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Investing in Technical & Vocational Education and Training

Does It Yield Large Economic Returns in Brazil?

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Abstract

Technical education and training has been dramatically expanding in Brazil recently. However, there remains no evidence on the cost effectiveness of this alternative track to a more general education. This paper quantifies the wage returns of completing technical and vocational education and training compared with the returns of completing the general education track, for individuals with similar observable characteristics. Exploring data from the Brazilian National Household Sample Survey, the paper profiles the students taking up this track and quantifies the impact of different types of technical and vocational education and training courses on individuals' hourly wages. After controlling for selection on observables with propensity score matching, the analysis shows positive and statistically significant wage premiums for students completing technical school at the upper secondary level (on average 9.7 percent) and for those completing short-term training courses (2.2 percent on average). The paper also documents significant heterogeneity of impacts depending on the courses and the profile of students. For realistic unitary costs of providing technical and vocational education and training, the evidence suggests technical education is a cost-effective modality. The courses offered by the publically financed and privately managed "Sistema S," together with courses in the manufacturing area have the highest positive impacts.

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Investing in Technical & Vocational Education and Training: Does It Yield Large Economic Returns in Brazil?[1]

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1. Introduction

The accumulation of human capital through formal education has two possible routes. One route is a more general education that aims to provide general knowledge in a variety of subjects, typically allowing for more flexibility in choosing a profession later on in life. The other route is technical-vocational education and training (TVET), which aims to prepare students/trainees for specific occupations in the labor market. TVET provides young individuals with more opportunities for insertion into the labor market in the short run but can generate more difficulties in finding employment at advanced ages due to the more specific skill set acquired from this education (Hanushek, Woessmann, and Zhang, 2011).

In Brazil, there is increasing education of the workforce and declining wage differences between high and low-skilled workers. In this context, technical-vocational education is presented as an important educational policy option.[2] Acquiring a suitable qualification level to work in the labor market is a common requirement to obtain a job (Aedo and Walker, 2012; Menezes Filho, 2012). A TVET course can provide students with the appropriate skills to enter the labor market in possibly a shorter period, and with higher productivity compared with regular education classes. However, usually technical and vocational education has a higher cost than regular education, so it is important to weigh its costs and benefits to ultimately quantify its returns. This paper analyzes the individual wage returns from completing a TVET course compared with a more general education. We also analyze the heterogeneity of these impacts and the probability of entering the labor market or tertiary education for individuals with a technical-vocational education background compared to those with a more general education.

We explore data from the professional education supplement of the *Pesquisa Nacional por Amostra Domiciliar* – PNAD – (National Household Sample Survey) published by the *Instituto Brasileiro de Geografia e Estatística* – IBGE (Brazilian Institute of Geography and Statistics) in 2007. To our knowledge this database is the best survey available for this purpose given the extent of information on the socioeconomic characteristics of the individuals who attended a technical-vocational education course as well as the details about the various types of this education. Furthermore, PNAD is a representative database for Brazil capturing both the formal and the informal sectors.

In the empirical work, we will focus on three types of technical-vocational education and training programs: i) technical education at the upper secondary level; ii) technical education at the

[2] See trends documented with *Pesquisa Nacional por Amostra Domiciliar* – PNAD - (National Household Sample Survey) in 1992, 1997, 2002, 2007, and 2012 and presented by Almeida et al. (2014). See Almeida et al. (2014) regarding education and wage trends in Brazil.

tertiary level; and iii) Initial and Continuing Training programs (short term training courses). These different options attract different types of students and likely lead to different impacts in the labor market. Because of this diversity, we create different control groups for each of the categories.[3] The idea is that individuals in those control groups share similar observable and unovbservable characteristics to the TVET students, including educational level, gender, geographic location, and employment characteristics, except for the fact that they never attended a TVET course. Given the heterogeneity of TVET courses we divided further the analysis for different groups: i) technical education at the general upper secondary level; ii) technical education after completion of regular upper secondary education; iii) technical education combined with regular upper secondarylevel; iv) technical education at the tertiary level; and v) short term training courses. Category i includes categories ii and iii, respectively.

