



The effects of occupational mobility on wages of rehabilitated workers in Brazil



Rayssa Alexandre Costa ^a, Alexandre Nunes de Almeida ^b, Edward Martins Costa ^c,
Pablo Urano de Carvalho Castelar ^{d,*}, Erivelton de Souza Nunes ^e

^a Brazilian Institute of Applied Economic Research (IPEA), Presidente Wilson - Av. Pres. Antônio Carlos 51 - Centro, Rio de Janeiro/ RJ 20020-010, Brazil

^b University of São Paulo (USP) – Department of Economics, Administration and Sociology (ESALQ/USP), Departamento de Economia, Administração e Sociologia – LES, Av. Pádua Dias 11, Piracicaba, SP, CEP 13418-900, Brazil

^c Federal University of Ceará (UFC) – Postgraduate Program in Rural Economics (PPGER/UFC), Universidade Federal do Ceará, Departamento de Economia Agrícola – DEA, Av. Mister Hull, 2977 – Bloco 826 – Campus do Pici – 60356000, Fortaleza, CE, Brazil

^d Federal University of Ceará (UFC) – Finance Course, R. Marechal Deodoro 400, 4o andar, Gabinete 412, Benfica, Fortaleza, CE 60020-060, Brazil

^e Federal University of Ceará (UFC) – Postgraduate Program in Rural Economics (PPGER/UFC), Universidade Federal do Ceará, Departamento de Economia Agrícola – DEA, Av. Mister Hull, 2977 – Bloco 826 – Campus do Pici – 60356000, Fortaleza, CE, Brazil

ARTICLE INFO

Article history:

Accepted 15 February 2022

Available online xxx

Keywords:

Occupational mobility

Professional rehabilitation

Staggered difference in differences

Event study

Brazil

ABSTRACT

This work investigates how occupational mobility, after a professional rehabilitation process, affects the hourly wages of workers who are inserted in the formal job market in the commerce, services and industry sectors of Brazil. For that purpose, a data panel was used with individual information from the Annual List of Social Information (*Relação Anual de Informações Sociais- RAIS*) for the period of 2007 to 2016. The methodology used was the Staggered Difference in Differences and dynamic treatment effects, through an event study design. The results show a positive effect of occupational mobility on hourly wages in the sectors analyzed, however, this effect is decreasing in the period after the professional change.

© 2022 Elsevier Ltd. All rights reserved.

1. Introduction

In the World Report on Disability 2011, produced jointly by the World Health Organization (WHO) and the World Bank, rehabilitation is defined as the process that helps individuals with functional limitations to interact with their environment, based on a set of measures. In other words, it is a way to recover the individual's social well-being.

Professional rehabilitation is the practice that aims to reintegrate into the job market the worker who is temporarily prevented from exercising their professional activities due to some accident or illness at work, unrelated or not. According to the Brazilian Statistical Yearbook of Social Security (*Previdência*, 2015, p. 539), professional rehabilitation: “it is a service that aims to provide insured persons who are partially or totally disabled for work, regardless of need, and for people with disabilities the means for their re-education or professional and social rehabilitation, for their participation in the labor market and in the context in which they live”.

In Brazil, the legislation for such rehabilitation, due to work accidents, is from the 1940s and was published before the norms established by the International Labor Organization (ILO). The Work Accident Reform Law, of 1944 (Brazil, 1944, Decreto No. 7036/1944), was intended for professionals who had suffered an accident at work, as a way to enable them to continue their career in their original job or in activities related to their physical conditions. During this period, professional rehabilitation was intended to provide physiotherapy services, orthopedic and reconstructive surgeries, as well as education in schools dedicated to adult education).

Although the rehabilitation process is important for the worker's return to the job market, that person is often unable to readjust to normal daily activities after suffering an accident/illness. The same logic applies to their income, as the time in a given occupation can interfere with their remuneration, that is, the greater the experience in a given occupation, the higher the wages should be (Ben Halima, 2005). Thus, the rehabilitated worker may face difficulties to re-enter the job market, as this individual considers their reservation wage after the intervention.

Thus, an interesting question is to investigate how the wages of workers, who previously did not have functional limitations and received professional rehabilitation, were affected. Therefore, the

* Corresponding author.

E-mail addresses: edwardcosta@ufc.br (E. Martins Costa), pcastelar@ufc.br (P. Urano de Carvalho Castelar).

objective of this work is to evaluate the effects of occupational mobility for workers in the sectors of commerce, services and production of industrial goods and services, who were reinserted in the job market after a process of professional rehabilitation in Brazil.

For this purpose, microdata from the Annual Social Information Report (*Relação Anual de Informações Sociais - RAIS*) are used, which allow the monitoring of the same individual over the years. Thus, it is possible to observe the occupational mobility of the worker who has gone through the rehabilitation process or not, while controlling for the unobserved characteristics of time-invariant workers. The period of analysis is from 2007 to 2016, since 2007 is the year in which RAIS started to identify the worker's condition in relation to the disability and the type of disability that this person may have, including whether that person is rehabilitated or not.

With this large period of time, it is possible to carry out an analysis with a greater number of workers who had to leave their jobs, due to accident or illness, and return to the job market as a rehabilitated worker.

In addition, the Difference in Differences (DID) method is used with various periods of time, with variation in treatment time and dynamic effects of treatment, through the study of events, which allows us to evaluate how occupational mobility affects the remuneration for hours of work of rehabilitated professionals, exploring the staggered nature of the sequential process of rehabilitation of Brazilian workers. Furthermore, two types of mobility were considered, immediate mobility and non-immediate mobility after rehabilitation. Therefore, this research aims to contribute to the literature on the subject, which has not yet been widely studied in the Brazilian economic literature.

The main limitation for the execution of this work refers to the lack of information regarding the degree of disability of workers, as the RAIS does not allow the identification of causes related to the type, degree and nature of the disability responsible for the rehabilitation of Brazilian workers. Seeking to minimize differences among groups and data limitations, occupational mobility was considered in terms of specific occupations, given that, although it is not possible to observe the exact nature of the workers' disability before the intervention, each specific occupation requires a set of skills and functions that homogenize the groups in the pre-treatment.

Furthermore, the analysis focuses on workers related to the sectors of Commerce, Services and Industry, to minimize possible effects of sectoral characteristics on the rehabilitation process. To compare the groups before the intervention, the difference of means test was used, in which the homogeneity between the groups was verified. In addition, the data imposed additional limitations, such as the impossibility of capturing the effect of company characteristics and the workers' family context in the rehabilitation process.

