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Amazon Green Recovery and Labor Market in Brazil: Can Green Spending Reduce Gender and Race Inequalities?

by

Pedro Romero Marques
MadeE Research Center, University of São Paulo, Brazil

Luiza Nassif Pires
Economics Institute at University of Campinas and Made Research Center, University of São Paulo, Brazil

Tainari Taioka
Made Research Center, University of São Paulo, Brazil

José Bergamin
Federal University of Minas Gerais and Made Research Center, University of São Paulo, Brazil

Gilberto Tadeu Lima
Department of Economics and Made Research Center, University of São Paulo, Brazil

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Levy Economics Institute
P.O. Box 5000
Annandale-on-Hudson, NY 12504-5000
http://www.levyinstitute.org

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ABSTRACT

Announced in June 2021, the never-implemented Green Recovery Plan for the Brazilian Legal Amazon Region (GRP) would be a green transition initiative to be carried out by the state governments of the region. The GRP represented the first large-scale proposal aiming at the transition to a low-carbon economy in Brazil and offered a preliminary framework to evaluate the opportunities and limitations of green development in Global South economies. The GRP's initial phase would provide an investment of 1.5 billion reais (around $315 million in September 2023) in four areas: control of illegal deforestation, sustainable development, green technology, and green infrastructure. This article presents a counterfactual analysis by assessing the impacts of green spending in Amazon on the labor market, quantitatively−in terms of the number of jobs created−and qualitatively−exploring the distribution of those jobs by region and according to gender and race categories. We build synthetic sectors representing each area of investment in a two-region input-output matrix ("Brazilian Amazon" and "Rest of Brazil"). Using employment multipliers, we simulate a demand shock on the Amazonian economy and its impact on job creation in the two regions. Results suggest that green spending in the Amazon offers good perspectives (but also highlights limitations) for a just transition to a low-carbon economy in Brazil: the effects on employment favored the female workforce (both black and white) relative to the male and black workforce in the Amazon, leading to inequality-reducing composition changes in the Brazilian workforce as whole.

KEYWORDS: Green and just transition, Brazilian Amazon, employment multipliers, green spending

JEL CODES: J15; Q57; Q58; R11; R53; R58

1. INTRODUCTION

The economic shock caused by the COVID-19 crisis produced a discourse of conciliation between the return of expansionary fiscal policies and the need to reorganize economic production toward low-carbon activities. This combination provided the tone of the alternatives to overcome the pandemic-related recession in developed economies after 2020: green public spending has become a priority as leaders demonstrated commitment to restoring growth and employment levels. The origin of this trend lay in the emergence of green recovery plans in the pandemic context, which reinstated the role of the public sector in leading investments to reduce fossil fuel dependency (Barbier 2020; Galvin and Hearly 2020; Sutherland 2020; Marques 2020). This aim was recently reinforced by the current global economic and political context, especially marked by the return of inflationary pressures and the war in Ukraine.

At the time, some of these plans stressed a concern about the impact of production changes on the structural features of the labor market: the zero-emission target would inevitably lead to the extinction of certain activities and, consequently, a significant demobilization of the workforce employed in some sectors, especially those associated with the fossil fuel industry. In that context, workers would likely face difficulties in being reabsorbed by the new industries or other existing sectors, as the reconciliation of activities is not straightforward and requires qualification and training. Thus, economic remodeling of low-carbon activities should also be accompanied by a just transition for workers—that is, an accommodation of the existing workforce to the new productive structure (Stevis and Felli 2015; Brecher 2020; Heffron 2021). Despite the term's amplitude, a just transition implies the maintenance of job and income levels by confronting inequalities and social exclusion (ILO 2015). The objectives and strategies toward a just transition vary according to different lines of political action,[1] however, as McCauley and Heffron (2018) suggest, one should understand the just transition beyond its relationship with the job guarantee: it must incorporate more structural notions of justice (environmental, social, climate) linked to the dynamics of income, race, and gender, among others, in developed and developing economies.

[1] The discussion in Stevis and Felli (2015) points to divergences in interpretations about the just transition in terms of the role to be fulfilled by the government, the weight of the different agents involved in the green transition process, the degree of contestation of the political system, among other factors.

In Brazil, the first contemporary initiative that brought together the need to promote growth, face the climate crisis, and improve social inclusion was the Green Recovery Plan for the Legal Amazon Region[2] (GRP), whose executive summary was released in July 2021 by the Interstate Consortium for Sustainable Development of the Legal Amazon, an instance of coordination between state governments in the Brazilian Amazon. The GRP proposal indicated an initial 1.5 billion reais round of spending, which would be equivalent to around $315 million in 2023[3]). It would address the following priorities: (i) eliminate illegal deforestation by 2030; (ii) confront inequalities in income, race, gender, and access to infrastructure; (iii) generate jobs in the forest, rural areas, and urban centers; and (iv) ensure that the transition would be based on greater technological sophistication and export capacity.

Although the GRP executive summary did not mention a "just transition," the issues of employment, income, and social inclusion appeared as central concerns, following the guidelines established in green recovery plans presented in developed countries. It indicated that the historical socio-economic challenges of Brazil's development were resumed in the environmental problem concerning the Amazon Region: the need to tackle income concentration, low qualification and remuneration of the workforce, the lack of access to basic infrastructure, and racial and gender disparities. Therefore, even if the initiative did not go forward,[4] the GRP stands out as a suggestive reference to elaborate on the meaning that a green spending plan−or instead, a transition to a low carbon economy−may present when concerning developing economies.

Therefore, by recognizing the domestic and international importance of the Brazilian Amazon to the climate change and the economic development agenda, this article aims to measure the impact of a green spending plan focused on the region in terms of both national and local employment. It uses the GRP executive summary to elaborate on and simulate a hypothetical green spending shock that reproduces the objectives and the main characteristics of the

[2] The Legal Amazon is an administrative region of approximately 5 million square kilometers (which is equivalent to around 58 percent of the Brazilian territory, or around half of Canada's territory). The region is formed by 772 municipalities and encompasses the states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, Tocantins, Mato Grosso, and parts of the state of Maranhão (https://www.ibge.gov.br/geociencias/cartas-e-mapas/mapas-regionais/15819-amazonia-legal.html?=&t=o-que-e).

[3] Based on the US dollar—Brazilian reais exchange rate valid on September 18th, 2023.

[4] An investigation on why the GRP did not take off is beyond the scope of this article.

original plan. The methodology proposes a match between the programmatic areas of the GRP and the economic sectors of the Brazilian input-output matrices. Each programmatic area is then considered as a synthetic sector, that is, a fictitious sector formed from the linear combination of existing sectors, which is included in a two-region (i.e., "Brazilian Amazon" and "Rest of Brazil") input-output matrix for 2015 (Haddad 2019).