Our empirical approach starts by exploring a reduced form Mincerian equation relating differences in hourly wages to different observable characteristics of the graduates, including whether they completed general or technical education. Our main coefficient of interest quantifies the differences in hourly wage between the two types of graduates, technical vs. general. However, a simple comparison of wages poses a major problem as the educational variable capturing technical education is likely endogenous. Participating in TVET is a choice for students that is most likely related to the student's individual characteristics, which, in turn, are related to their labor productivity and wages. If we do not control for these characteristics in a flexible manner, our reduced form impact estimates of technical education on wages, using OLS, will likely be biased because students can self-select for technical-vocational education in accordance with their distinct characteristics. Therefore, to minimize the self-selection problem and because we observe a wealth of student characteristics in PNAD , we explore propensity-score matching .

Our results are interesting. Students who have completed a technical education course at the general upper secondary level earned an hourly wage that was 9.7% higher on average than a student who completed regular secondary education. In addition, individuals who completed a short term training course earned an average hourly wage 2.2% higher than that those who worked and had never taken a TVET course. Interestingly, individuals who completed a technical education course at the tertiary level showed similar hourly wages to those with regular education at the

[3] A description of the technical-vocational education system in Brazil is briefly presented in section 3. Technical education at the upper secondary level in Brazil is divided into three types (subsequent, concurrent, and integrated). In 2013, 792,685 students were enrolled in the subsequent type, 338,390 in the integrated type, and 309,976 in the concurrent type. In 2007, 371,655 students were enrolled in the subsequent type, 86,009 in the integrated type, and 311,869 in the concurrent type. For more information about the different types of TVET course see section 4.1.

tertiary level. These results suggest that the effect of tertiary courses outweighs the effects of technical-vocational courses. Furthermore, we found that individuals who had completed a technical education course at the tertiary level had an average hourly wage that is 71.4% higher than those who had only completed regular secondary education. These results provide evidence that completing a technical education course at the tertiary level is much more beneficial than completing a general secondary education course and ceasing further education.

We also found very significant heterogeneity patterns between the different modes of technical education. The results indicate that technical-vocational courses held in Sistema S institutions had the greatest impact on the individuals' hourly wages. In addition, taking TVET focused on the "manufacturing" sector had the greatest impact on hourly wages (+32.9% on average) compared with those completing general upper secondary education. Among those who completed a short term training course, the greatest impact on hourly wages were courses in the sectors of "health or welfare" (+15.4% on average), "manufacturing or maintenance" (+11.6% on average) and "commerce or management" (+11.3% on average).

Our findings also show that the impact of technical courses at the upper secondary level was lower for older individuals. This could suggest the dissipation over time of the impact of these courses on the individual's hourly wages or could be capturing the fact that TVET provision may be increasingly aligned with the needs of the labor market over time. Furthermore, although the impact of technical courses at the secondary level was similar for individuals who reside in metropolitan or non-metropolitan areas, the greatest impacts of technical courses at the secondary level are in the Central-West, North, and Northeast regions. For short term training courses, the greatest impacts are in the North, Northeast, and South regions.

We also examined the insertion in the labor market and the likelihood of transtioning to tertiary education. Results show that those who completed a technical education course at the upper secondary level had the same chances of attending or having already attended tertiary education as those taking general education. This probability was higher for those individuals who took the technical track simultaneously with regular education, when compared to those taking the general track. Those individuals who completed a technical-vocational education course were more likely to be working or looking for work compared to those who pursued more general forms of education.

Finally, we compute the maximum cost for technical-vocational education courses that would lead this investment to break even. Assuming that TVET courses at upper secondary level last on average one year, to be economically viable the total cost could be at most R$ 2,398.3 per month. For short term training courses , the maximum amount would be R$ 613.6 per month.