The main results of the estimates indicate a positive effect of occupational mobility on wages per hour worked, considering the sectors of commerce and services and the production of industrial goods and services, but this effect decreases in the post-treatment period. What can be inferred, in general, is that workers belonging to the treatment group probably sought more educational qualifications and switched to activities that may require more specific knowledge, which is confirmed by descriptive statistics. Therefore, these changes in the level of education and in the type of occupation may explain the positive effect on wages per hour worked obtained in the Staggered DID. However, even after this increase in human capital accumulation by rehabilitated workers, there is evidence of a drop in hourly wages when compared to the control group.

This work is organized into four sections, including this introduction. While a brief literature review is presented in section 2,

the methodology and database are presented in the third section. The results can be seen in section four, followed by the concluding remarks in section five.

2. Brief literature review

Although it is not researched as often as some other topics, the analysis of the income and wages of individuals with disabilities, whether comparing with those who do have a disability, or comparing the same individual before and after a disability or accident, has several contributions throughout the years. In this section, we briefly compile some of the more relevant contributions, both considering the international literature as a whole, and specifically works which analyzed Brazil.

One early analysis of income differentials in individuals with and without disabilities is from DeLeire (2001). Using data from the *Survey of Income and Program Participation* for the United States from 1984 to 1993, the author suggests that the wage gap between individuals with work limitations and those without such limitations is due to the discrimination effect.

Another contribution is from Longui, Nocoletti, and Platt (2012) who, using the UK *Labour Force Survey* from 1997 to 2008, analyzed the difference in wages for men with disabilities after the *Disability Discrimination Act* (DDA) passed in the United Kingdom. Wage differences were estimated in the mean and in the different quantiles of the wage distribution into which it is broken down into three parts: 1) differences due to the characteristics of workers and type of work. 2) differences due to the characteristics of the worker's health and 3) differences due to discrimination. According to the authors, much of the differences observed is associated with productivity issues.

Gunderson and Lee (2016), using data from the *Participation and Activity Limitation Survey*, analyzed wage discrimination for people with disabilities in Canada for the year 2006. The methodology involves breaking down the wage gap between individuals with disabilities, who are not limited in the performance of their work, and a comparison group of people without disabilities. The authors found that people with disabilities receive about 10% less than those without disabilities.

Some authors sought to examine the effects of programs which promote the inclusion of individuals with disabilities in the job market. Button (2017) evaluated the impact of the *Prudence Kay Poppink* (PKP) Act on the employment of individuals with disabilities. This law from California expands the antidiscrimination law in the United States, also assuring rights for those with less severe disabilities. Using data from the *Current Population Survey Annual Social and Economic Supplement* and the Differences-in-Differences method, the author finds that the PKP Act increased employment for those individuals or, at least, assured there was no job loss.

Bae, Oh, Park, Roh, and Won (2019) sought to analyze changes in worker income in South Korea, particularly those in the construction sector of the country, who experienced industrial accidents according to their "return to work" status. The authors used data from the fifth Panel Study of Workers' Compensation Insurance. A repeated measure analysis of variance (ANOVA) method was used to compare annual differential incomes before and after the industrial accident, and a linear mixed model was used to investigate the changes in income from before to after the industrial accident according to the industry and return-to-work status. The authors find that construction industry workers exhibited greater incomes before the accident, and showed significant decrease in their incomes after the industrial accident. Regression analysis for assessing changes in income after the industrial accident showed that a comparison by industry revealed

a significantly greater reduction in income in the construction than service industry. A comparison by work status revealed significantly greater decreases in income in the reemployment and non-return to work groups than among those who returned to their original work (Bae et al., 2019).

The authors find that construction industry workers exhibited greater incomes before the accident, and showed significant decrease in their incomes after the industrial accident. Regression analysis for assessing changes in income after the industrial accident showed that a comparison by industry revealed a significantly greater reduction in income in the construction than service industry. A comparison by work status revealed significantly greater decreases in income in the reemployment and non-return to work groups than among those who returned to their original work (Bae et al., 2019).

Kambourov, Manovskii, and Plesca (2020) argue, while analyzing workers going through a training program, that wages of participants in employer-sponsored training increase substantially, while wages of participants in government-sponsored training hardly change. In their view, there is a potential selection issue, where most of the government-sponsored trainees went through an occupational change, while most participants in employer-sponsored training are “occupation stayers”. The work’s empirical analysis is based on data from the National Longitudinal Survey of Youth 1979 (NLSY79). The NLSY79 is, according to the authors, the only US dataset that asks questions pertaining to participation in both employer and government training. Thus, it allows the construction of the individuals’ job histories, including occupational tenure and occupational mobility, and to control for individual fixed effects.

The authors use propensity score matching and Ordinary Least Squares regressions, and find that occupational mobility and government training are conditionally independent. As a result, the authors evaluate the effect of training on the human capital of participants by studying separately the samples of occupational stayers and occupational switchers. On both samples, the results show a substantial positive effect of training on workers’ human capital. The magnitude appears to be similar for the participants in employer and government-sponsored training programs.

In Brazil, Castro, Moreira, and Silva (2019) sought to assess discrepancies in wages of individuals with disabilities in the Brazilian job market. Using the methodology featured in DeLeire (2001), and also data from the Brazilian National Health Survey (*Programa Nacional de Saúde - PNS*), for 2013, the authors found as a result the existence of a wage gap between individuals with disabilities and people who do not have disabilities, which can be explained by both the endowment (productivity) effect and the discrimination effect.

Becker (2019), on the other hand, assessed the effect of disability on employment and hourly wages in Brazil, using the same data from the previous work, for the same period. As a methodology, the author used the decomposition of the differences in remuneration in the quantiles of the wage distribution, and three groups were considered: non-disabled individuals, those who have disabilities and limitations in terms of work activities, and those with disabilities but without such limitations. The main results of that work suggest that the observable characteristics explain, for the most part, the wage differences between the groups of non-disabled and people with disabilities who did not have limitations in relation to those who have disabilities with limitations in some of the higher quantiles. According to Becker (2019), this result may be related to the fact that employers have a preference in allocating individuals who do not have functional limitations to positions that pay higher wages, as a way of complying with the Brazilian quota law, without having to make considerable changes in the physical structures of the business or the work routines.

3. Data and methodology

3.1. Data

For this work, microdata from the Annual List of Social Information (*Relação Anual de Informações Sociais - RAIS*), from the Brazilian Ministry of Labor (*Ministério do Trabalho - Mtb*), were used. The RAIS contains data on formal employment in the Brazil with the advantage that, through it, it is possible to monitor an individual over the years, through the national Register of Individuals (*Cadastro de Pessoas Físicas - CPF*), forming a longitudinal panel of data. It is important to note that the panel constructed is unbalanced due to the number of observations not being the same for each year of the survey.

The variable that identifies whether the worker has any disability and the type of disability, including whether he/she was rehabilitated, was inserted and made available in the RAIS database in 2007¹. So, from then on, there was a variable that covers the employment relationships exercised by people with disabilities. Therefore, the period selected for this analysis ranges from 2007 to 2016.

