0.715	0.690	0.400	0.529	0.124	0.040	0.038
2151	Electrical engineers	1.000	1.000	1.000	1.000	1.000	1.000	0.140	0.140	0.140
2152	Electronics engineers	0.500	0.419	0.500	0.419	0.500	0.500	0.110	0.055	0.046
2153	Telecommunications engineers	1.000	1.000	1.000	1.000	1.000	1.000	0.220	0.220	0.220
2161	Building architects	1.000	1.000	1.000	1.000	1.000	1.000	0.370	0.370	0.370
2162	Landscape architects	1.000	1.000	1.000	1.000	1.000	1.000	0.260	0.260	0.260
2164	Town and traffic planners	1.000	1.000	1.000	1.000	1.000	1.000	0.370	0.370	0.370
2356	Information technology trainers	1.000	1.000	1.000	1.000	1.000	1.000	0.100	0.100	0.100
2412	Financial and investment advisers	1.000	1.000	1.000	1.000	1.000	1.000	0.235	0.110	0.122
2413	Financial analysts	0.535	0.304	0.535	0.304	0.333	0.333	0.110	0.059	0.033
2421	Management and organization analysts	0.194	0.194	0.194	0.194	0.500	0.667	0.140	0.027	0.027
2422	Policy administration professionals	0.333	0.333	1.000	1.000	1.000	0.333	0.333	0.333	0.333
2424	Training and staff development professionals	1.000	1.000	1.000	1.000	1.000	1.000	0.100	0.100	0.100
2432	Public relations professionals	1.000	1.000	1.000	1.000	1.000	1.000	0.240	0.240	0.240
2433	Technical and medical sales professionals (excluding ICT)	0.794	0.639	0.794	0.639	0.500	0.500	0.055	0.044	0.035
2434	Information and communications technology sales professionals	0.523	0.340	0.523	0.340	0.333	0.333	0.037	0.019	0.012
2519	Software and applications developers and analysts not elsewhere classified	0.167	0.167	1.000	1.000	1.000	0.167	0.028	0.028	0.028
2529	Database and network professionals not elsewhere classified	0.101	0.058	0.607	0.347	0.500	0.154	0.014	0.009	0.005
2619	Legal professionals not elsewhere classified	1.000	1.000	1.000	1.000	1.000	1.000	0.050	0.050	0.050
2631	Economists	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2633	Philosophers, historians and political scientists	0.662	0.529	0.662	0.529	0.333	0.333	0.047	0.031	0.025
2642	Journalists	0.445	0.293	0.445	0.293	0.500	0.500	0.025	0.011	0.007
2643	Translators, interpreters and other linguists	0.249	0.322	0.249	0.322	0.500	0.500	0.070	0.017	0.023
3112	Civil engineering technicians	0.397	0.417	0.397	0.417	0.200	0.125	0.052	0.021	0.022
3113	Electrical engineering technicians	0.586	0.576	1.000	1.000	1.000	0.667	0.093	0.050	0.051
3114	Electronics engineering technicians	0.500	0.500	1.000	1.000	1.000	0.500	0.105	0.105	0.105
3115	Mechanical engineering	0.244	0.227	0.324	0.308	0.500	0.600	0.059	0.011	0.011