This methodology was developed based on Kim, İlkkaracan, and Kaya (2017; 2019), who seek to measure the impact of an investment in care activities through input-output modeling. The 1.5 billion reais spending shock is applied for the four synthetic sectors included in the Brazilian Amazon productive structure. We simulate the quantitative−the number of jobs created−and the qualitative effects−the distribution of those jobs among different population groups−of the shock in both national and local jobs following the estimation of employment multipliers obtained from the input-output analysis. Only direct and indirect impacts are considered. As a result, this study contributes to the literature that links the confrontation of the climate crisis with the need to tackle social and regional inequalities. In addition, it collaborates with the empirical literature regarding green employment multipliers including race and gender aspects.

The following section stresses the importance of the GRP for the idea of a green and just transition in developing economies such that of Brazil. The third section discusses the methodology employed in the analysis. In the fourth section a few characteristics of the Brazilian Amazon labor market are presented. The fifth section presents the simulation results and underlines the main trends observed. The final section summarizes the conclusions and puts forward additional comments.

2. THE GRP AS A MODEL FOR GREEN AND JUST TRANSITION PLANS IN DEVELOPING ECONOMIES

In July 2021, the Interstate Consortium for Sustainable Development of the Legal Amazon made public the executive summary of the GRP, a preview of what would have become the plan's first phase. It indicated the directions guiding the distribution of the 1.5 billion reais

amount:[5] combating illegal deforestation through inspection and land property regularization; incentives of regional economic activities that stand out for their symbiotic relationship with forest conservation, focus on the ability of technological innovations to expand the region's exporting potential; job creation in rural and urban landscapes; and, finally, the expansion of basic infrastructure and essential services access to tackle regional inequalities in income, race, and gender. In addition, the summary announced that the first phase would be organized around four areas, as described in Table 1 below.

Table 1. Synthesis of GRP Areas and Their Planned Actions

Area	Description	Amount to be spent (in Brazilian Reais)	Planned Actions
1	Combating Illegal Deforestation	375 million	1.1 - Integrated Amazon Action to reduce illegal deforestation in the short term
			1.2 - Strengthening of REDD+ programs and payment for environmental services (PES)
			1.3 - Restoration of the Amazon Forest
2	Productive and Sustainable Development	450 million	2.1 - Promoting value chains of the Amazon bioeconomy and accelerating green business
			2.2 - Improvement of the business environment and legal and environmental security of the territory
			2.3 - Income for farming families associated with institutional purchase programs and forest recovery projects
			2.4 - Development of green tourism in the Amazon
3	Green Technology and Training	225 million	3.1 - Investments, Technology, and Innovation for a green economy
			3.2 - Promotion of the Economic Industrial Health Complex
			3.3 - Promotion of Public Foundations that support research
4	Green Infrastructure	450 million	4.1 - Connectivity, innovation, and digital inclusion
			4.2 - Development of green tourism in the Amazon

Source: Elaborated by the authors based on the executive summary of the GRP.

According to the executive summary, the GRP followed "the international consensus that is formed around the impossibility of building a green economy without reducing economic and social inequalities" (Interstate Consortium for Sustainable Development of the Legal Amazon 2021, 28) and highlighted that "in the social sphere, this process needs to be associated with reducing poverty and fighting inequality, given the impact of climate change on the

[5] It is important to stress that this is a relatively low amount when compared not only to international initiatives but also to public investment in Brazil. For example, it represents less than 3 percent of total federal government public investments estimated for 2024 in Brazil.

population's living conditions (health, for example) and on the participation in the labor market" (24). Indeed, the GRP expressed a sensitive point of convergence between the climate crisis and social disparities in the Brazilian Amazon. On the one hand, regarding the country's contribution to carbon emissions, it should be stressed that 46 percent refers to changes in land use (mainly deforestation) and 27 percent to agricultural activities (SEEG 2021). The states that form the legal area of the Brazilian Amazon are the largest contributors to this scenario: Pará and Mato Grosso are the largest gross emitters (19.3 and 11.1 percent of the total, respectively), and Rondônia was in the fifth position (5.8 percent) (SEEG 2021). Moreover, in 2019, according to the Brazilian Institute of Geography and Statistics (IBGE), the Brazilian Amazon contributed to a large part of the national value added in agriculture (21 percent), livestock (21.4 percent) and forestry, fishing, and aquaculture production (27.2 percent). These sectors corresponded with almost 10 percent of the total value added in the region.

On the other hand, the region presents higher rates of poverty, income inequality, and social vulnerability when compared with other Brazilian regions (Alfenas, Cavalcanti, and Gonzaga 2020; Viana, Freitas, and Giatti 2015). As discussed in the following sections, disparities are also expressed in the labor market, especially considering the gender and racial dimensions. In a certain sense, therefore, the Brazilian Amazon domestically replicates disparities that characterize the Brazilian position as a developing economy vis-à-vis the developed ones. The lower the income levels, the higher the region's vulnerability to environmental risks, leading to a cumulative relationship between poverty and environmental risk exposure (Chancel 2020). This process is enhanced by structural trends in racial inequalities as black and indigenous populations are relatively significant in the regions (Young and Lustosa 2003; Young 2020).

The pioneering proposal of the GRP resumed some of the specific concerns related to the transition to a low-carbon economy in Brazil. It provided a preliminary but interesting design of a public policy mix indicating alternatives to be followed by other initiatives in Brazil and other countries with similar characteristics. Nevertheless, the GRP executive summary did not offer detailed information on the specific activities to be carried out. This implied the impossibility of a quantitative assessment of the GRP potential impact. As we believe that such an evaluation would represent an important contribution to the formulation of a green

transition agenda in Brazil, we developed a method that allows for an analysis of the impact of a public spending shock centered in the Brazilian Amazon concerning the jobs created within the region and in the rest of the country. Firstly, this method incorporates the design of the public policy mix envisioned by the GRP, which provides a more realistic picture of the needs associated with a green and just transition in Brazil and, consequently, in developing economies. Secondly, it allows this design to be quantitatively mensurable as it provides compatibility with the sectors included in the Brazilian input-output matrix employed in the analysis.

3. SIMULATING A SPENDING SHOCK IN THE BRAZILIAN AMAZON: BUILDING THE METHODOLOGY

The effort conducted here aligns with contributions that use input-output analysis to calculate employment multipliers, a simple way of estimating the direct and indirect effects within the input-output model developed by Leontief (1951) (Steenge 1990; Miller and Blair 2009). However, despite the simplicity of the method, input-output models are constantly being refined to incorporate new issues and analytical possibilities. A recent trend refers to attempts to identify or incorporate sectors and economic activities not explicitly considered in the existing input-output matrices.

