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The complexity of green job creation: An analysis of green job development in Brazil

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Abstract
Rising temperatures and sea levels, as well as the depletion of natural resource stocks, places green growth more than ever at the center of our political and economic agendas. But how can a country or region exactly "go green"? Transforming current economic structures into a green economy is a complex process. The structure of an economy is determined by the type of jobs that are present in an economy. Therefore, the creation of green jobs is one of the components of the "going green" process. Using occupational data for 27 Brazilian states between 2003 and 2013, this paper examines whether the level of economic complexity of a state explains why one state has a greener occupation space than another. First, we construct a "green jobs index" which quantitatively measures the greenness of the occupation space of a state. We then empirically show that economic complexity has a positive explanatory power when it comes to differences in this green jobs index. We also show that transitioning through this occupational space is a slow and difficult process. Nonetheless, we find evidence of declining regional differences in greenness. Initially, states which had a low green jobs index became relatively greener than states that had initially a high green jobs index. This indicates convergence across states.

Keywords Green economy · Sustainable development · Green jobs · Economic complexity · Brazil

JEL Classification O13 · Q55 · R58

1 Introduction

It is now widely accepted that our current way of living poses a serious threat to the quality of life of future generations (e.g., Sample 2003; Hopwood et al. 2005; Altenburg et al. 2017). In monetary terms, the costs of environmentally unsustainable practices are significantly high: The Lancet Commission on Pollution and Health has estimated the welfare losses due to environmental pollution at more than 4.6 trillion US dollars per year, or 6.2% of global GDP (Landrigan et al. 2017).

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Policies focused on green growth have ignited the transformation of economies into so-called green economies (Grazi et al. 2007). This rise of the green economy is accompanied by the rise of "green jobs." In fact, the emergence of green jobs is one of the driving forces behind the transition toward green economies (Renner et al. 2008). This paper adopts the definitions of a green economy and job proposed by the Occupational Information Network Resource Center (O*NET,[1] a program of the US Department of Labor/Employment and Training Administration). They define the green economy as "economic activity related to reducing the use of fossil fuels, decreasing pollution and greenhouse gas emissions, increasing the efficiency of energy usage, recycling materials, and developing and adopting renewable sources of energy."[2] Based on this, they use the following definition of green jobs: "The "greening" of occupations refers to the extent to which green economy activities and technologies increase the demand for existing occupations, shaping the work and worker requirements needed for occupational performance, or generate unique work and worker requirements." This includes a wide range of jobs, which all share a common factor: they contribute to economic activities that are beneficial to the environment. This contribution is sometimes very direct (e.g., solar plant engineers), but can also be rather indirect (truck drivers who work for the company that produces solar panels). We adopt the set of 204 O*NET-designated green occupations for the basis of our analysis.[3] The Brazilian Ministry of Labor and Employment uses a set of 616 distinct occupations to classify labor in the Brazilian economy. We match the O*NET set of 204 green jobs with the Brazilian set of 616 occupations in order to determine which of those 616 jobs are green. This results in the construction of a list of 185 green jobs in Brazil.[4]

The O*NET definition of green jobs differentiates between three types of green occupations:

1. The first set of green occupations is the so-called green increased demand occupations. These types of jobs experience an increase in demand due to the green economy, but the tasks of the jobs do not change. In general, these jobs contribute to the green economy in a rather indirect way. Examples of such jobs are chemists, electricians, and welders. This subset of green jobs is part of the broad definition of green jobs.
2. The second group of green jobs is the so-called green enhanced skills occupations. The workers in these occupations may or may not experience an increase in demand, but the green economy will change the work and worker requirements significantly. Examples of such occupations are agricultural engineers, civil engineers, roofers, and construction laborers/managers. The essence of their occupation has not changed, but the increased focus on the green economy forced them to consider the environmental quality and this alters their daily activities. This subset is part of a slightly more narrow definition of green jobs.

[1] According to O*NET, examples of green jobs used in this paper are: Agriculture Science Researchers, Geologists, Oceanographers, Geophysicists and Related, Agricultural Engineers, Biologist, Technical Support Bioengineering.

[2] For more details, see the Occupational Information Network Resource Center (O*NET): www.onetonline.org.

[3] For the full set of green jobs, see https://www.onetonline.org/find/green?n=0&s=0. Note that not all of the jobs in this online list are present in Brazil.

[4] For the full list of the 185 green jobs in Brazil, see the attached file.

3. The final set of occupations is the green new and emerging occupations. The impact of green economy activities and technologies is sufficient to create the need for unique work and worker requirements. These jobs are closely related to the core principles of the green economy and form the basis of the narrow definition of green jobs. Examples of such jobs are climate change analysts, environmental economists, and solar plant engineers.

Even though green jobs and the green economy are sisters—concepts of green growth, they do not have the exact same meaning as green growth. Nonetheless, they should be seen as variants of the same concept because the networks and institutions in which they are being discussed and supported are largely the same (World Bank 2012c; Green Economy Coalition 2012).

Despite the concept of green growth, policies that benefit the environment often have the stigma of being expensive and inefficient, which is why policymakers often expect such policies to hurt economic growth (Bezdek et al. 2008). The United Nations Environment Programme (UNEP 2008) argues that this belief is not based on facts. This claim is supported by the abundant literature that finds a positive link between sustainable development (and green job creation in particular) and economic growth (e.g., Bezdek et al. 2008; Cai et al. 2011; Engel and Kammen 2009; Lehr et al. 2012; Martinez-Fernandez et al. 2010). This literature shows that environmental protection, economic development, and job creation can be reconcilable and interdependent.

Environmental protection has become a large profit-making and job-creating industry since the late 1960s. Environmental protection represented a $300 billion industry in the USA in 2003 and accounted for five million jobs (Bezdek et al. 2008). Most of these five million people do not even realize that their occupation helps to protect the environment. Only a few of them have classic environmental jobs, such as environmental engineers and ecologists; most of them have standard jobs such as accountants, computer analysts, and factory workers. Since significantly more jobs are linked to environmental jobs than perhaps initially thought it is not surprising that Bezdek et al. (2008) find a positive relationship between economic growth, job creation, and environmental protection. The transition toward a green economy should thus not only be wished by policymakers due to its ability to mitigate the effects of climate change but also as a way to generate wealth (Shutters et al. 2015).

How can this desire be transformed into a concrete transition toward a green economy? Modern economies are immensely complex systems consisting of many dimensions, and several of these dimensions play a role in the transformation toward a green economy. GIZ and ICLEI (2012) analyze urban economies and identify several dimensions and goals which are relevant for a country that desires to transition to a green economy. This paper focuses on one of the dimensions identified by GIZ and ICLEI (2012), namely the important role of the creation of green jobs in the transition process.