Our paper relates closely to a large literature that quantifies the impact on the labor market – looking at employability and wages - of students who complete technical-vocational education compared with general education students. The evidence from Brazil is quite small, but some studies have shown a positive wage gap for students who have completed a technical-vocational education course in relation to those who pursued only general education. Neri (2010) explores OLS and PNAD data and finds a wage premium of 15.1% for individuals who have completed a technical education course at the secondary level and 23.3% for individuals who completed a technical education course at the tertiary level. He finds different returns for short term training courses across sectors (11.5% in "commerce and management", 8.4% in "manufacturing and maintenance", and 7.7% in "health and welfare"). Vasconcellos et al. (2010) explore a methodology similar to ours but use fewer control variables. They find wage gains of 12.5% due to completion of a technical education course at the secondary level.

This topic is also of great relevance in many other developiong countries. Tan and Nam (2012) in Almeida, Behrman, and Robalino (2012) summarize the most recent studies in developing countries. Table 1 summarizes this literature and shows that the evidence is not as robust as the main findings for Brazil.

Table 1: Returns to TVET in selected countries.

Country and Year	Impact on Earnings	Methodology	Author(s)
Studies showing more favorable results for TVET than for general education			
Egypt (1998)	Returns to vocational secondary education are 35.4%, while returns to general secondary education are 6.1% for men.	Mincerian earnings regression (1st stage: ordered logit)	El-Hamidi (2006)
Singapore (1998)	Returns to vocational/technical education are 10.3% at the secondary level and 12.7% at the post-secondary level, compared with the corresponding figures of 9.4% and 11.3% for general education.	Extrapolation of Mincer equation results from 1980s Singapore data	Salkeriou (2003)
Sri Lanka (2002)	Returns to formal vocational training are 17 % compared with7.9% for general education.	Mincerian earnings regression (not controlling for selectivity bias)	Riboud, Savchenko, Tan (2007)
Thailand (1989-1995)	Returns to vocational education at the upper secondary level exceed those to general education by 63.9 percent for men and 49.4 percent for women.	Mincerian earnings regression (1st stage: probit)	Moenjak and Worswick (2003)
Israel (1983)	Vocational school graduates employed in occupations related to their field of study earn between 8.1 percent (widely related) and 9.6 percent (directly related) more than peers that graduated from general education or that are working in fields unrelated to their studies.	Mincerianearnings regression (OLS, without first stage)[1]	Neuman and Ziderman (1991)

Malasya & Tailand (circa 2005)	Average wage returns to on-the-job training are 7.7% for Malaysia and 4.5% for Thailand. Returns are higher for males than for females in Malaysia and that, for both countries, returns are higher for workers with at least secondary education.	PSM	Almeida and Faria (2014)
Studies showing no difference or mixed results			
India (2004)	Returns to formal vocational training are approximately 8%, comparable to returns to general education at 8.4%.	Mincerian earnings regression (not controlling for selectivity bias)	Riboud, Savchenko, Tan (2007)
East Germany (1984-1996)	No advantage in earnings or employment among graduates of public-sector-sponsored continuous vocational training and retraining in the first years following training.	Propensity matching score techniques	Lechner (2000)
Romania (1995-2000)	No significant differences exist in labor market participation or earnings between vocational and general education students.	Regression discontinuity	Malamud and Pop-Eleches (2008)
Tanzania (1997-2000)	Returns are higher for high levels of academic education than for vocational or lower levels of academic education; the returns to vocational or technical education are lower the higher the level at which it is entered.[2]	Mincerian earnings fixed effects regression	Kahyarara and Teal (2008)
Indonesia (1993, 1997, 2000, 2007)	No significant differences exist in labor market outcomes between public general and public vocational school graduates. Private vocational school graduates have same (OLS) or higher (LAD) rates of return than public school graduates.[3]	Mincerian earnings regression (OLS and LAD) (1st stage: multinomial logit regression)	Newhouse and Suryadarma (2009)
Turkey (2009-2012)	Small and insignificant effect of trainings on employment and earnings	RCT	Hirshleifer et al (2014)
Studies showing less favorable results for TVET than for general education			
Pakistan (2004)	Returns to formal vocational training are 8.1%, while returns to general education are slightly higher at about 9%.	Mincerian earnings regression (not controlling for selectivity bias)	Riboud, Savchenko, Tan (2007)
Rwanda (1999-2001)	Returns to vocational education are 12.5%, while returns to general secondary education are 29.0%.	Mincerian earnings regression (1st stage: multinomial logit)	Lassibille and Tan (2005)
Suriname (1990, 1992, 1993)	Returns to general language and mathematics tracks exceed returns to technical or vocational education for both males and females.[4]	Mincerian earnings regression (1st stage: probit regression)	Horowitz and Schenzler (1999)