The sample consisted of workers between 16 and 65 years² of age. Public servants were excluded, as it is assumed that, when they go through the rehabilitation process and return to the job market, they receive the same wages, and that may overestimate the results of the analysis. Furthermore, following Guimarães (2013), Costa, Sousa and Guimarães (2015) and Mariano and Costa (2015), members of the armed and military forces were also excluded, as market forces do not determine their wages. Such procedures were carried out in view of the legal nature of the companies in which the rehabilitated workers perform their occupations, whether in pre-treatment or post-treatment.

From 2007 to 2010, some variables had different names and formats and had to be standardized so that these were consistent over the years. Another necessary filter was to exclude individual information that was duplicated in the database, as some workers had more than one relationship with the same company, or even in another company, and appeared more than once in the database, as a result of self-declaration errors by part of employers³.

In addition, as the same worker can be observed at different moments in time, workers who presented the condition of non-disabled in the pre-treatment period and who started to declare themselves as rehabilitated in the post-treatment period were effectively maintained, but workers who switched from non-disability to rehabilitated only in the post-treatment period were withdrawn. Given that most non-disabled workers move to the condition of rehabilitated predominantly only after one year, the sample in this work mostly focuses on workers who rehabilitated between 2009 and 2010.

The variables used are presented according to Table 1 below. As a variable of interest, the hourly wage (w/h) was used, deflated by the IGP-DI⁴, therefore, it is intended to assess whether occupational

¹ It should be noted that the data from RAIS does not allow the identification of the causes related to the type of disability responsible for the rehabilitation of the Brazilian workers, however, it is possible to identify the specific occupations before and after the rehabilitation process, and, thus, considering that a specific occupation accommodates workers with similar characteristics, it is understood that it is possible to make a comparison between the treatment and control groups.

² The Brazilian Work and Social Security Card (*Carteira de Trabalho e Previdência Social - CTPS*) can be issued from the age of 14, but the registration of activities for young people between 14 and 16 years of age can only be done as a minor apprentice. In view of this, it was decided to consider the minimum age of 16 years.

³ It is important to note that the employers themselves report these data.

⁴ The General Price Index – Internal Availability (*Índice Geral de Preços – Disponibilidade Interna - IGP-DI*) is an index that measures the price variation of the Brazilian economy within a certain period.

Table 1
Description of the Variables.

Variable of Interest	
w/h	Hourly wages
Treatment Variables	
Treatment	Dummy variable that assumes value 1 if the worker belongs to the treatment group, and 0 otherwise
treatment*time	interaction between treatment and the period in which the worker underwent treatment
treatment*time2	effect of occupational mobility which does not happen immediately after rehabilitation
Covariates	
Age	Age of the worker
Gender	1 for males, 0 if otherwise
Race	1 for whites and 0 for non-whites
Education	Level of education dummy variables
Experience	time of employment of the employee at the company (in years)
Experience squared	time of employment of the employee at the company (in years)
Mobility between companies	Mobility of the rehabilitated employee, considers the company in which the worker was occupied before rehabilitation with the company in which the worker started to work in the condition of rehabilitated.

Source: Prepared by the authors.

mobility has positive or negative effects on this variable. The variable that captures the effect of the occupational mobility after the rehabilitation period for workers is the *treatment*time* variable. However, it is possible that the change in occupation after rehabilitation occurs not immediately, that is, rehabilitated workers can remain in the same occupations after the intervention, as well as move from the treated group to the control group in the post-treatment. Thus, to capture this effect, the *treatment*time2* variable was constructed, which captures the effect of occupational mobility which does not occur immediately after the rehabilitation period.

The occupational mobility after rehabilitation is built from the 2002 Brazilian Code of Occupations (*Código Brasileiro de Ocupações - CBO*). With these codes, and considering the longitudinal monitoring of workers through the Register of Individuals (*Cadastro de Pessoas Físicas - CPF*), it became possible to verify the occupation before and after the intervention, thus making it possible to construct the treatment variable. The CBO identifies which sector a worker is in according to digits, and it is possible to identify which specific function they perform with more digits used. Thus, it is worth mentioning that, in the present work, for the purpose of analyzing occupational mobility, all six digits of the 2002 CBO were considered, that is, changes in specific occupations were considered.

Covariates were selected according to their importance to explain wage returns, as proposed by Mincer (1974). The age variable will indicate the effect of individuals' age on income.

The education variable was analyzed through the construction of the following dummy variables to represent the level of schooling: illiterate, elementary school, high school, higher education (college) and graduate school. It is expected that more educated individuals have higher hourly wages.

The variables of sex and race are considered as a way to capture the discrimination effect. Experience was measured in years of work, so it is expected that the accumulation of experience generates an increase in earnings. Furthermore, as from a certain age onwards, the worker's productivity drops, despite the accumulation of experience, the marginal remuneration also tends to be reduced, thus, to correct this possible bias, experience squared was also included. Lastly, mobility between companies was constructed by comparing the company in which the worker was occupied before rehabilitation with the company in which the worker started to work in the condition of rehabilitated. This procedure was carried out using the Brazilian National Register of

Legal Entities (*Cadastro Nacional de Pessoa Jurídica - CNPJ*) of the companies in question.

3.2. Treatment and control groups

To assess the effects on the hourly wages of those professionals who had occupational changes after a rehabilitation process, it is necessary to build two groups: a treatment group, which is the group of interest in the analysis, and a control group, with individuals who adequately represent the situation of not having gone through the treatment. (Foguel & Diferenças, 2012). We define these two groups as follows:

- **Treatment group:** Individuals who did not have any functional limitations and went through a rehabilitation process, changing occupations afterwards.
- **Control group:** Individuals who did not have any functional limitations and went through a rehabilitation process, but remained in the same occupations afterwards.

Although the two groups have undergone rehabilitation, only those in the treated group have gone through an occupational change after the process. Therefore, the control group serves as a satisfactory comparison, given that the return to the same occupation indicates that the professional was able to occupy his/her previously performed function, so they are not directly affected in the job market by the rehabilitation process.

3.3. Model specification

The central point of this work is the relationship between the rehabilitation of workers and the results of the local job market. In the evaluation of public policies, the differences-in-differences (DD) method is widely used⁵. This method assesses the effect of the policy, using information from the treatment and control groups before and after the intervention is carried out. It consists of calculating a double difference: first, the differences between the means of the outcome variable before and after the treatment period are calculated, and then the difference between the treated and control groups. With panel data, the method controls for unobservable characteristics (e.g., race, gender, motivation, optimism, self-discipline) that are time-invariant. It is considered as a bidirectional fixed effects model with a post-treatment dummy variable, and is therefore used to identify the average treatment effect on the treated, given the assumption of common trends (Foguel & Diferenças, 2012; Wooldridge, 2010).