The creation of green jobs is closely related to the occupational structure of a country and is a logical consequence of a transition toward a green economy. The occupational structure of a country or region is the mix of different types of jobs found in an economy and is, therefore, one of the defining characteristics of an economy (Renner et al. 2008). The characteristics of this occupational structure change in a significant way when new green jobs enter the economy. However, transforming an occupational structure into one that suits the green economy is a slow and difficult process (Shutters et al. 2015). Some countries and regions struggle to become green, while others transition relatively easy, which raises the question: What explains the differences in this transition process of various countries and regions? This paper sets out to examine whether the level of economic complexity of an economy plays an important explanatory role in the transition toward a green economy through the channel of green job creation.

This paper applies the analytical perspective from Shutters et al. (2015) who argue that the set of knowledge, skills, and technologies that are present in an economy crucially determines an economy's ability to transition toward a green economy. The jobs that are present in a country and region represent the available skills and knowledge in that area. Some skills and technologies, by their nature, are easily transitioned into other economic activities (such as managers and politicians), while others are not (such as truck drivers), and may even hinder the transitional process. This observation is not particularly new, as it was first proposed by Arrow (1962) and later by Robert and Lucas (1993) and Stokey (1988).

However, Hausmann and Hidalgo (2011) and Hidalgo et al. (2007) have recently revived this insight when they proposed the concept of the "Product Space." The Product Space is a network representation of the relatedness or proximity between products traded in the global market (Hausmann et al. 2014). The Product Space is closely related to the concept of "economic complexity." Economic complexity is defined as a measure that seeks to explain the knowledge accumulated in a country's population (the networks that people form) and that is expressed in the country's industrial composition (Hidalgo et al. 2007). The Product Space can be seen as a visual representation of the relationship between products in terms of their economic complexity. Section 2.2 provides a more elaborate explanation of what economic complexity is and how it relates to green job creation.

The purpose of this paper is twofold: We first apply the methodology by Muneepeerakul et al. (2013) and Shutters et al. (2015) to measure the greenness of the Brazilian states. Second, we examine whether the level of economic complexity of an economy plays a statistically significant role in the transition toward a green economy through the channel of green job creation. In order to do that, we conduct an empirical analysis of the Brazilian economy based on panel data for the 27 Brazilian states over the period 2003–2013. We use data on occupational information from RAIS (Relação Anual de Informações Sociais) from the Brazilian Ministry of Labour and Employment.

The paper is structured as follows: Sect. 2 discusses the importance of the green economy and the theoretical framework, which reviews both the theoretical and empirical literature. This includes literature on sustainable development and the link between green jobs and economic complexity. Section 3 describes the data and the variables of interest and takes a closer look at the methodology that is applied in this paper. Section 4 discusses the results and provides concluding remarks and policy recommendations.

2 Theoretical framework

2.1 Becoming a green economy: why and how

Over the last decade, the concept of green growth has become one of the prominent pillars of the international policy scene. This emergence is reflected in the policy discourse of international economic and development institutions. Many multilateral banks, including the World Bank, have committed themselves to green growth goals (World Bank 2012a, b). The OECD has implemented a strategy for its research that focuses on green growth.

Additionally, a new international institution, the Global Green Growth Institute (GGGI), supported by a number of governments, has been created to advise countries on its implementation. Finally, several countries have explicitly incorporated green growth in their policy objectives (OECD 2012).

The need for such objectives is evident given the forecasts for population growth and rising incomes. These trends will change consumption patterns toward more demand but in the face of natural resources constraints and environmental impact. The scientific and anecdotal evidence of human caused climate change is, for example, overwhelming (Sample 2003). This raises the concern of whether the world is able to support the pressure on the environment if living standards in the rest of the world were to increase to Western levels.

Brazil, as an emerging economy, experiences rising income and population size. As a result of this, there is an increasing demand of goods which causes pressures on the environment. This growth of population and demand of goods and services should be incorporated in the proper definition of sustainable development in Brazil. Associated with this issue, the forestry and land use are the main activities responsible for emissions of greenhouse gases. According to the Brazilian Science and Technology Ministry (2009), in 1990, 76.1% of the CO_2 emissions in Brazil originated from forestry and land use. In 2005, this figure slightly decreases to 73.3%.

According to the Ministry of the Environment (2008), Brazil's efforts are based on the commitment to reduce social inequality and to increase income by seeking an economic dynamic with a low emissions trajectory, not repeating the pattern and the standards of the countries that have already industrialized. However, the country faces challenges given "the difficult task of significantly reducing emissions from land-use change and the requirement of continuously increasing efficiency in the use of the country's natural resources."

Caruso (2010) states that Brazil has a very well-structured environmental legislation and institutional mechanisms to implement a transition from a carbon economy to a low-carbon economy. As the use of lands and forests is the major emitter of greenhouse gases, there are plenty of specific mechanisms created to solve such problems. At the same time, there is a set of laws and programs for the following economic sectors: Energy; Transport; Construction; Agricultural; Forestry/Forests; Waste and Steel Sector. The author also argues that it was possible to identify in the Brazilian economy a number of new technologies that can be used to mitigate the effects of gas emissions. This attribute could be a positive factor to create a range of green occupations, for example, engineering professionals, physical and engineering science technicians, agricultural, forestry, and fishery workers.

Jacobs (2012) presents a theoretical foundation supporting the notion that environmental protection can promote economic growth. The author identifies three different theoretical arguments that are based on their own framework and economic theory. The first, and core argument is based on Keynesian theory. Environmental stimulus during a recession will boost economic growth through the multiplier effect. Such investments are needed in order to sustain aggregate demand in the economy; lost private sector demand has to be replaced with public expenditure. As Jacobs (2012) argues: "Such spending does not have to be green, but given the extent of the environmental opportunities available, and the various additional amenity and health benefits they offer, a green stimulus package offers particular advantages."

The second argument stems from the growth theory. Classical growth theory has paid insufficient attention to the simple observation that the natural environment is also a factor of production. This so-called natural capital is often seen as a free gift from nature and therefore goes unpriced. This can be considered as a market failure, and growth theories that do not incorporate natural capital into their models are therefore sub-optimal. Green growth theories correct this market failure by including natural capital as a factor of production and lead to an optimal outcome. The third and final argument is more Ricardian in nature and states that environmental policies create a significant number of new jobs in environmental industries. Countries that adopt such policies are able to obtain a comparative advantage in the relevant sectors. Comparative advantage in such sectors can lead to growth as the world transitions into green economies (Jacobs 2012).

Despite significant support in the literature for the notion that environmental protection can promote economic growth, there is also literature that warns for the dangers of green growth. Bowen (2012), for example, says that "the potential adverse impacts of green growth policies on labor productivity and the costs of employment tend to be overlooked." Dercon (2014) argues that green growth might not be good for the poor if no social protection measures are taken. He also stresses the function of economic growth as a way of poverty alleviation. Jacobs (2012) questions whether unsustainable exploitation would not possibly reach much higher levels of growth than sustainable growth. Two arguments support this idea. First, Jacobs (2012) says that the period under consideration is crucial when it comes to this question. The now-industrialized countries exploited resources at a time when nature was abundant, and where the costs of resource depletion were therefore in the far future. This is now no longer the case; the costs of resource depletion are already tangible. The second argument comes from Dercon (2014) who points out that the poor suffer the most from climate change as they do not possess the means that are needed to mitigate the effects of climate change. High non-green economic growth, therefore, hurts the poor, rather than benefit them.