	technicians									
3116	Chemical engineering technicians	0.667	0.667	1.000	1.000	1.000	0.667	0.154	0.154	0.154
3117	Mining and metallurgical technicians	0.759	0.819	1.000	1.000	1.000	0.714	0.185	0.086	0.091
3119	Physical and engineering science technicians not elsewhere classified	0.628	0.599	0.738	0.747	0.500	0.500	0.173	0.021	0.019
3141	Life science technicians (excluding medical)	0.302	0.302	0.302	0.302	0.500	0.500	0.500	0.151	0.151
3142	Agricultural technicians	0.500	0.500	1.000	1.000	1.000	0.500	0.060	0.060	0.060
3155	Air traffic safety electronics technicians	0.500	0.500	1.000	1.000	1.000	0.500	0.105	0.105	0.105
3257	Environmental and occupational health inspectors and associates	0.429	0.425	0.737	0.730	0.500	0.333	0.122	0.040	0.039
3322	Commercial sales representatives	0.043	0.083	0.043	0.083	0.250	0.250	0.027	0.001	0.002
3323	Buyers	0.261	0.261	0.261	0.261	0.333	0.333	0.080	0.021	0.021
3331	Clearing and forwarding agents	0.881	0.165	0.881	0.165	0.500	0.500	0.045	0.040	0.007
3339	Business services agents not elsewhere classified	0.184	0.210	0.580	0.654	0.250	0.188	0.047	0.020	0.024
3351	Customs and border inspectors	0.035	0.000	0.207	0.000	0.333	0.111	0.011	0.002	0.000
3353	Government social benefits officials	0.097	0.000	0.581	0.000	0.500	0.143	0.016	0.009	0.000
3354	Government licensing officials	0.069	0.000	0.415	0.000	0.500	0.111	0.016	0.007	0.000
3522	Telecommunications engineering technicians	0.500	0.500	1.000	1.000	1.000	0.500	0.105	0.105	0.105
4321	Stock clerks	0.234	0.264	0.234	0.264	0.333	0.167	0.030	0.007	0.008
5221	Shopkeepers	1.000	1.000	1.000	1.000	1.000	1.000	0.060	0.060	0.060
7111	House builders	1.000	1.000	1.000	1.000	1.000	1.000	0.280	0.280	0.280
7119	Building frame and related trades workers not elsewhere classified	0.607	0.603	0.769	0.767	0.600	0.500	0.482	0.114	0.113
7121	Roofers	1.000	1.000	1.000	1.000	1.000	1.000	0.300	0.300	0.300
7126	Plumbers and pipe fitters	0.917	0.917	0.917	0.917	0.500	0.667	0.135	0.124	0.124
7127	Air conditioning and refrigeration mechanics	0.440	0.464	0.880	0.927	0.500	0.333	0.058	0.051	0.053
7231	Motor vehicle mechanics and repairers	0.452	0.410	0.702	0.638	0.200	0.182	0.036	0.013	0.012
7411	Building and related electricians	0.007	0.009	0.007	0.009	0.500	0.500	0.500	0.004	0.004
7543	Product graders and testers (excluding foods and beverages)	1.000	1.000	1.000	1.000	1.000	1.000	0.060	0.060	0.060

8211	Mechanical machinery assemblers	0.504	0.504	0.504	0.504	0.500	0.500	0.065	0.033	0.033
8332	Heavy truck and lorry drivers	0.993	0.947	0.993	0.947	0.500	0.500	0.045	0.045	0.043
9313	Building construction labourers	0.814	0.811	0.814	0.811	0.125	0.125	0.023	0.018	0.018
9611	Garbage and recycling collectors	0.830	0.965	0.830	0.965	0.500	0.500	0.500	0.415	0.483
9612	Refuse sorters	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9622	Odd job persons	0.928	0.927	0.928	0.927	0.500	0.500	0.282	0.051	0.051

Source: OECD.