Although this work is not exclusively evaluating the effect of the rehabilitation service on hourly wages, it uses the aforementioned method considering, as an intervention, the occupational change after the worker's professional rehabilitation. The pre-treatment period is when the professional is in a certain occupation and does not have any type of functional limitation, therefore, he/she did not go through the rehabilitation process⁶, while the post-treatment period refers to the period in which the non-disabled worker enters the labor market as rehabilitated.

Being $D = \{1,0\}$, in which D indicates the treatment position ($1 - \text{treatment}$, $0 - \text{control}$) and $t = \{1,0\}$ the period after and before treatment, respectively, the DD estimator can be given by:

⁵ For more methodological details, see Foguel (2012).

⁶ A hypothesis to be tested in the DD design is that the outcome variable of the control group should represent the temporal trajectory that should occur with the treated in the absence of the treatment. However, it is a difficult hypothesis to test and, therefore, what can be done is to test this assumption indirectly, assessing whether the two groups show the same trend with regard to the outcome variable in the pre-treatment period.

$$\beta_{DD} = \{E[Y|D = 1, t = 1] - E[Y|D = 1, t = 0]\} - \{E[Y|D = 0, t = 1] - E[Y|D = 0, t = 0]\} \tag{1}$$

In other words, it represents the time difference of what happened to professionals who went through occupational mobility after rehabilitation, subtracted from the same calculated difference for professionals who remained in the same occupation after this process. The model specification will be done as follows:

$$w/h_{it} = \beta_0 + \beta_1 Treatment_i \times Time_t + \alpha_i + \mu_{it} \tag{2}$$

where, the subscript *i* represents the workers and *t* the time period (*t* = 2007, 2008, . . . , 2016). As for α_i , it is the control of fixed effects of individuals and μ_{it} is the error term. Parameter β_1 represents the parameter of interest, as it identifies the direct effect of occupational mobility on the outcome variables. In order to ensure greater robustness of the results, some other strategies were also used. First, equation (2) was specified considering a vector of the workers' characteristics X_{it} (as mentioned in Table 1):

$$w/h_{it} = \beta_0 + \beta_1 Treatment_i \times Time_t + \beta_2 X_{it} + \alpha_i + \mu_{it} \tag{3}$$

However, given that the assignment of the treatment condition can occur at any time during the post-treatment period, and not necessarily immediately after the intervention, this work explores the staggered nature of the sequential process of rehabilitation of Brazilian workers. The rehabilitation of workers takes place at a given time, and, subsequently, these workers remain exposed to treatment during the post-treatment period. For this purpose, the staggered Difference in Differences (DID) approach is adopted to identify and calculate the parameters of the treatment effect. The implementation of this approach is inspired by Gonçalves, Rodrigues, and Chagas (2020), who point out, as advantages, the possibility of accommodating many periods of time, variations in treatment time and the assumption of maintenance of parallel trends after conditioning on the covariates.

Initially, only the heterogeneity of the treatment effect was considered as a function of time and covariates, where non-disabled workers are treated immediately after rehabilitation (intervention), and this time can be different among workers. Thus, in view of Gonçalves et al. (2020), this specification can be described using the expression (4):

$$Y_{r,t} = \beta_0 + \beta_1 L_{r,t} + \beta_2 X_{r,t} + \gamma_r + u_t + \varepsilon_{r,t} \tag{4}$$

In which $Y_{r,t}$ corresponds to the hourly wage of the worker rehabilitated in time *t*; $L_{r,t}$ refers to a variable that identifies the rehabilitated worker *r*, which in year *t* went on to the condition of being rehabilitated; $X_{r,t}$ concerns the characteristics related to each worker *r* in time *t*, described in the methodology; γ is associated with the fixed effects of workers; *u* indicates the fixed year effect; $\varepsilon_{r,t}$ is related to disturbances; and β_0 , β_1 and β_2 represent the parameters.

In this first specification, the same worker is observed as treated in and control between periods. The different transitions of non-disabled workers to the condition of rehabilitated over time are considered as the source of variation that makes it possible to analyze the effect of occupational change on the results in the job market for the rehabilitated.

Subsequently, aiming to analyze the extent and duration of the effects of the post-rehabilitation occupational change/mobility on job market outcomes, the dynamic effects of treatment were considered. In this case, an event study was adopted, in which an extension of the scaled differences-in-differences model is adopted with the incorporation of five leads and delays among the explanatory variables of the model in order to measure the average dynamic effects of shocks discrete and non-transient treatments. Furthermore, the possibility of pre- and post-treatment combined with the contemporary estimate of the average treatment effect

(ATE) is also considered (Gonçalves et al., 2020). In this sense, the study of events can be specified through expression (5) that follows:

$$Y_{r,t} = \beta_0 + \sum_{i=1}^l \beta_{pre,i} L_{r,t+i} + \sum_{j=0}^J \beta_j L_{r,t-j} \alpha X_{r,t} + \gamma_r + u_t + \varepsilon_{r,t} \tag{5}$$

In this case, $L_{r,t-j}$ refers to specific indicators of the annual period and indicate that the rehabilitated worker *r* is treated in time *t-j*; $L_{r,t+i}$ indicates whether the rehabilitated worker is treated in *i* future years; and $\beta_{pre,i}$ are coefficients tested to identify possible past trends in job market outcomes. Furthermore, according to Gonçalves et al. (2020), the inclusion of that parameter is relevant, since it allows a lag in the effects of occupational mobility after rehabilitation, as well as in the variability of the treatment in terms of exposure time.

However, for the results to be interpreted reliably, it is necessary to fulfill some assumptions by the rehabilitated workers: 1) the date of assignment to treatment must be random; 1) validation of conditional parallel trends, which suggests that rehabilitated workers have similar trends in hourly wage terms, considering the absence of treatment; 2) rehabilitated workers do not know in advance the probability of occupational mobility over the period, and therefore should not anticipate treatment; and 3) absence of selective treatment. (Callaway & Sant'anna, 2020; Gonçalves et al., 2020).

Considering that the characteristics between the control and treated groups are quite different, the use of the staggered DID and the study of events was carried out by disaggregating occupations by sectors, in this sense, as the majority of rehabilitated workers are concentrated in the sectors of production of industrial goods and services, commerce and services, estimates were carried out considering each case, in order to homogenize the characteristics of the rehabilitated before treatment, as well as the concept of mobility from the point of view of occupation-specific mobility, through the six digits of the 2002 CBO, as highlighted in the previous subsection.