Countries experience different outcomes in their transitions into green economies. One question that arises is why some countries struggle to transition. The neoclassical view states that markets perform the allocation function more efficiently than agents. Vazquez-Brust et al. (2014), however, note that markets have consistently failed to allocate resources appropriately in earlier stages of developments when economies transitioned from an agrarian into industrial. They, therefore, argue that coordination is needed during the early stages of any socio-technical transition, as markets will be inefficient during the initial stage of transitions from "brown" to "green" economies. Mathews (2017) presents an example of this when he discusses India's green shift to renewables. He notes that, even though India is transitioning relatively well, finance remains an obstacle. For example, in 2017, some of India's banks have been exposed as being complacent in their approach to lending to fossil fuel projects. Despite the uncertain future of coal plants, the banks put nearly two billion US dollars into them. Mathews argues in favor of coordination and national guidelines, similarly to China's guidelines on green finance.

This connects to the framework for green growth that the OECD (2011) has constructed. They state that "the overarching goal of a framework for green growth is to establish incentives or institutions that increase well-being." They identify three crucial pathways toward that goal:

1. Improving resource management and boosting productivity;
2. Encouraging economic activity to take place where it is of the best advantage to society over the long term;
3. Leading to new ways of meeting the above two objectives, i.e., innovation.

Promising developments that are in line with this framework can be identified in Asia. For example, newly established Multilateral Development Banks (MDBs), such as the

China-ASEAN Asian Infrastructure Investment Bank (AIIB), explicitly refer to green growth as a goal in their policy notes (Mathews 2017). However, not the whole of Asia is as successful in its transition. Indonesia is attempting to create a pathway for green growth by eliminating costly energy subsidies in the near future, promoting cleaner energy sources, and innovating its climate funding mechanisms. A lack of proper coordination is a problem in Indonesia, as some policies lead to conflicting outcomes. A lack of coherence among existing policies prohibits Indonesia from achieving green growth. The Indonesian experience should be an example for other countries that want to pursue green growth (Jupesta et al. 2011). Not only the coherence of policies is important, but also the continuity. Since Korea has adopted green growth policies, it has shown outstanding progress (Mathews 2012). Moreover, the Korean case illustrates how important political continuity is for the green transition.

Some economists emphasize that green policies can have an impact on the distribution of investment and employment, but not on their levels (e.g., Schmalensee 2012). Mathews (2011) illustrates that this assertion is unfounded. He shows that China's model of the strategic pursuit of green growth is delivering economic benefits, creating jobs in great numbers, and reducing carbon emissions at the same time.

This paper fills up various gaps in the existing literature. First, virtually all studies either focus on differences between countries or on countries as a whole. Drivers of green growth within countries are largely ignored. This is especially worrisome as the literature also shows that if the consequences of a green transition are not taken into account, the poor could suffer. Many developing countries already struggle with internal inequality, and a green growth process that does not consider regional differences could lead to undesirable outcomes. In this paper, we focus on individual states and our results enable states to identify which of their sectors are most suitable for a green transition and which virtually have no potential at all. This creates the possibility of tailor-made policies, rather than a generic green growth policy for the entire country, which is what most of the existing literature suggests. Moreover, there are very few studies, which quantitatively estimate the greenness of regions. Most existing studies are qualitative, which makes comparing results troublesome as arbitrary decisions and interpretation play a role.

This paper quantitatively measures the greenness of regions with a methodology that could be applied to any desired region. This makes the results objective and comparable. Finally, the existing literature has not been able to determine the characteristics of green countries. There are both green and non-green rich countries, developing countries, democracies, and oligarchies. This paper investigates whether economies that are more economically complex are also greener, which is something that has not been researched before. The following section considers this relationship.

2.2 Green jobs and economic complexity

Hidalgo and Hausmann (2009) propose that economic complexity is a driving force of economic growth. They argue that as people and firms specialize in different activities, economic efficiency increases, suggesting that development is associated with an increase in the number of individual activities and with the complexity that emerges from the interactions between them. They have developed a view of economic growth and development that gives a central role to the complexity of a country's economy.

Ultimately, the complexity of an economy is related to the multiplicity of useful knowledge embedded in it. When we allocate productive knowledge to individuals, it is important that the bits of information each person gets is internally coherent so that a person can perform a certain task. Hausmann and Hidalgo refer to these “modularized chunks of embedded knowledge” as capabilities (Hausmann and Hidalgo 2011). Some capabilities are active at the individual level and others at the level of organizations or even networks. Countries do not simply make the products and services they need, they make the ones they can. To do so, they need people and organizations that possess relevant knowledge. Economic complexity, therefore, is expressed in the composition of a country’s productive output and reflects the structures that emerge to hold and combine the knowledge.

To understand how the complexity of a country can be measured, it is important to consider two other aspects of economic complexity: ubiquity and diversity. First of all, the amount of embedded knowledge that a country has is expressed in its production diversity or the number of distinct products that it makes. Second, products that demand large volumes of knowledge are feasible only in the few places where all the necessary knowledge is available. They define ubiquity as the number of countries or regions that make a product. In this sense, it is assumed that production factors are randomly spread across the world, and not highly concentrated. Using this terminology, we can observe that complex products—those that require a lot of knowledge and different capabilities—are less ubiquitous. The ubiquity of a product, therefore, reveals information about the amount of knowledge that is required for its production. Hence, the amount of knowledge that a country has is expressed in the diversity and ubiquity of the products that it makes (Hausmann and Hidalgo 2011).

Hausmann and Hidalgo have the following to say on the role of economic complexity within the development economics framework:

> Development economics has tended to disregard the search for detailed capabilities and their patterns of complementarity, hoping that aggregate measures of physical capital (e.g., measured in dollars) or human capital (e.g., measured in years of schooling) would provide enough guidance for policy. Our line of research would justify and provide guidance to develop strategies that look to promote products (or capabilities) as a way to create incentives to accumulate capabilities (or develop new products) that could themselves encourage the further coevolution of new products and capabilities (Hidalgo and Hausmann 2009, p. 10575).

This quote helps to make the link between green job creation and economic complexity clear. The creation of green jobs is a development strategy that seeks to promote certain green products and services. Knowing what the best way to achieve this goal is would assist policymakers.

This paper hypothesizes that it is the level of economic complexity of a region that explains the differences in the greenness of the region’s occupational space. When we consider what the fundamental driving factors behind green job creation and economic complexity are, this relationship becomes clearer. Ultimately, economic complexity is driven by the amount of embedded knowledge in a region, which is closely related to the human capital that is present (Hausmann et al. 2014). The creation of green jobs is aimed at substituting natural capital with human-made capital. Investing in human capital is one of the channels through which both green job creation and raising the level of economic complexity of a region can be achieved.

Connected to the concept of economic complexity, Angelo, Jabbour and Galina (2012, p. 115) state that “green/environmental innovation can be the result of pro-active environmental management, which can develop innovation in products/services, processes or markets, but on the other hand, innovation can provide the evolution of organizational environmental management promoting their environmental pro-activity."