Table A.3. ISCO 4-digit measures of Brownness

ISCO code	ISCO title	emp_uw_brown_6d	emp_ew_brown_6d	share_brown_6d
2113	Chemists	0.957	0.956	0.5
2145	Chemical engineers	1	1	1
2146	Mining engineers, metallurgists and related professionals	0.691	0.803	0.5
3122	Manufacturing supervisors	1	1	1
3133	Chemical processing plant controllers	1	1	1
3134	Petroleum and natural gas refining plant operators	1	1	1
3135	Metal production process controllers	1	1	1
6210	Forestry and related workers	0.11	0.099	0.167
7112	Bricklayers and related workers	0.01	0.017	0.5
7132	Spray painters and varnishers	0.444	0.529	0.5
7211	Metal moulders and coremakers	0.154	0.459	0.5
7221	Blacksmiths, hammersmiths and forging press workers	0.44	0.44	0.5
7222	Toolmakers and related workers	0.064	0.077	0.333
7224	Metal polishers, wheel grinders and tool sharpeners	1	1	1
7314	Potters and related workers	0.882	0.676	0.5
7315	Glass makers, cutters, grinders and finishers	1	1	1
7412	Electrical mechanics and fitters	0.181	0.152	0.154
7413	Electrical line installers and repairers	0.735	0.804	0.5
7421	Electronics mechanics and servicers	0.071	0.027	0.143
7511	Butchers, fishmongers and related food preparers	0.028	0.038	0.25
7514	Fruit, vegetable and related preservers	0.441	0.441	0.5
7516	Tobacco preparers and tobacco products makers	0.66	0.182	0.667
7521	Wood treaters	1	1	1
7522	Cabinet-makers and related workers	1	1	1
7523	Woodworking-machine tool setters and operators	1	1	1
7532	Garment and related pattern-makers and cutters	0.243	0.342	0.333
7533	Sewing, embroidery and related workers	0.049	0.043	0.333
7534	Upholsterers and related workers	1	1	1
7542	Shotfirers and blasters	1	1	1
8112	Mineral and stone processing plant operators	1	1	1
8121	Metal processing plant operators	1	1	1
8122	Metal finishing, plating and coating machine operators	1	1	1
8141	Rubber products machine operators	1	1	1
8142	Plastic products machine operators	0.374	0.367	0.538
8143	Paper products machine operators	1	1	1
8151	Fibre preparing, spinning and winding machine operators	1	1	1
8152	Weaving and knitting machine operators	1	1	1
8154	Bleaching, dyeing and fabric cleaning machine operators	1	1	1
8160	Food and related products machine operators	0.855	0.842	0.833
8171	Pulp and papermaking plant operators	1	1	1
8172	Wood processing plant operators	1	1	1
8181	Glass and ceramics plant operators	1	1	1
8183	Packing, bottling and labelling machine operators	1	1	1
8189	Stationary plant and machine operators n.e.c.	0.161	0.227	0.5
8311	Locomotive engine drivers	0.114	0.145	0.333
8342	Earthmoving and related plant operators	0.055	0.081	0.4
8343	Crane, hoist and related plant operators	0.014	0.042	0.2
9129	Other cleaning workers	0.785	0.649	0.5
9311	Mining and quarrying labourers	0.76	0.76	0.5
9623	Meter readers and vending-machine collectors	0.502	0.502	0.5

Source: OECD.

Table A.4. ISCO 4-digit measures of ambiguous Grey occupations

ISCO code	ISCO title	emp_uw_ green_8d	emp_ew_ green_8d	emp_uw_ green_6d	emp_ew_ green_6d	share_ green_6d	share_ green_8d	greenness	greenness_uw	greenness_ew	emp_uw_ brown_6d	emp_ew_ brown_6d	share_ brown_6d
2131	Biologists, botanists, zoologists and related professionals	0.028	0.019	0.028	0.019	0.1	0.083	0.063	0.002	0.001	0.055	0.056	0.1
3111	Chemical and physical science technicians	0.281	0.251	0.386	0.306	0.667	0.667	0.121	0.02	0.018	0.614	0.694	0.333
3131	Power production plant operators	0.159	0.33	0.159	0.33	0.5	0.5	0.135	0.009	0.019	0.841	0.67	0.5
3132	Incinerator and water treatment plant operators	0.005	0.006	0.018	0.025	0.25	0.143	0.063	0.001	0.002	0.628	0.388	0.5
7213	Sheet-metal workers	0.872	0.883	0.872	0.883	0.333	0.333	0.08	0.07	0.071	0.028	0.016	0.333
7223	Metal working machine tool setters and operators	0.445	0.418	0.445	0.418	0.083	0.083	0.006	0.003	0.002	0.089	0.117	0.333
7233	Agricultural and industrial machinery mechanics and repairers	0.007	0.007	0.007	0.007	0.111	0.111	0.111	0.001	0.001	0.608	0.592	0.333
7513	Dairy-products makers	0.24	0.321	0.24	0.321	0.5	0.5	0.025	0.006	0.008	1	1	1
8111	Miners and quarriers	0.203	0.22	0.203	0.22	0.125	0.125	0.021	0.004	0.005	0.754	0.733	0.75
8113	Well drillers and borers and related workers	0.305	0.321	0.305	0.321	0.167	0.167	0.008	0.003	0.003	1	1	1
8114	Cement, stone and other mineral products machine operators	0.011	0.014	0.044	0.056	0.25	0.143	0.063	0.003	0.004	0.956	0.944	0.75
8131	Chemical products plant and machine operators	0.222	0.303	0.222	0.303	0.333	0.167	0.017	0.004	0.005	1	1	1
9329	Manufacturing labourers not elsewhere classified	0.151	0.084	0.151	0.084	0.25	0.25	0.25	0.038	0.021	0.047	0.026	0.25

Source: OECD.


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