One of these attempts, for instance, refers to the need to promote changes in production toward less polluting activities as a way of reducing the level of greenhouse gas emissions. In this agenda, efforts made by the International Labor Organization (ILO 2013; 2017) incorporate information concerning the generation of green jobs into input-output matrices: some pre-existing economic sectors in the input-output matrix (such as the "agriculture" sector) are divided into two versions—conventional and green (agriculture)—thus making it possible to estimate different multipliers for each type. Pereira Filho (2020) attempts to identify these green occupations in Brazil by using information on the country's recognizably sustainable production along with similar estimations for other countries. (Sultan and Harsdorff 2014; Lehr et al. 2018). Also noteworthy are the contributions of Pollin et al. (2014); UNIDO and GGGI (2015), and Pollin, Lala, and Chakraborty (2022), who use job multipliers to simulate the effects on the labor market of eventual restructuring of energy

matrices and physical infrastructure in some countries, aimed to reduce greenhouse gas emissions.

Another trend concerns the area of gender studies. It focuses on evaluating the economic impact of activities corresponding to the care economy, which tend to be underrepresented in a country's national accounts (Antonopoulos et al. 2010; De Henau, Himmelweit, and Perrons 2017; ILO 2018; Ilkkaracan, Kim, and Kaya 2015; Kim, Ilkkaracan, and Kaya 2017; 2019). Specifically, we highlight the initiative to generate a synthetic sector that corresponds to care activities and services in a Turkish input-output matrix (Ilkkaracan, Kim, and Kaya 2015; Kim, Ilkkaracan, and Kaya 2017; 2019). Similar to what is suggested by the ILO (2017) for the identification of green jobs, a synthetic sector is built from the results of field research on Turkish preschool care and education services that make it possible to identify its cost structure, (i.e., from which other sectors it demands inputs).

The present simulation replicates the latter method of building synthetic sectors to jointly address the climate and the social aspects of the green transition debate. It provides information on the local (Brazilian Amazon) and national (rest of Brazil) impact of a 1.5 billion reais shock in green spending in the Brazilian Amazon, both quantitatively (number of jobs created) and qualitatively (in terms of disparities between race and gender). In this case, the strategy for estimating the cost structure is different. Instead of relying on sampling and field research, it builds the synthetic sectors by matching the programmatic areas indicated in the GRP executive summary with budgetary information provided by the Brazilian government. Nevertheless, some caveats deserve attention. First, the simulation does not assess the impact of green spending on carbon emissions, considering only its economic potential specifically associated with job creation. Second, the new jobs that result from the shock simulation do not necessarily correspond to jobs associated with less polluting economic production (green jobs). Although this might yield biased results, we stress that the original intention of the GRP was to reduce carbon emissions along with creating higher growth and lower inequality. Along these lines, we must be careful to recognize that changes in the direction of low-carbon economies can be slow and non-linear processes with unpredictable consequences (Henry, Bazilian, and Markuson 2020).

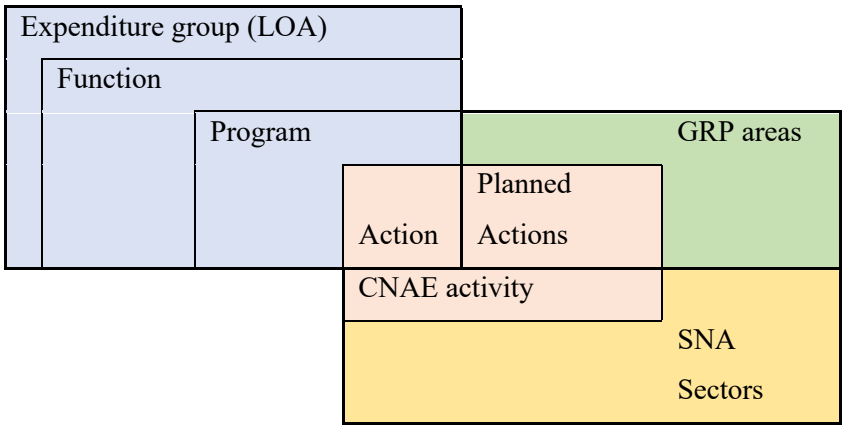
3.1 Matching Programmatic Areas with Real Economic Sectors

Given the limited information provided by the GRP executive summary, the chosen strategy was to consider the most significant number of activities that would fit the description of the planned actions (Table 1) and for which enough data to estimate their relative importance within public spending was available. The solution was to access the Federal Government's budgetary information, which publicizes the specific value of public resources allocated in each spending action. Following the Brazilian Annual Budget Law (LOA), actions compose a program, which refers to a function and, finally, to an expenditure group (Figure 1). The problem, however, is that part of these budgetary categories changes every four years according to the Pluriannual Plans (PPA). This implies the impossibility of following the same action for more than four years. This limitation was central to the decision to use the LOA of 2011 as the default model, as this was the last year of the 2008–11 PPA when Brazilian carbon emissions stabilized in a lower plateau following the substantial reduction that started in 2004 (Brazil 2022). Moreover, 2011 not only preceded the economic contraction experienced by the post-2014 Brazilian economy (Serrano and Summa 2015) but also expressed continuity regarding the downward trajectory of deforestation in the Brazilian Amazon, which recorded a low in 2012 (Prodes 2021). As the years that followed were characterized by changing trends in carbon emission reductions, deforestation rates, economic growth rates, and especially, the size of public spending directed to environmental actions, 2011 represents an interesting mark that bypasses the limitation imposed by the PPA.

The four GRP areas were defined according to the federal government's 2011 expenditures, following the effective budgetary execution of actions that match the "planned actions" defined by the executive summary. In the end, 232 actions were selected among 48 programs, representatives of 14 functions which refer to four expenditure groups.[6] It also allowed the indication of the weight of each sector that composes the areas, according to the relative amount spent by the federal government. Not all LOA categories were considered, only those that could be associated with the description in Table 1. Finally, each selected budget action was identified with the 68 Brazilian System of National Accounts sectors, as expressed in Figure 1.

[6]The complete compatibility list can be accessed at: https://bit.ly/3yKAANb .

Figure 1. Compatibilization Scheme



Source: Elaboration by the authors

3.2. Including the Areas as Synthetic Sectors in an Input-Output Matrix

By matching the GRP executive summary description with the federal government's budgetary information and the SNA, the four areas are finally adaptable to become four fictitious—or synthetic—economic sectors of the Brazilian input-output matrix used in the analysis. The synthetic sectors are built from an imputed productive structure, resulting from a linear combination of sectors that are part of the original input-output matrix.

This methodological artifice assumes that the synthetic sectors, when promoting the demand for certain goods and services, behave "as if they were" already existing sectors of the economy. Since the productive structure attributed to the synthetic sectors also demands inputs from other sectors, the impact generated by a public spending shock in each synthetic sector depends on how much the considered specific sector is likely to demand from the other sectors of the economy. In fact, this is a fundamental premise of the input-output analysis, which maps the sectoral dynamics referring to the intermediate consumption of the economy.