4. Results

4.1. Descriptive statistics

Table 2 presents the descriptive statistics for the control and treated groups, considering the period prior to the rehabilitation process, and the subsequent period, for Brazil from 2007 to 2016. It is noteworthy that, in addition to the control variables mentioned in the methodological section, the rehabilitated workers were distributed in the different regions of the country, namely, North, Northeast, Southeast, South and Midwest, and in addition, according to the occupational groups before and after the intervention. For this purpose, the 2002 Brazilian Classification of Occupations (CBO) was used, which presents the following occupational groups: Managers, professionals in the sciences and arts, high-school level technicians, administrative service workers, agricultural sector workers, workers in the production of industrial goods and services, workers in continuous industries, chemical and steel, and repair and maintenance workers.

It can be observed that the hourly wage for both groups increases after the rehabilitation period, but those in the treatment group show higher hourly wages (BRL 47.21) when compared to the control group (BRL 46.78). In terms of experience, it can be noted that individuals belonging to the control group had a longer time of employment than workers in the treatment group; this can be explained by the fact that the post-treatment of the treated group features an easier transition into another occupation.

Table 2
Descriptive Statistics for the control and treatment groups, before and after the rehabilitation process – Brazil.

Variáveis	Control				Treatment			
	Pre-treatment		Post-treatment		Pre-treatment		Post-treatment	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
hourly wages (nominal wages/hour)	41.49***	50.66	46.78	55.23	35.82***	37.50	47.21	46.57
Age (years)	39.09***	9.63	43.20	9.53	34.83***	9.19	39.34	9.22
Time of employment (years)	7.78***	7.60	10.06	8.88	4.84***	5.41	5.58	6.36
Educational level	(%)		(%)		(%)		(%)	
Illiterate (up to 1 year in school)	2.44		2.31		0.62		0.48	
Elementary school (9 years in school)	40.46		39.85		35.70		31.73	
High school (12 years in school)	44.54		43.54		53.47		53.36	
Higher Education (completed undergraduate course)	12.47		14.14		10.17		14.32	
Masters_doctorate (complete masters or doctorate degree)	0.10		0.16		0.04		0.11	
Region	(%)		(%)		(%)		(%)	
North	3.70		3.76		4.37		4.15	
Northeast	21.79		21.88		15.20		15.68	
Southeast	42.54		42.74		45.87		45.54	
South	27.67		27.31		28.39		28.46	
Center-west	4.31		4.31		6.17		6.17	
Occupation	(%)		(%)		(%)		(%)	
Arts and sciences workers	3.21		3.21		2.13		2.90	
High school level technicians	7.01		7.01		7.23		7.42	
Administrative Services	20.92		20.92		18.47		32.76	
Commercial Services	10.67		10.67		21.96		20.75	
Agricultural workers	11.54		11.54		3.64		2.64	
Workers in the production of industrial goods and services	33.55		33.55		34.48		25.01	
Workers in continuous industries, chemical and steel	9.48		9.48		8.01		5.73	
Repair and maintenance workers	3.63		3.63		4.08		2.79	
Sectors	(%)		(%)		(%)		(%)	
Public administration and international organizations	0.74		0.77		0.59		1.03	
Agricultural activities and aquaculture	1.32		1.25		1.95		1.95	
Financial, real estate and administrative services	10.57		10.80		6.83		7.82	
Commerce and services (including domestic and administrative)	16.65		16.00		32.79		26.77	
Communication and scientific and technical activities	2.09		1.86		4.30		3.56	
Education, health, arts, culture and sports	2.02		2.09		2.02		4.22	
Electricity and sanitation	2.15		2.12		1.51		1.14	
Extractive industries, transformation and Civil Construction	56.68		57.36		40.65		43.04	
Transportation, accommodation and food industry	7.78		7.74		9.36		10.47	
N	3112				2723			

Source: Prepared by the authors using data from the RAIS (Mtb, 2021). Data from 2007 to 2015.
Notas: SD = Standard Deviation. *** indicates statistical significance at the 1% level for the *t*-test.

As for education, it is clear that for the control group the percentage of education in the sample is very close between the pre and post rehabilitation periods, with a minor change in percentages. In addition, it appears that there is greater growth between the periods in which individuals were in the process of getting a college degree.

Regarding the different regions of Brazil, the statistics show that the largest concentration of people is in the Southeast region of the country, and it can also be noticed that in the treatment group, there is an increase in the number of individuals in that region, while there is a decrease for the other regions (with the exception of the South region), indicating that there is a considerable number of people migrating to the Southeast.

Another relevant information is related to the occupation groups. Since for the control group, it is considered that there is no occupational mobility between the two periods, the percentage remains the same in the transition from pre to post-treatment, with the production of industrial goods and services group presenting the highest proportion of individuals, followed by occupations in trade and service activities. As for the treatment group, before the rehabilitation period, around 34.5% of individuals were allocated to activities in the industrial goods and services production group, but this percentage drops to 25% after the rehabilitation process. On the other hand, there is a considerable increase in the activities of administrative service groups, which rose from 18.5% to 32.8%. As for sectoral changes, it is worth highlighting the sectors of industry and civil construction and commerce and services, for all cases, however, there is a reduction in the percentage of work-

ers in commerce and services in the transition to professional rehabilitation.

Furthermore, in order to verify the differences between the two groups (treated and control) before rehabilitation, the *t* test of means was applied for the variables *hourly wage*, *age* and *time of employment*. Thus, given the statistical significance in the selected variables, the existence of mean differences between the groups in the pre-treatment was observed, considering the aforementioned test. However, although the means of these variables are different, the *t* test does not provide robustness for the existence of a common pre-trend before the intervention, that is, that the “shocks” have a common effect in both groups. In this sense, to verify the common trend between the groups before the intervention, when performing the estimation of the models, parallel trend tests were performed, as can be seen in subsection 4.3.

4.2. Effects on hourly-wages

This subsection presents the general estimates of the scaled DID on the immediate and non-immediate occupational mobility after the professional rehabilitation process, for workers in the sectors of Commerce and Services and for professionals in the production of industrial goods and services⁷. Thus, in Tables 3 and 4, we present these estimates, in which we test four specifications. The first and

⁷ An important point in this work is that occupational mobility on the part of rehabilitated workers may have occurred inside a sector or between two different sectors.

third columns show the results of the unconditional staggered DID for rehabilitated professionals in *Commerce and Services* and *Industry*, respectively. On the other hand, the second and fourth columns present these estimates controlled by covariates, considering the fixed effects on individuals.

From Table 3, we can see the set of results for workers who had immediate occupational change after the rehabilitation process. Overall, we have a positive and statistically significant effect of occupational mobility on wages per hour worked, in the four specifications for the sectors analyzed, indicating that, in all cases, occupational mobility was responsible for wage gains.

Table 4, on the other hand, shows the estimates of occupational mobility which did not occur immediately after the rehabilitation process. Thus, in all specifications, there is a positive and statistically significant effect for occupational mobility in the analyzed sectors. As it occurred in the estimates of immediate mobility, there was no significant change when the estimates were controlled (or not) for covariates and fixed effects.