Other studies such as Brunnermeier and Cohen (2003), Wagner (2007), and Ming-Ji and Ching-Hsun (2009) consider the importance of environmental innovation and green learning processes are capable of mobilizing knowledge, technological advances, and the concessions of novelties in their offers (products/services). It can contribute through new products and services or the change in manufacturing processes, which are closely related to economic complexity. It is, therefore, both interesting and useful to analyze the relationship between green job creation and economic complexity.

3 Methodology

The methodology that is used in this paper in order to determine why some states are greener than others consists of two stages. The occupational greenness of the Brazilian states is calculated in the first stage. The green jobs index variable, which is the result of this first stage, is then the main dependent variable in the second stage of the methodology. The second stage consists of an empirical analysis of the impact of the economic complexity of the states and various control variables on the capability of an economy creates green jobs.

3.1 Green jobs index

Even though the index by Shutters et al. (2015) appears to be very similar to existing indices at first glance, it provides several important advantages.[5] Most of the existing indices are qualitative, rather than quantitative. Secondly, Shutters et al. (2015) method can easily be used to determine the occupational greenness of regions, and even cities. Their approach also defines an economy based on its mix of worker skills instead of its prevalent industries, which is more common. Finally, their measure allows for the assessment of specific regions across a country for which sufficiently detailed employment data are available (Shutters et al. 2015). Furthermore, this index provides an original way of measuring an economy's progress toward a green economy. Even though it can be classified as an economic index, it is not based on GDP, economic growth, or consumption. This adds value as such factors are increasingly seen as incomplete indicators of well-being (Costanza et al. 2014).

The green jobs index that Shutters et al. (2015) construct finds its roots in the work by Muneepeerakul et al. (2013). Here, we follow the methods from Muneepeerakul et al. (2013) and Shutters et al. (2015). However, instead of applying the methodology to urban areas, this paper uses it to measure the occupational greenness of the Brazilian states. This is a three-step process. The first step determines whether a state is specialized in occupation by constructing the location quotient (Azis et al. 1998). This is considered to be the case when the fraction of the states' employment in that occupation exceeds the mean fraction across all states. Similarly, we may use the location quotient of occupation i in state m which is defined as:

[5] Such as the STAR communities (http://www.starcommunities.org/) rating and the UN prosperity index (http://unhabitat.org/urban-initiatives/initiatives-programmes/city-prosperity-initiative/).

$$\mathrm{LQ}_i^{(m)} = \frac{\left(X_i^{(m)} / \sum_i X_i^{(m)}\right)}{\sum_m X_i^{(m)} / \sum_m \sum_i X_i^{(m)}} \tag{1}$$

where $x_i^{(m)}$ is the number of workers employed in occupation i in state m. Thus, state m is specialized in occupation i if its location quotient $LQ_i^{(m)} > 1$. The economic structure that is constructed here is based on occupational data. These data cover the skills and human capital in the labor force that characterize an economy (Florida 2012; Florida et al. 2008; Jones and Romer 2010; Moretti 2012). The specialization of occupation is taken as a proxy for the aggregate comparative advantage that a given state economy has for that occupation. Location-specific conditions presumably account for this relative specialization.

The next step includes calculating the colocation pattern of these occupational specializations. The goal of this step is to learn more about the interdependence between occupations. Muneepeerakul et al. (2013) employ conditional probability: Do conditional probabilities differ from marginal ones if the presence of a specialized occupation in a state is partly determined by the presence of another specialized occupation? We define the interdependence between occupations i and j, ζ_{ij}, as:

$$\xi_{ij} = \frac{P\left[\mathrm{LQ}_i^{(M)} > 1, \mathrm{LQ}_j^{(M)} > 1\right]}{P\left[\mathrm{LQ}_i^{(M')} > 1\right] P\left[\mathrm{LQ}_j^{(M'')}\right]} - 1 \tag{2}$$

where M, M', and M'' denote a randomly selected state (Muneepeerakul et al. 2013). How a state's specialization in one occupation may enhance or hinder its specialization in another occupation is represented in this metric. Positive ξ_{ij} means that occupations i and j are more likely to be specialized in the same states than if they are independently distributed across states. This implies that the two occupations may share some common requirements or contribute to common economic outputs (Shutters et al. 2015), for example, the occupations related to water treatment and chemical technicians. The opposite is true for $\xi_{ij} < 0$, while $\xi_{ij} = -1$ means that occupations i and j are never specialized in the same state (Muneepeerakul et al. 2013). These interdependencies can be used to develop the so-called occupation space, a structural perspective that views an urban economy as a Web of interdependencies, both positive and negative, among its labor occupations (Muneepeerakul et al. 2013). This is closely related to the Product Space proposed by Hidalgo et al. (2007).[6]

Shutters et al. (2015) use the occupational space to make the green jobs index less abstract, and their occupational space is represented in Fig. 1a. What is remarkable is that the occupations are not uniformly distributed in the occupational space. The occupations with a high interdependence form a dense core, and the occupations with weak or negative interdependencies form the periphery of the occupational space. It is now also possible to construct the idealized green occupational space. In this stylized occupational space, all the green occupations (as defined by O*NET) are specialized. The green nodes are spread out over the entire occupational space. Figure 1b shows that the occupations closest to a green occupation, that is, those with the greatest positive ξ's with the green occupation, do not have to be green themselves. This already suggests that transitioning to a green economy is no straightforward process. The current SOS of a state determines the difficulty of different paths toward the green economy.

[6] Note that the purpose of this paper is not to construct an occupation space; however, the concept does play a central role in this paper.

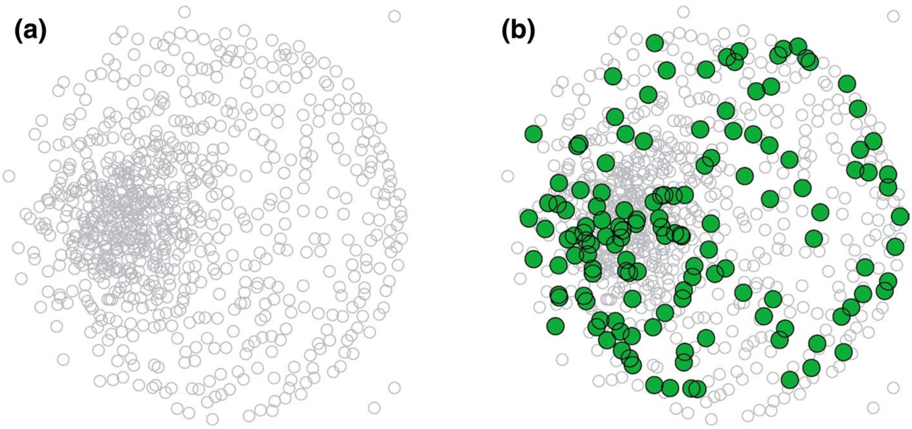

Fig. 1 The occupational space (**a**) and the idealized green occupational space (**b**), *Source*: Shutters et al. (2015)

Just like a country is the most likely to specialize in a product that is the closest to products that a country is already producing, a state is also most likely to specialize in an occupation that is the closest to a states' current specializations (Hidalgo et al. 2007; Shutters et al. 2015).