However, if a demand structure is fundamental for synthetic sectors, the same premise does not apply to a supply structure. How much each of the original sectors of the input-output matrix will demand from the new sectors created and how they interact with each other are out of the scope of this analysis and do not compromise the results obtained. As previously described, the relative weight of each budget action obtained via LOA and linked with SNA sectors makes up the linear combination of each synthetic sector. Table 2 gives an example of how this matching was produced for the first synthetic sector (Area 1), which refers to the confrontation of illegal deforestation.

Table 2. Cost Structure of the Synthetic Sector - Area 1 (Combating Illegal Deforestation)

SNA Sector Code	Description of the sector	Total amount spent in 2011 (BRL)	Relative weight
0280	Forest production, fishing, and aquaculture	1,651,315.72	0.9%
6280	Development of systems and other information services	30,287,388.45	16.3%
7380	Other professional, scientific and technical activities	432,934.89	0.2%
8000	Surveillance, security and investigation activities	3,279,661.96	1.8%
8400	Public administration, defense and social security	149,090,092.18	80.3%
9080	Artistic, creative and entertainment activities	933,891.27	0.5%

It is important to emphasize that constructing synthetic sectors based on the LOA is a hypothetical artifice with no practical commitment to the federal government's 2011 budget expenditures. In other words, Table 2 indicates that, in a hypothetical green-spending shock, the amount allocated to fight illegal deforestation would mobilize the demand structure of six existing sectors, according to the proportions expressed in the “Relative Weight” column. Table 3 expresses the cost structure proportion for all four synthetic sectors or areas.

Table 3. Composition of Synthetic Sectors Based on SNA Sectors

SNA sector code	Description of the sector	Area 1	Area 2	Area 3	Area 4
0191	Agriculture, including support for agriculture and post-harvest		7.69%		
0192	Livestock, including support for livestock	0.89%	0.02%		
0280	Forest production, fishing, and aquaculture		1.45%		
0791	Iron ore extraction, including beneficiation and agglomeration		0.07%		
2100	Manufacture of pharmaceuticals			0.41%	
2600	Manufacture of computer equipment, electronic and optical products			0.09%	
2800	Manufacture of machinery and mechanical equipment		3.02%		

3680	Water, sewage and waste management		0.25%		
4180	Construction		1.79%	4.69%	5.56%
6280	Development of systems and other information services	16.31%	3.65%		1.59%
6100	Telecommunications				62.97%
6480	Financial intermediation, insurance and supplementary pensions		0.48%		
6980	Legal, accounting, consulting and company headquarters		12.49%		
7180	Architectural, engineering, technical testing/analysis and R&D services			24.66%	
7380	Other professional, scientific and technical activities	0.23%	6.02%	1.66%	12.05%
7880	Other administrative activities and complementary services				1.13%
8000	Surveillance, security and investigation activities	1.77%			
8400	Public administration, defence and social security	80.30%	57.93%	38.86%	12.92%
8591	Public Education			4.70%	
8691	Public health			24.90%	
9080	Artistic, creative and entertainment activities	0.50%	0.57%	0.03%	
9480	Membership organizations and other personal services		4.59%		3.78%
		100%	100%	100%	100%

After defining their cost structure, the four synthetic sectors can be incorporated as columns in the input-output matrix. Since we aim to consider the Brazilian Amazon separated from the rest of the country, we employ the interregional input-output matrix for the Legal Amazon calculated by the University of São Paulo Regional and Urban Economics Lab (NEREUS-USP) (Haddad 2019). The matrix comprises ten regions (nine states of the Brazilian Amazon and the rest of the country), but we recombined it to express only two regions: the Brazilian Amazon and the rest of Brazil. The synthetic sectors are included in the technical coefficient matrix by adding four additional columns that only exist in the Brazilian Amazon but demand inputs from the two regions. Now extended to 72 sectors, the new matrix is then used in an input-output model to calculate the employment multipliers of interest.

The total number of jobs resulting from the hypothetical public spending shock on the synthetic sector and the subsequent effects in each of the other sectors is calculated by means of a scalar multiplication (element by element) between the vector of labor coefficients—which reflects the ratio between occupations and gross value of production of each sector—and the column of each synthetic sector in the Leontief inverse matrix. The result is a vector that yields the number of direct and indirect jobs created in each sector. Direct jobs are jobs created within synthetic sectors, and indirect jobs result from an increase in demand for inputs used in the production of synthetic sectors, as well as in the production of the inputs themselves. In other words, the demand shock for goods and services produced by synthetic sectors triggers an increase in the production of several input supplier sectors and boosts job generation beyond synthetic sectors. Therefore, the calculation considers all jobs created in a chained process by the initial shock.

It is also assumed that the gross production value of the synthetic sectors was considerably low prior to the shock. This allowed us to express the productive structure of the synthetic sectors without attributing a significant value to their product. The shock size in these sectors follows the values expressed in the executive summary of the GRP (see Table 1). Finally, the workforce composition of the synthetic sectors was imputed as a weighted average of the employment coefficients of the existing sectors associated with the synthetic sectors. In order to assess job specifications (in terms of race and gender), data from the declarations of the Annual Social Information Report (RAIS) was used. This data is compatible with the SNA classification and, therefore, with the input-output matrix sectors.

The workforce was considered according to six population categories available in the RAIS: white men, white women, black men, black women, other men, and other women.7 The representative share of those groups was applied to separate occupations by sector expressed in the input-output matrices based on race and gender criteria. RAIS provides information on occupations exclusively related to formal employment, which represents a limitation, especially in relation to the labor structure of the Brazilian Amazon, as will be discussed later. In the input-output matrix, this distinction between formal and informal links is not

[7]In "black men" and "black women" are included black and brown men and women, as categorized by the IBGE. "Others" include people who declared themselves to be indigenous and yellow.