It is noteworthy that the hourly wages, which consists of remuneration per hour worked, was chosen instead of the average wage, as in Suliano and Miro (2014), as it contemplates the distinctions in the working hours of workers in the transition to rehabilitation, given that there is the possibility that some rehabilitated workers have shorter working hours than in the pre-rehabilitation period, reflecting more satisfactorily any productive or discriminatory aspects.

Analyzing the effects of a non-immediate occupational change by sectors, and controlling the model by covariates and fixed effects, it can be observed that, contrary to what was observed for the dynamics of immediate mobility, when the worker goes through the rehabilitation process and does not enter immediately in the job market, the effect on hourly wages is greater for workers in the *Industry* sector who changed their original occupation to other positions in this same sector, or went to other sectors of the economy, than for workers rehabilitated in occupations in *Commerce and Services*, given that the “non-immediate mobility” generated, respectively, increases in remuneration per hour worked of 1.53% and 4.22% for the sectors of *Commerce and Services* and *Industry*. In addition, rehabilitated workers in the sectors of *Commerce and Services* who did not immediately reintegrate are allocated, for the most part, to occupations with lower wages⁸.

In general, from the results obtained, it is possible to observe that there was an increase in the hourly wage, regardless of whether the rehabilitated worker had an immediate occupational change or not, or had remained in the occupational sector he was in before the intervention. The positive relationship between occupational mobility and wages was also found by Fitzenberger and Kunze (2005). However, given the lower estimates obtained in Table 4, workers in the trade and services sectors who did not immediately reintegrate into the job market sought to occupy jobs with remuneration close to what they received before the rehabilitation process, regardless of the sector they were reinstated.

4.3. Event study design

In this section, we apply the staggered DID method with the inclusion of the dynamic effects of occupational mobility of rehabilitated workers, to verify the behavior of hourly wages over time. We address pre-existing trends in outcomes through an event-study approach, as described in Equation (5), including regressors and treatment lags.

Given that occupational mobility for Brazilian workers occurs predominantly soon after treatment or in years close to treatment,

and in view of the small sample size, the dynamic study was carried out for 1 period before and after treatment in all sectors, when there is immediate mobility. On the other hand, when non-immediate mobility is analyzed, 3 periods before and after the treatment for occupational mobility for the analyzed sectors were used. Therefore, the study of events allows us to analyze the extent and duration of occupational mobility of workers who have gone through the rehabilitation process.

An important point of the event study is that its estimates consider the heterogeneity of time through the dynamic effects of treatment, and that these estimates do not depend solely on exposure to contemporary treatment. Furthermore, the study of events allows us to test pre-existing trends in the results of the analyzed occupational mobilities, that is, to assess the reliability of the causal results through two statistical tests of parallel trends⁹.

The results of the estimated event studies are presented in Table 1.A in the appendix and in Fig. 1. In Fig. 1, we have the estimated pre- and post-intervention coefficients, where the periods and the periods were plotted on the x-axis and on the y-axis. values of pre- and post-intervention estimates, respectively¹⁰. In this sense, Fig. 1(a) and (b) show the dynamic effects of immediate occupational mobility of workers rehabilitated in *Commerce and Services* and *Industry*, respectively, for other occupations in the same sectors or in other sectors of the economy. On the other hand, Fig. 1(c) and (d) present the dynamic effects for non-immediate occupational mobility in these same sectors.

From Figs. 1(a) and (b) and Table 1.A in the appendix, a positive and statistically significant effect of immediate mobility can be seen, at the exact time of intervention, for rehabilitated workers in both sectors, and, in the post-intervention period, there was no effect for rehabilitated workers in the industry. However, there was a significant and positive effect for those who changed occupation in the *Commerce and Services* sectors, however the magnitude of the effect was smaller than the estimated average of the staggered DID.

The effects of non-immediate occupational mobility are shown in Figs. 1(c) and (d) and in Table 1.A in the appendix, in which there was no effect on occupational mobility after the intervention, in the period analyzed, for workers of commerce and services. However, for rehabilitated workers in the industrial sector, there was a positive and statistically significant effect in contemporary time, and in the second period after treatment, but with less magnitude.

Therefore, from these results it can be seen that the dynamic effects, when found, were positive, however, they were inferior than the average estimates measured in the staggered DID, indicating that the dynamics of the hourly wage relationship after the occupational change tends to be decreasing over time. In fact, considering the specific human capital theory, this drop in hourly wages also occurs in other situations of occupational mobility in the labor market, as described by Kambourov and Manovskii (2008) and Parrado, Caner, and Wolff (2007), in which the authors provide evidence that occupational change over time is associated with a loss of occupation-specific skills, which in turn leads to low relative wages.

5. Concluding remarks

This work sought to assess the possible effects of occupational mobility, (immediate and not immediate) on the part of workers who have gone through the process of professional rehabilitation,

⁹ Thus, the common trend assumption was tested through: i) joint test of significance in the leads (Parallel trend test 1); ii) time trend significance test (Parallel trend test 2). These tests allow the verification of the non-violation of the hypothesis of common tendency for those involved.

¹⁰ The 70–99% confidence intervals are arranged in a vertical column.

⁸ This is verified when comparing the sectors in tables 3 and 4.

Table 3
Effects of immediate occupational changes after the rehabilitation process on Hourly wages

Immediate occupational changes	Commerce and Services	Commerce and Services	Industry	Industry
Hourly wages	4.6313*** (0.8780)	4.3431*** (0.8560)	3.7588*** (0.8710)	3.5653*** (0.7693)
R-squared	0.8125	0.8154	0.7070	0.7075
Controls	NO	YES	NO	YES
Observations	3.420	3.420	8.354	8.354
Treated	1.042	1.042	1.757	1.757
Controls	2.378	2.378	6.597	6.597

Source: Prepared by the authors using data from the RAIS (Mtb, 2021).
Notes: ***p < 0.01. Columns report staggered Difference-in-Differences regressions and include cpf and year fixed-effects. Robust standard errors in parentheses. Control variables: age; sex; race; education; experience; experience squared and mobility of the rehabilitated between companies.

Table 4
Effects of no immediate occupational changes after the rehabilitation process on Hourly wages

No Immediate Occupational Mobility	Commerce and Services	Commerce and Services	Industry	Industry
Hourly wages	1.4271*** (0.7869)	1.5266*** (0.784)	4.4764*** (0.6679)	4.2186*** (0.6600)
R-squared	0.8109	0.8141	0.7080	0.5980
Commerce and Services	YES	YES	NO	NO
Industry	NO	NO	YES	YES
Controls	NO	YES	NO	YES
Observations	3.420	3.420	8.354	8.354
Treated	2.109	2.109	5.666	5.666
Controls	1.311	1.311	2.688	2.688

Source: Prepared by the authors using data from the RAIS (Mtb, 2021).
Notes: ***p < 0.01. Columns report staggered Difference-in-Differences regressions and include cpf and year fixed-effects. Robust standard errors in parentheses. Control variables: age; sex; race; education; experience; experience squared and mobility of the rehabilitated between companies.