The third step also builds on the work done by Muneepeerakul et al. (2013). Shutters et al. (2015) define the green jobs index of a state m, $G^{(m)}$, as follows:

$$G^{(m)} = \frac{1}{N_{\mathrm{G}}} \sum_{g \in \mathrm{SOS_G}} V_g \left(\mathrm{SOS}_{\mathrm{c}}^{(m)}\right)^{1-\delta_g} \tag{3}$$

where $\mathrm{SOS_G}$ represents the SOS of the green economy (Fig. 1b), $\mathrm{SOS}_{\mathrm{C}}^{(m)}$ the current SOS of state m, and N_{G} the total number of green occupations in SOSG. The potential of a state to become specialized in occupation i is represented by V_i, which is based on the interdependencies between occupation i and all occupations currently specialized. δ_g is an indicator function: It is 1 if state m already specializes in occupation g and 0 if it does not. Thus, a green occupation g has a value of 1 if the state already specializes in that occupation and has the value of V_g if it does not. $G^{(m)} = 1$ if the economy specializes in all N_{G} green occupations. Thus, $G^{(m)}$ measures the degree to which state m penetrates the green economy. On the other hand, $1 - G^{(m)}$ measures how far a state m must move through the occupation space to become a completely green economy.

3.2 Empirical methodology: dynamic panel data

As stated in "Theoretical framework," based on the literature we expect the level of economic complexity of an economy to have a positive effect on the occupational greenness of a state. The econometric model includes an indicator of the level of economic complexity of an economy (ECI) and several control variables. The green jobs index is the main dependent variable, and the following model is estimated:

$$\mathrm{GJI}_{i,t} = \beta_0 + \beta_1 \mathrm{GJI}_{i,t-1} + \beta_2 \mathrm{ECI}_{i,t} + Z_{i,t} + \alpha_i + \varepsilon_{i,t}. \tag{4}$$

We test the null hypothesis that β_1 and β_2 are zero. In other words, under our null hypothesis we expect $\mathrm{ECI}_{i,t}$ and the lagged green jobs index $\mathrm{GJI}_{i,t-1}$ to have no effect on the green jobs index. Our alternative hypothesis is that these parameters are larger than zero, which means that $\mathrm{ECI}_{i,t}$ and $\mathrm{GJI}_{i,t-1}$ have a positive effect on the level of occupational greenness of a state. $Z_{i,t}$ represents the additional control variables included in the model. A full list of all the control variables is given in Table 1. α_i is the unobserved time-invariant individual effect and $\varepsilon_{i,t}$ is the error term.

The newly constructed green jobs index variable allows us to empirically investigate the relationship between greening the occupational space and economic complexity. This paper uses dynamic panel data to examine this relationship because the model includes a lagged dependent variable ($\mathrm{GJI}_{i,-1}$) as a control variable. We expect that the current level of the green jobs index of a state is heavily determined by its past level. A state that was very green in the previous period is unlikely to be suddenly completely non-green in the following period. Only an external shock could cause such a sudden shift. We, therefore, deem it necessary to include the lag of the green jobs index in our model, not including this control variable would lead to omitted variable bias.

Doing this will increase the consistency of the results, but also leads to various difficulties with the estimation of the model. Adding a lagged dependent variable causes the strict exogeneity of the regressors assumption to no longer hold. Dynamic panel data also lead to inconsistent results when many of the usual ordinary least square (OLS) estimators are applied such as least square dummy variables, fixed effects and random effects (Nickell 1981). Various authors have proposed solutions that allow us to obtain a consistent estimator of β_1. This paper applies the popular generalized method of moments (GMM) approach that was designed by Holtz-Eakin et al. (1988), Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998) in order to solve this problem. We pay attention to two general estimators that are designed for situations with "small T, large N" panels. This means that there are few time periods and many individuals; with independent variables that are not strictly exogenous, with fixed effects; and with heteroskedasticity and autocorrelation within individuals (Roodman 2006). The dataset that is used for this paper is small with data for just 10 years and 27 states. We, therefore, need an estimator that is suited for a small sample.

The usual first-differenced GMM estimator eliminates the individual effects α_i and the time-invariant variables Z_i. This usual GMM estimator experiences several issues, which are increasingly present in the case of small samples. Windmeijer (2005) shows that there commonly is a small-sample downward bias of the estimated asymptotic standard errors of the efficient two-step GGM estimator. This is explained by the fact that the asymptotic standard errors do not take the extra variation in small samples due to the estimated parameters in the weight matrix into account. Blundell and Bond (2000) also argue that it is important to exploit initial condition information in generating efficient estimators for dynamic panel data models where the time-series observations are small. Asymptotic variance comparisons suggest that the system GMM estimator is significantly more efficient than nonlinear GMM in this case (Blundell and Bond, 2000).

Since the system GMM estimator will give us the most consistent and efficient estimates, it will be used as the main estimator in this paper. For completeness, we will also show the results of various other estimators: pooled OLS, fixed effects, and the differences GMM. Here, it is important to note that the pooled OLS estimator overestimates the coefficient for the lagged dependent variable, whereas the fixed effects estimator underestimates the coefficient. The coefficient of the lagged dependent variable should

Table 1 Description of the variables used in the model. *Source*: Created by the authors

Variable	Description	Hypothesized sign	Source
Green jobs index	It is calculated based on the concept and methodology of Muneepeerakul et al. (2013)	Positive	Author's calculations (based on occupational data from RAIS)
Economic complexity index	ECI is a scale that uses the theory and calculations for economic complexity to rank countries according to their level of complexity, following Hidalgo and Hausmann (2009)	Positive	Fapemig (2016)
LN GDP per capita	This variable represents the gross domestic product per capita, 1,000,000 R$ (current—2010)	Positive	IPEADATA
Urbanization rate	This variable describes the projected average rate of change of the size of the urban population over the given period of time	Positive	Author's calculations (Based on population data from IBGE)
Fiscal government result	This variable describes the fiscal government result as a share of GDP	Positive	ControladoriaGeral da União
Credit supply	This variable describes the credit supply (public and private) as a share of GDP	Positive	Banco Central do Brasil
Southeast	A dummy variable, 1 if the state is part of the Southeast region, 0 otherwise	Positive	Authors
Northeast	A dummy variable, 1 if the state is part of the Northeast region, 0 otherwise	Negative	Authors
South	A dummy variable, 1 if the state is part of the South region, 0 otherwise	Positive	Authors
North	A dummy variable, 1 if the state is part of the North region, 0 otherwise	Negative	Authors

be between the estimated coefficients of pooled OLS and fixed effects when estimated with the differences GMM estimator. If that is the case, the estimator is stable.