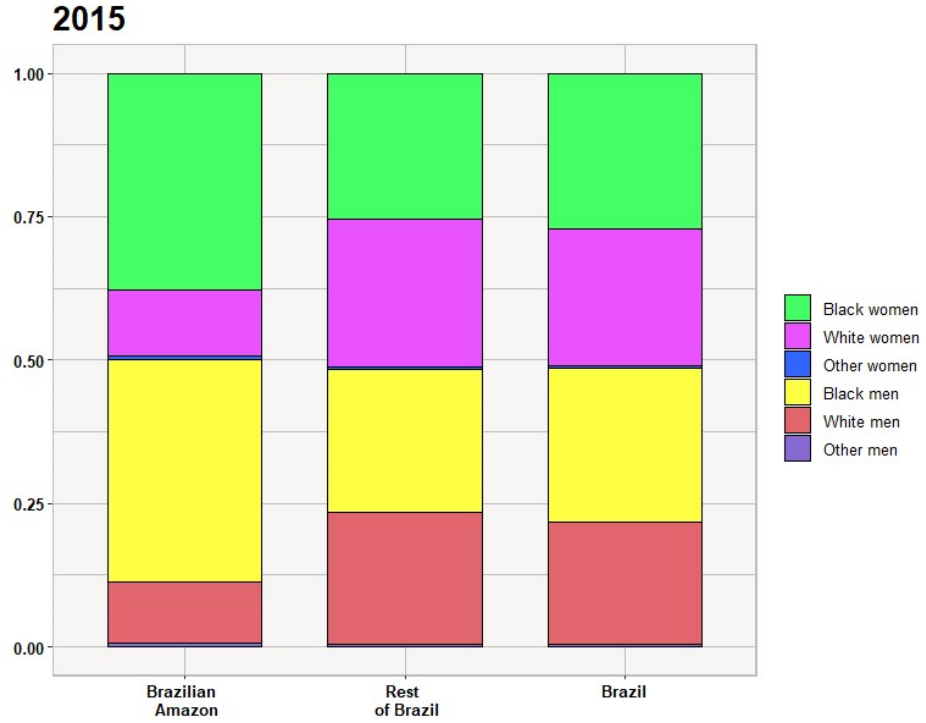
established. Thus, it should be clarified that a demographic distribution associated with the formal market is used to analyze the total number of sectoral occupations.[8]

4. THE PARTICULARITY OF THE LABOR MARKET IN THE LEGAL AMAZON IN THE BRAZILIAN CONTEXT

This section highlights some aspects of the occupational structure in the Legal Amazon and compares it with the rest of the country. The aim is to stress that local demographic particularities are important enough to influence the impacts of a spending shock on the types of jobs created. To do so, we present data from the *Pesquisa Nacional por Amostra de Domicílios* (PNAD) for 2015, the corresponding year of the input-output matrix employed. In Figure 2, data indicates that the Amazon's population is mostly composed of black people, which represent a larger proportion than when considering Brazil as a whole. In 2015, these groups represented 76.57 percent of the Amazon's total population, a high figure compared to 50.38 percent of the Rest of Brazil. Considering the whole country (Amazon + Rest of Brazil), the size of the black and brown population reached 53.92 percent, showing that the Legal Amazon contributes to increasing the representative share of this group in the total country's population.

[8]Even so, as Proni and Gomes (2015) point out, the black population, especially women, tend to be overrepresented in informality.

Figure 2. Demographic Composition: Brazilian Amazon, Rest of Brazil and Brazil, 2015



Source: PNAD-IBGE.

The labor market structure in the Brazilian Amazon also has several particularities. As in the country as a whole, black men and black women are the groups that present the worst occupational indicators. In the Amazon, the percentage of the black population is higher, and the indicators of informality and average income show a more accentuated disparity. Overall, these aspects reflect the less favorable positions of these demographic groups in the Brazilian labor market. By looking at the main occupation for Amazonian workers, the percentage of informal employment is higher than the national average for all groups. Table 4 indicates that, in the case of black women, 36.78 percent were formally employed, against 63.22 percent who were in informality. In Brazil, this difference was between 50.11 percent and 59.89 percent, respectively. When looking only at the Rest of Brazil (i.e., not considering the Amazon region), the formal employment rate for black women was slightly higher than the national average (52.83 percent).

Table 4. Occupation by Population Group: Brazilian Amazon, Rest of Brazil and Brazil, 2015

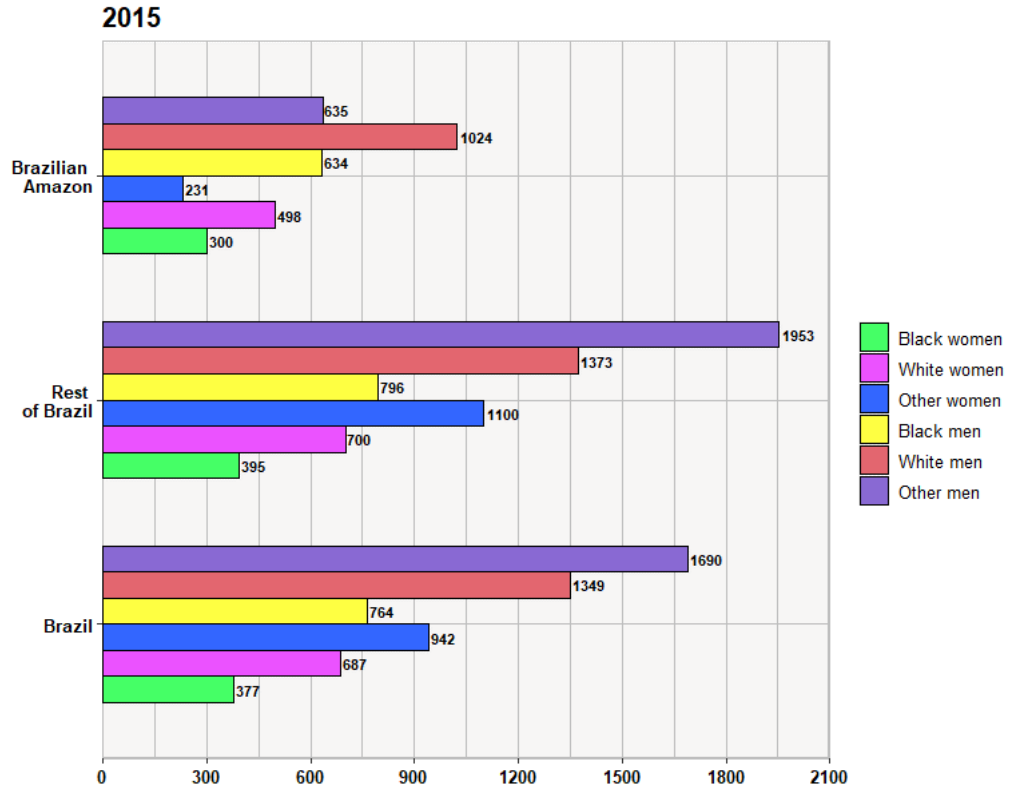
Population group	Brazil		Brazilian Amazon		Rest of Brazil	
	Formally employed	Informal	Formally employed	Informal	Formally employed	Informal
White men	65.51%	34.49%	47.14%	52.86%	66.79%	33.21%
Black men	51.77%	48.23%	34.70%	65.30%	55.85%	44.15%
Other men	56.20%	43.80%	26.21%	73.79%	62.65%	37.35%
White women	65.13%	34.87%	49.15%	50.85%	66.08%	33.92%
Black women	50.11%	49.89%	36.78%	63.22%	52.83%	47.17%
Other women	57.89%	42.11%	27.52%	72.48%	63.48%	36.52%

Fonte: PNAD-IBGE.