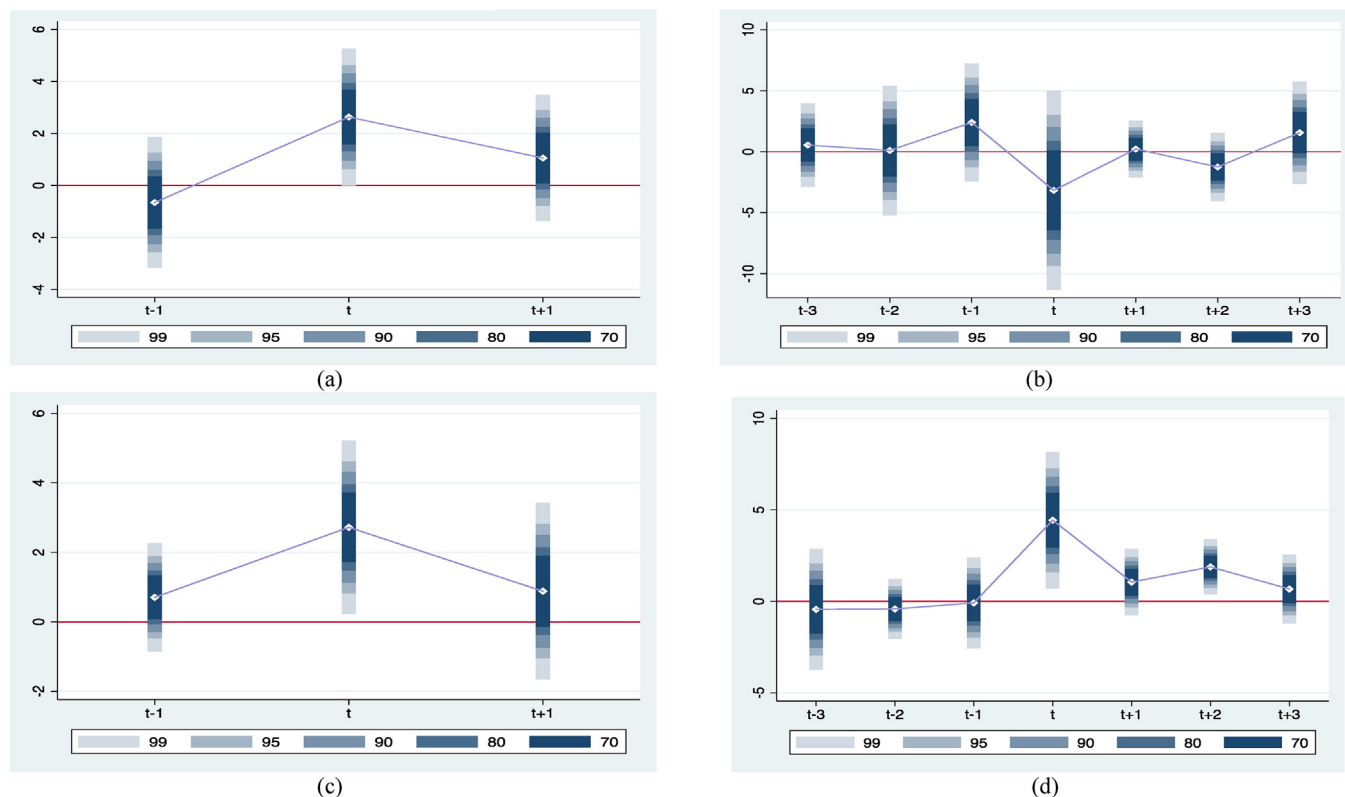


Fig. 1. Event-study analysis for Hourly wages. Note: Graphical result of the estimation of Equation (2) with covariates, and fixed effects for cpf, which meets the common trend criteria.

on the hourly wage in the Brazilian formal job market, considering the sectors of commerce and services and the production of industrial goods and services, thus contributing to the literature, given

the scarcity of studies with this purpose. Our analysis is based on data from the Annual Social Information Report (*Relação Anual de Informações Sociais - RAIS*), from the Brazilian Ministry of Labor –

(Ministério do Trabalho – Mtb), and on the methods of Staggered Differences in Differences and event study design. Furthermore, to ensure the causality of the estimates found, parallel trend tests were performed.

The main results in the analyzed sectors are positive, both for those workers who changed occupations soon after the rehabilitation process, and for those who rejoined after some later periods. Comparing the sectors, workers originally linked to industrial occupations obtained higher levels of hourly wages, compared to rehabilitated workers who did not undergo occupational change. The dynamic effects, on the other hand, show that there is a downward trend over time of hourly wages in the sectors analyzed, regardless of the type of mobility.

What can be inferred, in general, is that workers belonging to the treatment group probably sought more educational qualifications and switched to activities that may require more specific knowledge, which is confirmed by descriptive statistics. Therefore, these changes in the level of education and in the type of occupation may explain the positive effect on wages per hour worked obtained in the staggered DID. However, even after this increase in human capital, there is evidence of a drop in hourly wages when compared to the control group.

Although this work has shown positive results, it can frequently occur that these individuals, due to their limitations, may face difficulties to obtain further professional qualification (Oliveira, Araújo, & Romagnoli, 2006). Therefore, the importance of investments in policies aimed at guaranteeing admission to schools, professional courses and higher education institutions is emphasized, with actions that ensure that the physical structure and technological equipment are accessible. It is necessary to understand that some of these people may not be able to continue their studies and are unable to obtain the necessary qualifications for a particular activity, due to restrictions in the educational environment itself.

Among the limitations of this research, one can mention the scarce economic literature that deals with people with disabilities, especially with regard to rehabilitated professionals. In addition, there are restrictions in the databases that are disclosed, for example, in the case of RAIS, which does not have any variables related to the degree of limitation of people with disabilities, which generates a lack of information about the nature of the limitation as well as the degree of disability, which can limit the occupations that these people may be inserted in.