The last issue that warrants discussion is the difference between one-step and two-step GMM results. Both one-step and two-step are consistent, but the latter is more asymptotically efficient. However, the two-step GMM estimator also experiences a small-sample downward bias of the estimated asymptotic standard errors in linear models. This is explained by the fact that the asymptotic standard errors do not take the extra variation in small samples due to the estimated parameters in the weight matrix into account (Windmeijer 2005). A solution to the problem is presented by the author. The existing bias is corrected with Windmeijer's procedure, and researchers, therefore, prefer the two-step GMM estimation method. This paper follows the same approach. Finally, the standard test of over-identifying restrictions associated with Sargan (1958) and Hansen (1982) (the Sargan or *J*-test) will be performed to ensure the model is correctly specified, as well as the Arellano–Bond autocorrelation test for dynamic panel data.

3.3 Data

This section briefly discusses the data, describes the variables that are used in this research, and indicates the sources of the data. This paper uses panel data for the 27 Brazilian states over the period 2003–2013.[7] It is difficult to extract variables that have an impact on the greenness of the occupational space of a region from the literature. We, therefore, have used intuition and economic reasoning to determine which other variables could have an impact on the green jobs index. Additionally, we take variables which recur throughout cross-countries and cross-regional studies. The states in Brazil are very diverse in social and economic terms which guarantee a lot of variability in our dataset. The name of all the variables, their hypothesized signs, as well as their descriptions and sources, are provided in Table 1.

Since the relationship between the used variables and the green jobs index has never been researched before, we need to rely on economic and intuitional reasoning for the hypothesized signs of our variables. The lag of the green jobs index is included in the model. We expect this variable to have a positive effect on the green jobs index because economies that are well developed and have a lot of green jobs are likely to have a lot of green jobs in the next period as well. The hypothesized positive sign of the economic complexity index has already been explained.

We expect GDP per capita to have a positive effect because richer and thus often more developed countries have more means and instruments to rich green growth goals. Even though we do not expect a significant impact of GDP per capita, there is no reason to expect a negative impact. We expect urbanization to have a positive effect because it creates economies of scale (resulting in, e.g., supply of professional training), which facilitates the inclusion of green jobs.

[7] The list of the 27 states including their abbreviations and aggregated by regions: North region—Acre (AC), Amapá (AP), Amazonas (AM), Pará (PA), Rondônia (RO), Roraima (RR), Tocantins (TO); Northeast region—Alagoas (AL), Bahia (BA), Ceará (CE), Maranhão (MA), Paraíba (PB), Pernambuco (PE), Piauí (PI), Rio Grande do Norte (RN), Sergipe (SE); Center-West region—Distrito Federal (DF), Goiás (GO), Mato Grosso (MT), Mato Grosso do Sul (MS); Southeast region—Espírito Santo (ES), Minas Gerais (MG), Rio de Janeiro (RJ), São Paulo (SP); South—Paraná (PR), Rio Grande do Sul (RS), Santa Catarina (SC).

The fiscal responsibility of the government variable has been added as a proxy for institutions. Based on our theoretical framework, we know that coherent policies are crucial for achieving green growth; therefore, we expect a positive influence of this variable. The credit supply variable serves as a proxy for financial development. Since green growth requires investments, we expect a positive relationship between green job growth and financial development. The hypothesized signs for the regional dummies follow from the same logic as those of the GDP per capita and urbanization. The north of Brazil is relatively poor and underdeveloped compared to the south.

4 Results and discussion

4.1 Green jobs index results

The green jobs index shows how the greenness of the occupational spaces of the 27 Brazilian states has developed between 2003 and 2013. São Paulo has a much greener occupational space than all of the other Brazilian states. São Paulo is the most populous state in Brazil, and it is also the major industrial and economic powerhouse of the Brazilian economy. It is not a surprise that the richest and most complex state[8] has the greenest occupational space. A lot of green jobs are quite developed and therefore require solid investment and developed financial institutions. In the 10-year period of our dataset, no big changes occur in the occupational greenness of a state in Brazil. This is in line with Shutters et al. (2015) and their finding that becoming green is very difficult.

With the exception of São Paulo, nearly all states have a green jobs index between 0.20 and 0.50, with most states being between 0.20 and 0.30. For the interpretation of these figures, it is important to remember that the green jobs index is a scale that ranges from zero to one. If the green jobs index for a state is one, that state has a perfect green occupational space, which means that that state is specialized in all green occupations. On the other hand, if a state has a green jobs index of zero, it is as far away as possible from the idealized green economy and is not specialized in any of the green occupations. The average green jobs index throughout Brazil is a little above 0.30 for all years. This shows that Brazil is nowhere near the idealized green economy.

However, when we compare these results to Shutters et al. (2015), we find that Brazil is performing relatively well even though the authors have calculated the green jobs index for 364 metropolitan statistical areas in the USA. The best performer there is Houston–Sugar Land–Baytown, TX, with an index of 0.685, which is below the best performer in Brazil (São Paulo with about 0.7). The ten worst performers in the USA have indexes between 0.123 and 0.174, which is also below the worst performers in Brazil. Unfortunately, Shutters et al. do not report an average green jobs index, which makes it impossible to say something about how the countries relatively compare as a whole.

Throughout the analyzed period, there are both rising and falling states in terms of the green jobs index, but there is not a single state that experienced considerable changes in its index. This shows that the occupational greenness of a region is rather stable in the short term. When we analyze the development of the average green jobs index (Fig. 2), we see that the average occupational greenness of Brazil moves very slowly, but is increasing

[8] For more details, see Fapemig (2016)—economic complexity index for Brazil.

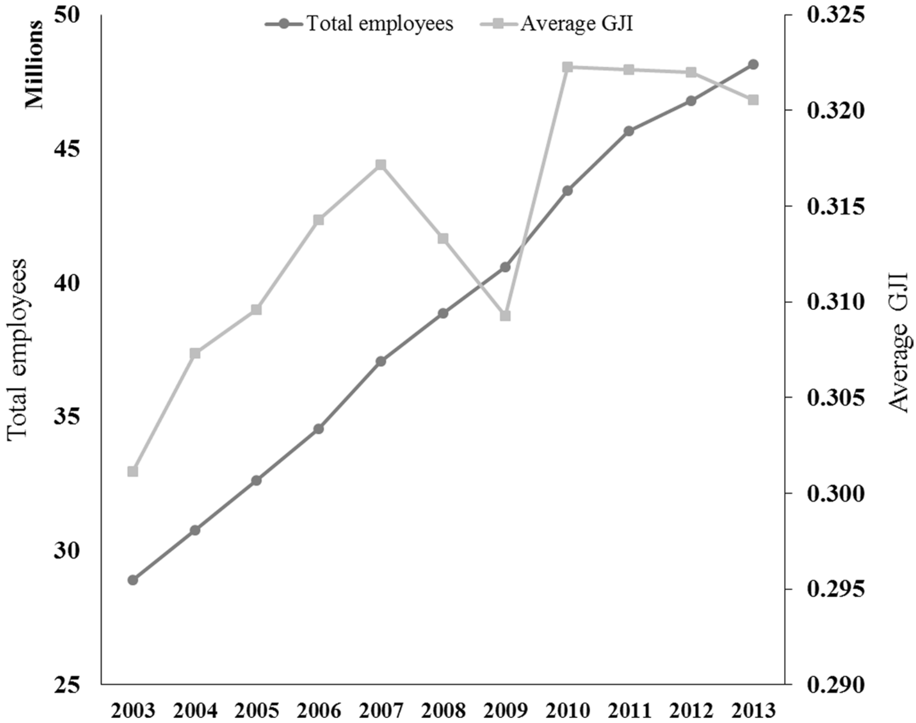

Fig. 2 The average green jobs index and total employees overall states 2003–2013. *Source*: Created by the authors

(from 0.30 in 2003 to 0.32 in 2013). There was a clear decline in the green jobs index in 2008–2009 which coincides with the global financial crisis. A decreasing trend also becomes visible around 2012, which is when it became apparent that Brazil was having serious economic struggles.