The high degree of informality in occupations also has negative implications for the corresponding level of remuneration. Referring to the average monthly income from the main job, all Amazonian population groups had wages lower than the national average. Figure 3 shows this difference and indicates that the lowest average wage gaps were between black men and black women when comparing all of Brazil and the Brazilian Amazon. As these groups tend to earn less when compared with white men and white women, respectively, data indicates that both gender and race are essential characteristics to be considered when looking at Brazilian labor market inequality. For example, the average income of Amazonian black women was R$300.43 and R$ 377.14 for the Brazilian average. Amazonian white men, in turn, received R$1023.69, which was lower than the Brazilian average (R$1348.93). In both cases, white men had an average income approximately 60 percent higher than black men and earned at least 3.4 times more than black women. On the one hand, the smallest wage gap indicates a general condition of remuneration for the black population. Conversely, the intragroup and intra-regional differences suggest that gender and race are distinctively reflected in labor market structure.[9]

[9] The most significant average gap refers to other men and women due to differences in internal composition: in the Amazon, the indigenous population stands out in these groups, but in national terms, the relative participation of people who declare themselves as yellow increases. Although these groups compose the same

Figure 3. Average Income from Main Work by Population Group Brazilian Amazon, Rest of Brazil and Brazil, 2015



Source: PNAD-IBGE.

Finally, the proportion of each population group in the composition of the workforce should be underlined. Considering the employed or job-seeking population, there are disparities between men and women on the national average: in 2015, around 60 percent of all men were part of this population, against 44.26 percent and 43.21 percent of white and black women, for example. Although all population groups in the Amazon are less expressive in the workforce in relation to the national average, gender inequality in this dimension is greater than in Brazil. This is due to the low participation of Amazonian women: only 38 percent of white and black women were part of the workforce.

This shows the specificity of the Brazilian Amazon regarding the inequalities of the country's occupational structure. Employment data and work remuneration in Brazil show that, in

population categories (other men and other women), they differ significantly in terms of their insertion into the labor market, which might be reflected in the higher average wage.

general, the black and female populations tend to occupy relatively unfavorable positions in the labor market compared to white men. It follows that, in the case of the Brazilian Amazon, these features are exacerbated: since the relative participation of the black population is more significant in the region, the impact of discriminatory mechanisms in the labor market is more expressive. The occupations carried out by the Amazonian population are not only concentrated in informality but also receive lower wages than the national average, with black women in the region being the group with the worst earnings. At the same time, women in the Amazon participate less in the labor market, and more than 60 percent of them do not even make up the local workforce.

5. IMPACT OF A GREEN SPENDING SHOCK ON EMPLOYMENT IN BRAZIL AND BRAZILIAN AMAZON

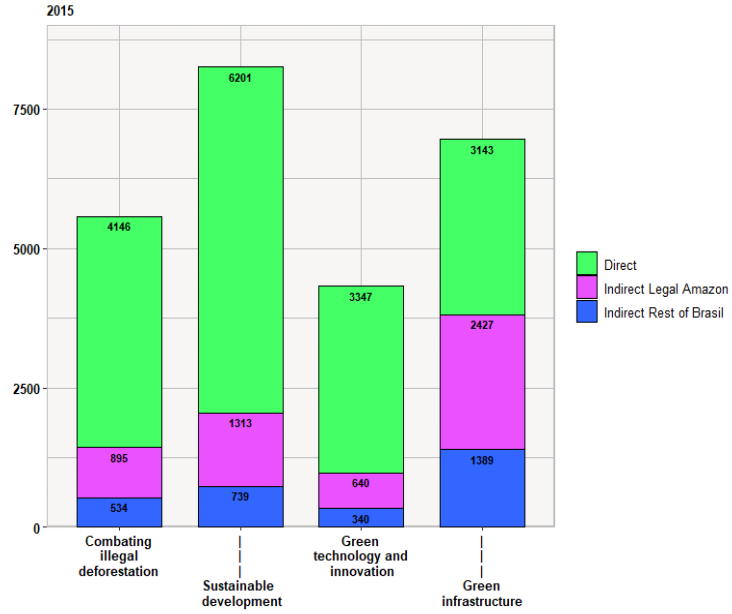
This section presents and discusses the results of a 1.5 billion reais spending shock on the four synthetic sectors included in the productive structure of the Brazilian Amazon. The analysis considers direct and indirect effects obtained from the employment multiplier, which relates the number of occupations per sector with the gross value of production. The direct effects indicate occupations generated directly in the synthetic sectors. Indirect effects correspond to occupations generated in other sectors, resulting from the demand for inputs generated from the shock in the synthetic sectors.

Figure 4 expresses the number of occupations potentially generated with the simulated green spending shock. Considering the existing productive structure at the time, the 1.5 billion reais distributed among four areas (synthetic sectors) could generate 25,114 jobs in 2015. Around 86.5 percent of that total (21,717 jobs) would result from direct and indirect effects within the Brazilian Amazon. Such an impact would represent approximately 0.17 percent of total occupations in the region in 2015. The magnitude of this impact reflects the size of the shock mobilized by the GRP and could be greater in the face of a more significant contribution: 1.5 billion reais represents only 0.3 percent of the GDP of the Brazilian Amazon in 2015. Despite its relevance, this amount is far from converging with international figures associated with post-pandemic green spending recovery plans (Marques 2020).

Figure 4 also shows that each synthetic sector has different job-creation potential. In this case, area two (productive and sustainable development) and area four (green infrastructure) stand out. They correspond to the synthetic sectors with the highest and second-highest job-generating potential at the national level, respectively. While, in the case of area two, this potential is fundamentally due to the direct effects—that is, within the sector and the Amazon— in the case of area four, the relevance stems from the indirect effect both in the Amazon and in the rest of Brazil. This occurs not only because the amount allocated to these areas is relatively large but also due to the type and quantity of inputs demanded, and the mobilized workforce.

Still, regarding total jobs, it should be noted that area three (green technology and training) has the least potential to affect the labor market. Although it goes beyond the scope of this article, a detailed analysis of the determinants of this result—the intuition for the lower job-generating potential of area three—is due, even if not exclusively, to the fact that technological innovation tends to be more capital-intensive. Even so, area three would be responsible for about 15.7 percent of the total jobs generated in 2015. As shown in Table 3, this potential is probably associated with the relative importance of labor-intensive sectors (Public Health, Public Education, and Public Administration) in the synthetic sector's cost structure.