Therefore, the results found suggest that the condition of those individuals which went through a professional rehabilitation and an occupational change in the formal job market, in a way, is improving, but there are still many workers who, due to their limitations, may be unemployed or working in the informal market, who were measured in this work. This reinforces the Government's performance in compliance with the Brazilian Quota Law, which aims to include these people in the job market, as well as reinforcing the attention that companies must have, and the appropriate working conditions that must be offered to workers, to avoid accidents at the workplace.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors wish to thank the Brazilian Ministry of Labor (Ministério do Trabalho – Mtb) for providing access to the RAIS (Relação Anual de Informações Sociais) database

Appendix A

Table 1.A

Effects dynamic of occupational changes after the rehabilitation process on Hourly wages

Hourly wages	Industry	Commerce and Services
Immediate occupational changes: Year –1	0.7031	–0.6533
Immediate occupational changes: Year 0	2.7187***	2.6300***
Immediate occupational changes: Year + 1	0.8805	1.0568***
Test parallel trend 1	YES	YES
Test parallel trend 2	YES	YES
No immediate occupational changes: Year –3	–0.4406	0.5363
No immediate occupational changes: Year –2	–0.4212	0.1052
No immediate occupational changes: Year –1	–0.0870	2.3993
No immediate occupational changes: Year 0	4.4359***	–3.1672
No immediate occupational changes: Year + 1	1.0477	0.2192
No immediate occupational changes: Year + 2	1.8815***	–1.2497
No immediate occupational changes: Year + 3	0.6696	1.5618
Test parallel trend 1	YES	YES
Test parallel trend 2	YES	YES

Source: Prepared by the authors using data from the RAIS (Mtb, 2021).

Note: Result of the estimation of Eq. (2) under the benchmark specification with covariates, and fixed effects for cpf, which meets the common trend criteria.

Appendix B. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.worlddev.2022.105859>.

References

- Anuário Estatístico Da Previdência Social: Aeps 2015 (2016) - Ministério Da Fazenda – Vol. 24 – . – Brasília: Mf, 917 P.
- Bae, S.W., Oh, S.S., Park, W.M., Roh, J., & Won, J.U. (2019). Changes In Income After An Industrial Accident To Industry And Return-To-Work Status. *International Journal Of Environmental Research And Public Health*. Public Health 2019, 16, 2603; doi:10.3390/ijerph16142603.
- Becker, M. L. (2019). Deficiência, Emprego E Salário No Mercado De Trabalho Brasileiro. *Estudos Econômicos, São Paulo*, 49(1), 39–64.
- Ben Halima, M. A. (2005). The Determinants For Labour Contract Length. A French Micro-Econometric Study. Gate Working Paper No. 05-03, *Gate Groupe D'analyse Et De Théorie Économique*. https://Papers.Ssrn.Com/Sol3/Papers.Cfm?Abstract_Id=907410. Access In: May 26th, 2021..
- Button, P. (2017). Expanding employment discrimination protections for individuals with disabilities: Evidence from California. *ILR Review*. <https://doi.org/10.1177/0019793917716633>.
- Callaway, B., & Sant'anna, P. H. C. (2020). Difference-in-differences with multiple time periods. *Journal of Econometrics*. <https://doi.org/10.1016/j.jeconom.2020.12.001>.
- Castro, N. R., Moreira, G. C., & Silva, R. P. (2019). Wage structure differential and disability in Brazil – Underperformance or discrimination? *Economia*, 20(3), 211–228.
- Costa, E. M.; Sousa, D. T. & Guimarães, D. B. (2015) Decomposição Dos Diferenciais De Rendimentos Por Cor E Gênero No Mercado De Trabalho Brasileiro: Uma Análise Por Níveis Ocupacionais Nas Regiões Metropolitanas. In: *Economia Do Ceará Em Debate*, 11, *Anais Do Xi Encontro De Economia Do Ceará Em Debate*, Fortaleza.
- Deleire, T. (2001). Changes in wage discrimination against people with disabilities. *The Journal of Human Resources*, 36(1), 144–158. <https://doi.org/10.2307/3069673>.
- Fitzenberger, B., & Kunze, A. (2005). Vocational training and gender: Wages and occupational mobility among young workers. *Oxford Review of Economic Policy*, 21(3), 392–415.
- Foguel, M. N. Diferenças Em Diferenças. (2012) In: Menezes-Filho, N. (Org.). *Avaliação Econômica De Projetos Sociais*. 1 Ed. São Paulo: Dinâmica, P. 69–83.
- Gonçalves, S., Rodrigues, T. P., & Chagas, A. L. S. (2020). The impact of wind power on the Brazilian Labor Market. *Renewable and Sustainable Energy Reviews*, 128 109887.
- Guimarães, D. B. (2013) *Avaliações De Abordagens Metodológicas Da Equação De Rendimentos Aplicadas Em Cenários Selecionados No Mercado De Trabalho*. 117f. Doctoral Thesis – Universidade Federal Do Ceará. Programa De Pós Graduação Em Economia, CAEN.

- Gunderson, M., & Lee, B. Y. (2016). Pay discrimination against persons with disabilities: Canadian evidence from Pals. *The International Journal Of Human Resource Management.*, 47(14), 1549–1553.
- ILO – International Labour Organization (1925). C019 - Equality Of Treatment (Accident Compensation) Convention, 1925, 7thsession.Geneva.
- Kambourov, G., & Manovskii, I. (2008). Rising occupational and industry mobility in the United States: 1968–97. *International Economic Review*, 49(1), 41–79.
- Kambourov, G., Manovskii, I., & Plesca, M. (2020). Occupational mobility and the returns to training. *Canadian Journal of Economics.*, 53(1), 174–211. <https://doi.org/10.1111/Caje.12421>.
- Longui, S., Nocoletti, C., & Platt, L. (2012). Interpreting wage gaps of disabled men: The roles of productivity and discrimination. *Southern Economic Review.*, 78, 931–953.
- Mariano, F. Z. & Costa, G. M. (2015) Comportamento Dos Diferenciais Dos Salários No Brasil: Evidências Por Índice De Theil Em Categorias Ocupacionais. *In.: Anais Do IV Encontro Pernambucano De Economia.*
- Mincer, J. (1974). *Schooling, Experience and Earnings*. New York: National Bureau For Economic Research.
- Mtb - Ministério Do Trabalho. Available At: <[Http://Www.Rais.Gov.Br/Sitio/Index.jsf](http://www.rais.gov.br/Sitio/Index.jsf)>Access In: June 2nd, 2021.
- Oliveira, J. M., Araújo, J. N. G., & Romagnoli, R. C. (2006). Dificuldades Relativas À Inclusão Social Das Pessoas Com Deficiência No Mercado De Trabalho. *Latin-American Journal of Fundamental Psychopathology On Line, São Paulo*, 6(1), 77–89.
- Parrado, E.; Caner, A. & Wolff, E.N. (2007) Occupational And Industrial Mobility In The
- Suliano, D. C., & Miro, V. H. (2014). Existe igualdade na terra da luz? *Economia e Desenvolvimento*, 26(1).
- World Health Organization (WHO). (2011). The World Bank. World Report On Disability. *WHO, Genebra.*
- Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). The MIT Press.