These initial results also enable us to say something about the regional differences that exist in Brazil. The South and the Southeast are the greenest in terms of their occupational space. This was to be expected since these regions are the richest and most economically developed. In fact, the only state (that is not from the South or Southeast) that is greener than a state from the South or the Southeast is Amazonas, which is, in a few years, greener than the Southeast's state of Espírito Santo. A possible explanation for this is that its capital Manaus is known for its Free Trade Zone which attracts a lot of diverse economic activity. The non-governmental organizations that present in that area to protect the rainforests could also be a possible explanation for the relatively high amount of green jobs that are present in Amazonas. The North and the Northeast are the least green. This was also expected since these regions are also the poorest and not very well developed.

4.2 Empirical results and discussion

This section will show and discuss the empirical results of this paper based on the estimation of a model to evaluate which variables have a relationship to the greenness of an economy. In order to make sure our model was correctly specified, we run several tests,

Table 2 Regression results of the applied estimation methods. *Source*: Created by the authors of this paper

Variables	Pooled OLS	Fixed effects	FD-GMM	SYS-GMM
Initial green jobs index ($t-1$)	0.6766*** (0.03707)	0.1096*** (0.03615)	0.3008 (0.25053)	0.3443*** (0.10621)
Economic complexity index	0.0006*** (0.0001)	0.0004 (0.00048)	0.00002 (0.00033)	0.0007** (0.00019)
Ln (GDP per capita)	0.0053** (0.00169)	0.0071 (0.00441)	0.0099 (0.00619)	0.0011 (0.004)
Rate of urbanization	−0.04554 (0.03817)	0.1718** (0.07986)	−0.3503*** (0.09811)	−0.2298*** (0.06303)
Fiscal government result	0.0005 (0.00094)	−0.00007 (0.00063)	0.0007* (0.0004)	0.0015*** (0.00025)
Credit supply	−0.0076 (0.00928)	0.04789*** (0.01631)	0.0195 (0.01259)	0.0463*** (0.01000)
Southeast	0.0473*** (0.01017)			0.0582* (0.03323)
Northeast	−0.03094*** (0.00885)			−0.1090** (0.05506)
South	0.0486*** (0.01054)			0.1871** (0.07774)
North	−0.0145* (0.007948)			−0.0297 (0.02829)
_cons	0.1904*** (0.03904)	0.07083 (0.06211)	0.3891*** (0.09232)	0.3856*** (0.10292)
Observations	296	296	243	270
R-squared	0.9305	0.6186	–	–

Standard errors in parenthesis

***$p<0.01$; **$p<0.05$; *$p<0.1$

which showed the model is correctly specified, and there is no serial autocorrelation. The main results are presented in Table 2.

The variable initial green jobs index has a positive and significant coefficient. This means that a high green jobs index in the previous period has a strong positive effect on the index in the following period. It means that regions that are well developed and have many green jobs are likely to keep this characteristic in the next period as well.

As for the main dependent variable, our hypothesis is that we expect the level of economic complexity of a state to have a positive effect on the greenness of the occupational space of a location. We find that the economic complexity of a state has a positive coefficient and it is statistically significant. That means more economically complex regions also have a greener occupational space. As discussed in Sect. 4.1, the regions with the highest Green Job Index are, also, the most complex in Brazil. Overall, higher-income states in Brazil have much higher economic complexity index (ECI) scores than middle-income states, which, on the other hand, perform better than low-income states. However, a few exceptions to this rule stand out, for example, Amazon state, which has a high ECI mostly a result of the "Free Economic Zone of Manaus" which is a free economic zone in the city of Manaus, the capital of the State of Amazonas. Tax incentives created comparative advantages for the city and surrounding region with respect to other regions of the country (Oliveira et al. 2016).

According to Poncet and De Waldemar (2013), localities that are able to produce complex products have a higher revealed comparative advantage (RCA) than other places. Economic complex regions are also seen as more developed areas because of higher diversity levels, which can be translated into capabilities as technology, human capital, institutions, inputs, culture, and geography, required to produce different products (Helpman 2004). In that sense, the spillover created by an economic complex environment can influence the agglomeration of green job index, mainly the most specialized green products.

Mathews (2012) shows that Korean and China' strategy to promote a green industrial system is connected to goals related to "developing green technology, e.g., investment in green tech R&D, and fusing green and smart technology" for example, and associate with a government commitment and leadership to coordinate the industrial green policy. This strategy is associated with innovation and sophisticated goods, which relates to economic complexity and requires a more diverse green occupational space. In this context, the author states that "(…) except that Korea is starting with a more advanced technological level, and with more sophisticated international firms, and (…) have clear goals of catching up with the technological leaders in green sectors." Analyzing Korean and Chinese economic complexity in the past 20 years, it is possible to confirm they are ranked in 40th most economic complex countries around the globe.[9]

Along the same lines, according to the product space, a region can invest in green industries of certain green products that require skills that are nearby. Therefore, according to Hidalgo and Hausmann (2009), the concept of product space is highly related to "proximity": Once a region is able to produce solar panel, for instance, it will possibly also be able to produce solar water heaters, because the knowledge and specific occupation requirements for both products are relatively similar.

Another variable that is significant statistically is the urbanization rate, and it has a negative coefficient. This variable is added as a control variable to check whether the urbanization rate of a state has an impact on the green jobs index. We expected that states where more people live in the cities to have more green jobs because cities are usually more developed than rural areas, which means more (green) jobs are present there. This negative coefficient is therefore not in line with our hypothesis. A possible explanation for this is that highly urbanized areas always attract a lot of different economic activities. Almost all businesses are attracted to urbanized areas due to the huge benefits that accompany these areas. This could lead to relatively fewer people working in the green sector, which has a negative impact on the green jobs index. To illustrate whether a (large) green company or non-governmental organization (NGO) is located in a rural area, it is very likely that a relatively large share of the labor force is working for that company and thus that that region is specialized in the accompanying occupations. The same company or NGO in a highly urbanized area is less likely to attract a relatively large share of the labor force (due to the relative abundance of other economic activity) and is thus less likely to be specialized in the related occupations.