Figure 4. Number of Jobs Generated via Direct and Indirect Effects in the Amazon and the Rest of Brazil

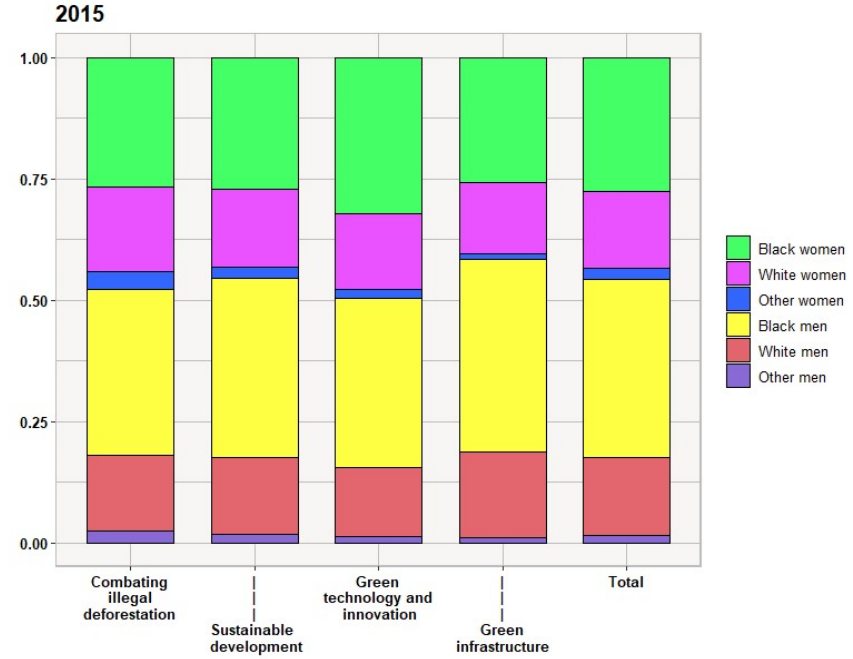


Source: own elaboration.

Based on the distribution of the workforce by race and gender extracted from the RAIS, it was also possible to observe how each type of effect (direct, indirect in the Legal Amazon, and indirect in Brazil) would impact the occupations of the selected population groups. Figure 5 shows the total number of jobs created by the GRP in each synthetic sector by group. Despite the different cost structures presented in Table 3, the occupations potentially created by each synthetic sector follow a certain pattern in terms of workforce composition: in all of them, most occupations would tend to be occupied by the black population, mainly males. As shown in Figure 6, 9,230 jobs (36.7 percent of the total) would be occupied by black men and 6,908 jobs (27.5 percent) by black women. Differentiating between the types of effect, the increase in employment among the black population is fundamentally due to the magnitude of the direct effects. Concentrated in the Amazon region, jobs generated within the synthetic sectors favor black women and black men, highlighting the specific demographic composition of the region.

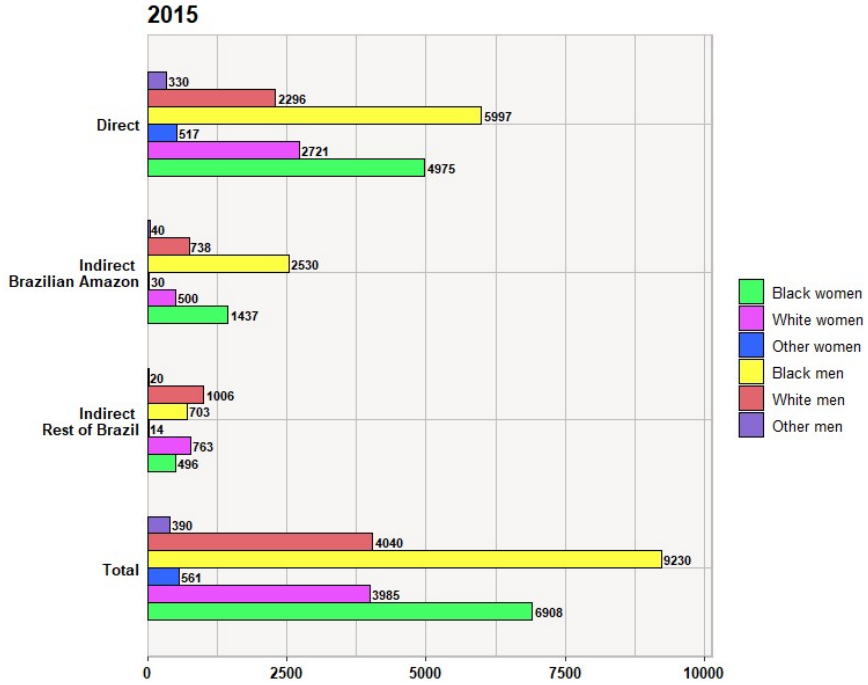
As regards the indirect effects, the distribution of jobs by race and gender reflects the particularities of the Amazonian labor market structure when compared with the rest of Brazil: while the shock on the Brazilian Amazon productive structure replicates the pattern observed in the direct effects, prioritizing the black population, the same does not occur for the rest of Brazil. In the latter, what is observed is the replication of the composition of the existing workforce: first, white men and white women, then black men and, finally, black women. This observation draws attention to the preponderant impact in aggregate terms. That is, do the effects generated by the shock, by benefiting the black population in absolute terms, have the potential to reduce the inequality that characterizes the composition of the Brazilian occupational structure?

Figure 5. Distribution of Jobs in Populational Categories Based on Sectoral Shocks (%)



Source: own elaboration.

Figure 6. Direct and Indirect Effects on the Amazon and Rest of Brazil, by Race and Gender



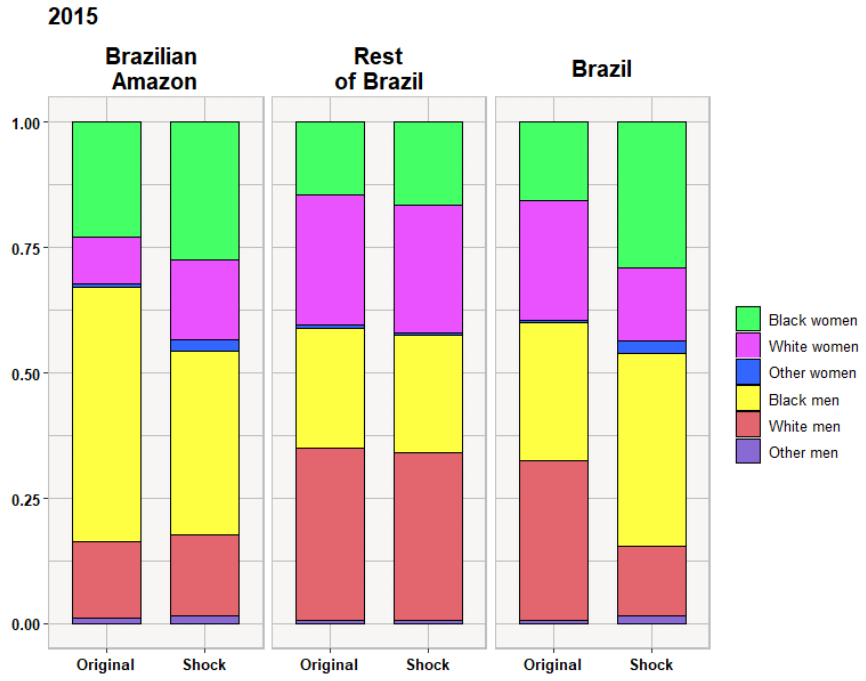
Source: own elaboration.