We also added a variable that represents the fiscal responsibility of a government which is positively related to greener economies and significant at the 1% level. This variable is a proxy for institutions and controls for the effect of institutional quality on green job development. A stable government, which is financially responsible, is more likely to pay attention to sustainable development and to be able to promote the growth of the green

[9] For more details about economic complexity index in a country level, see https://atlas.media.mit.edu/en/rankings/country/eci/.

sector. This variable has a positive impact on the green job index, and it is significant at the 1% level. This result endorses the importance of coordinated government and institutional policies, whether through focusing on social justice to promote more equal form of development in the current and future generations, a government institution with an inclusive perspective to promote the sustainable economic activity, and an institutional support that generates trust and collaboration with broader society, as pointed out in Vazquez-Brust et al. (2014).

We also controlled for financial development with the credit supply variable. This proxy variable consists of both the public and private credit supply. This is a proxy for financial development since economies that are more financially developed have better institutions that provide credit. This credit is important for investment and other economic activities. Both investment and economic activity are directly related to green job creation. This variable has the expected positive sign, and it is statistically significant. Financial development therefore positively affects the creation of green jobs, which makes sense because especially innovative new green ventures require capital. Mathews (2012, p. 05) suggests the importance of financial strategy as assistance to the transition path from a "brown" economy to a greener one. According to the author, "while the advances registered by these eco-industrial initiatives are clear, there has so far been lacking the kind of ministerial-level coordination and financial support that can be observed for energy initiatives in Korea."

Finally, we also add regional dummy variables. We do this to check whether the location of a state has an effect on the occupational greenness of that state. We expect that being in the less developed North to have a negative effect on the GJI of a state. Similarly, we expect states in the richer and more developed South to have more green jobs. We added dummies for the North, Northeast, South, and Southeast. The omitted dummy represents the West-Center region. All dummies have the expected sign, being in the North or the Northeast has a negative impact on the green jobs index of a state, while being in the South or the Southeast has a positive impact, relative to being in the West-Center region. All dummies, except for the North dummy, are significant, and thus, we find clear evidence that the geographical location of the state has an impact on the green jobs index.

These results allow us to conclude that we accept the hypothesis that economic complexity has a positive effect on green job development in the Brazilian states. We also find that financial development and institutional quality play an important role when it comes to the creation of green jobs. Finally, we also see that being located in the South has a positive effect on the green jobs index. This again underlines that there are significant regional differences in Brazil.

5 Conclusion

This empirical paper set out with two goals in mind. The first was to measure the occupational greenness of the 27 Brazilian states. The second was to examine the assumption that higher levels of economic complexity contribute to the greenness of the occupational space of a state.

First, it was constructed the green jobs index for the Brazilian states and the results show that São Paulo is not only the economic capital of Brazil but also its green capital, as no other state even comes close to the green jobs index of São Paulo. The second thing that is clear is that the green jobs index of states changes very slowly on a regional level, not a single state experienced considerable change between 2003 and 2013.

This supports similar evidence that is found by Shutters et al. (2015). We also find the expected significant regional differences; the more developed South and Southeast are much greener in terms of their occupational spaces than the less developed North and Northeast. However, the states with the lowest initial green jobs index show promising growth, whereas the states with the highest initial green jobs index remained practically at the same level between 2003 and 2013. This could be a sign of regional convergence. Finally, we see that the average green jobs index throughout Brazil is slowly increasing between 2003 and 2013. The global financial crisis led to a slump in 2008–2009, but the increase picked up again after those years. Brazil seems to become greener; however, the green jobs index growth seems to respond to the state of the economy. It is no secret that recent years have shown that Brazil's rapid growth and an emerging economy have come to a stop. The last few years of our green jobs index numbers appear to reflect this stagnation.

We also find that states that were previously relatively green are more likely to be greener in the future as well, as the initial green jobs index variable has a strong positive and significant coefficient. The results also show that financial development and institutional quality have a positive impact on green job growth. Finally, our regional dummies empirically prove what our green jobs index results already indicated. States that are located in the more developed South do indeed have a greener occupational space than states that are located in the North, Northeast, and West-Center.

These results are relevant for policymaking on various levels. First of all, the greenness of the 27 Brazilian states is now measured. This enables the federal government to quickly get an overview not only of which state is green and which is not, but also of what the regional differences are in regard to what jobs certain states are specialized in. We know from the theory of economic complexity that the existing knowledge and skills in an economy determine for a large part in which directions a country can grow. Some non-green jobs are, by their nature, very close to green jobs. Knowing in which of these jobs, that are close to being green, a state has a relative comparative advantage is useful for policymakers who want to make their economy greener, as it shows which sectors have potential for that state. This knowledge shows the best channels through which a state can go green. If a state is specialized in high-tech engineering, it should focus on green jobs that are close to this sector, as that state already possesses the required knowledge for such green jobs. This way the index that we created allows policymakers to make full use of the existing potential in a state when "going green." Regional policies can be based on this index as it shows what region is specialized in what kind of jobs.

Various policy implications can be derived from the positive relationship that we have found between economic complexity and the green jobs index. The policy message for states that seek to green its occupational space is clear: Create an environment where a greater diversity of productive activities can thrive and, in particular, activities that are relatively more complex. The ability to successfully export new products is a reflection of the fact that the state has acquired new productive knowledge that will then open up further opportunities for progress. What a state needs to do to achieve this will be highly specific to the context of the state and the product. States are more likely to succeed in this agenda if they focus on products that are close to their current set of productive capabilities, as this would facilitate the identification and provision of the missing capabilities. However, economic complexity clearly focuses on differences between states. A state should not seek to find a "golden" set of policies that are right for every state to implement. A state should start with evaluating what it produces now and then look for options that are in the same realm.

It is clear that increasing the complexity of an economy is not an easy task, especially since most knowledge is difficult to transfer. The results also indicate other policy measures that a country can focus on, which are perhaps easier to implement. Establishing good institutions and stimulating financial development within a country have positive effects on green job development. Such matters can be achieved by reforming banking regulations and reforming the legal system, for example. Surely no simple tasks, but perhaps more achievable than increasing the complexity of the economy in the short run. For achieving the latter, it would be wise of countries to map their own product space, in order to get a clear view of which directions they should focus their economic growth.

When it comes to the limitations of this research, the small sample is the most problematic one. We only have data for 27 states over a 10-year period. Particularly, when researching the green jobs index, which changes very slowly, a large sample would be very useful. It would be interesting to see whether further research would find more pronounced results with data for a larger period. Repeating the same research on a municipality level would also add value, as this would greatly expand the dataset. Furthermore, it would be interesting and useful for future research to redo this analysis for green products, rather than green jobs. This would directly show what products a state is specialized in and which of these products are close to a green product. This provides relevant knowledge for both policymakers and industries. Finally, it would also be useful to test whether there are regional spillover effects. Does the greenness of neighboring states have a positive impact on the greenness of a state? It would be valuable to know whether such a relationship exists because convergence is more likely to occur when there are strong regional spillover effects since this would allow states to catch up quicker.

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