Figure 7 addresses this relevant question. It describes the three comparative scenarios of the composition of the occupational structure generated under criteria of race and gender: the first for the Brazilian Amazon, the second for the rest of Brazil, and the third for the country

as a whole (Amazon and the Rest of Brazil). In each of these scenarios, the original composition (obtained from RAIS) is compared with the workforce composition that would result from the simulated shock. It is important to recognize that this is not a before and after shock comparison but rather between the original composition and the shock itself. As discussed earlier, the total impact is relatively small (due to the magnitude of the resources mobilized) to establish the existence of a significant impact on labor market disparities. Even so, the result of the shock points to directions in which significant changes in the occupational structure could possibly be obtained, considering more expressive resource injections.

First, considering the Amazon region, Figure 7 shows that the jobs generated considerably increase the participation of the female workforce in relation to the original labor structure. The group composed of white women is the one whose difference between the shock and the original structure is more significant in proportional terms, followed by black women. In this case, the populational group that has a relative loss is black men. In the case of white men, the proportion is very similar when comparing the shock with the original structure.

Figure 7. Comparison Between the Composition of the Original Workforce Structure and that Generated by the Shock



Source: own elaboration.

By isolating the effects of the spending shock on the rest of Brazil, it is observed that it reproduces the composition of the original workforce, contrary to what occurs in the Amazon. This observation is in line with what is shown in Figure 6, that is, indirect jobs generated in the rest of Brazil point to a replication of the characteristic composition of the Brazilian labor market.

Finally, considering the whole country, it is possible to identify in the simulated shock significant potential for reducing occupational disparities. The composition of the workforce generated by the shock is considerably different from that established initially and mainly benefits the black population. The shock generates a composition that differs from the original, as there is a reduction in the relative participation of white men and white women in favor of all other population categories: black men, black women, other men and other women. Comparatively, the population groups disadvantaged by the shock are those that, considering the Brazilian labor structure, are historically better positioned in the labor market (Marques et al. 2022).[10] It is worth noting that the difference between Brazil's original occupational structure and that generated by the shock is likely the result of: (i) the high contribution of direct effects of being located in the Brazilian Amazon; (ii) the particularities of the demographic composition of the Amazon in comparison with the rest of Brazil in terms of the proportion of the non-white population; (iii) the shock composition in the rest of Brazil which indicates stability in relation to the original composition; and (iv) the synthetic sectors, whose cost structure crucially influences the effects on population groups.

In short, the results suggest that a spending shock replicating the green recovery envisioned by the GRP can potentially positively change the composition of the Brazilian workforce, favoring the fight against inequalities in the labor market. This effect stems from the composition of the Amazonian workforce, the direct impact of a green spending shock in the region and the specific cost structure associated with the synthetic sectors that emulate the GRP's four programmatic areas. The effects on employment in the Amazon tend to favor the female workforce—white and black—relative to the male and black workforce and, due to the relative concentration of jobs in the region, impact the entire country's labor market

[10]An important caveat is that the positive impact in relation to the composition of the workforce does not necessarily mean an increase in the income received by those groups since this depends on the value of labor remuneration associated with the sectors in which the jobs are generated.

structure. As seen in Section 3, the impact would also likely be significant in terms of the wage bill, as the average remuneration of women is lower than that of men in the region. On the other hand, the relative loss associated with these female jobs falls on black men. Even though this group, together with white men, is relatively well positioned in terms of remuneration within the Brazilian Amazon, one should not underestimate the role played by informality in local occupations. In any case, our results do not undermine the fact that a green-spending shock in the Brazilian Amazon would lead to relevant changes in the Brazilian workforce composition in terms of race and gender.

6. FINAL REMARKS

Since it officially brought together for the first time the idea of a green and just transition for Brazil, the Green Recovery Plan for the Legal Amazon (GRP) offered an interesting reference point for further exploration into the opportunities and limitations at stake for Brazil in the present context where both inequality and the climate crisis come to the fore as urgent matters. The GRP indicated that a green and just transition in Brazil must deal with the deforestation issue (the country's main source of greenhouse gas emissions) without losing sight of growth and employment in the Amazon, which also entails concerns associated with race and gender disparities. In some sense, such a preliminary proposal indicated possible trajectories to be followed by Brazil and other developing economies that face similar challenges.

Faced with the scarce information provided by the GRP executive summary and the importance of evaluating its potential impact on job generation for the green and just transition debate in Brazil, this article developed a method to assess the impact of a green-spending shock on the Brazilian Amazon based on the original proposal presented in the GRP. By relying on an effort of compatibilization between the Brazilian Federal Government's budgetary information, the Brazilian SNA, and the GRP four areas, it employed the methodology developed by Kim, İlkkaracan and Kaya (2017; 2019) to include these areas as four synthetic sectors in a two-region input-output matrix (Brazilian Amazon and rest of Brazil). This allowed for the simulation of a demand shock equivalent to the amount foreseen by the GRP (1.5 billion reais) to be allocated to the four areas, which was

analyzed in terms of job creation in the two regions, considering both direct and indirect effects. Moreover, a division of the workforce regarding race and gender criteria was also taken into consideration.

Results indicate that a hypothetical green spending shock in the Brazilian Amazon has the potential to positively change (by reducing inequalities) the composition of the workforce employed in both the Amazon and other Brazil regions. Given the magnitude of the direct effects of the shock and the particular demographic composition of the Brazilian Amazon, jobs potentially generated by the 1.5 billion reais suggest a relative expansion of the female workforce in the former and to a relative increase of the black workforce when the two regions (Amazon and Rest of Brazil) are considered. This fact is indeed relevant because it suggests that the positive effects on employment within the Brazilian Amazon can lead to a change in the composition of the workforce in the country, indicating changes in the original labor market structure toward lower race and gender disparities.

Of course, the present analysis could not exhaust a significant research agenda related to the impact of a green and just transition in Brazil. Future research, for example, could explore the links between economic and environmental impact, adding greenhouse gas emissions to the input-output framework. It would also be possible to look at disparities among workers while considering other dimensions, such as educational levels or the presence of formal or informal contracts. Another interesting possibility would be to analyze the impacts of interest in other countries by considering developing economies in a similar stage of development and the main guidelines on a green and just transition for these economies.

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