1. No first stage because selectivity bias is controlled by comparing vocational education graduates employed in matched or study-related occupations versus their general education counterparts.
2. The returns for those who enter vocational schools after primary school are estimated at 9.6% compared with 8.8% for those who enter after completing lower secondary school, and only 3.2 % for those who enter after completing upper secondary school. Similarly, the returns for those that enter technical colleges after completing lower secondary school are estimated at 10.5% compared with 7.3% for those that enter after completing upper secondary school.
3. Private general school graduates earn 27.8 percent less wages than public school graduates while private vocational

school graduates earn 18.8 percent less wages than public school graduates.

4. For males, the private returns to technical secondary education are 10.4%, compared with 11.6% for general education (U track), 12.3% for the general language track, and 11.2% for the general mathematics track. For females, the returns to vocational secondary education are 2.5%, compared with 12.3% for the general language track, and 11.6% for the general mathematics track.

Sources: Author's based on Tan and Cho (2012). see Annex 1 of Tan and Cho for detailed description of data sources.

Table 1 shows that several studies find positive private returns for technical-vocational education while others find negative premiums, even after controlling for selection and endogeneity. However, these heterogeneous results may also reflect data limitations as there is often no information about the different types of programs and their modalities. In this sense, the data that we used in this study for Brazil provides much more detail on the technical-vocational education provided than in other countries.

This paper is organized as follows. Section 2 presents the methodology used in the quantitative analyses, and the data sources explored are presented in section 3. The main results are described in section 4. Section 5 presents the results on the heterogeneity of technical-vocational courses, and section 6 presents the results on entry in the labor market and individuals who attended tertiary levels of education in addition to technical-vocational education. Section 7 provides an analysis on the maximum costs for technical-vocational education courses and section 8 concludes.

2. Empirical Methodology

Our main objective is to examine the effect of completing a certain type of technical-vocational education course on the wages of individuals who work in relation to a similar comparison group.[4] However, this analysis poses a fundamental problem. Students who pursue a technical career are most likely different, in various observable and unobservable characteristics, from other students who opt for a more general education. Moreover, these characteristics are most likely linked to the individual productivity and wages in the labor market, which makes it difficult to quantify the wage impact of this type of education.

We start by estimating a simple Mincerian equation where we relate hourly wages with several characteristics of the students.

$$log(hour\_wage_i) = \alpha + \beta_1 edutec_i + \sum_{j=2}^{n} \beta_j x_{i,j-1} + u_i \quad \text{(a)}$$

[4] Our group of interest are those individuals who completed a specific type of education (technical-vocational, or regular), had a job during the reference week, and were 14 years of age or older.

where $log(hour\_wage_i)$ represents the logarithm of the hourly wage from the main job of individual i. The $edutec_i$ variable is a binary variable that takes the value 1 if individual i has completed a certain type of technical-vocational education course and 0 if the individual belongs to the comparison group. *x* represents the observable variables of individual i. u_i is the error term. Our coefficient of interest is β_1. We will estimate equation (a) for different samples using ordinary least squares (OLS). In each analysis, the $edutec_i$ variable will be conditional to a treatment group and to a control group.

We then adopt a more flexible and robust method to control for observable differences between the treatment and control groups ("selection on observables"): propensity-score matching. For the methods based on the selection on observables to produce unbiased estimates, it is necessary that the following condition of conditional independence be met:

$$log\ (hour\_wage_i\ (edutec_i = 1)),\ log\ (hour\_wage_i\ (edutec_i = 0)) \perp edutec_i \mid X \qquad (1)$$

where the potential hourly wage of the comparison group "sal_hora_i $(edutec_i = 0)$" and the potential hourly wage of those who completed a technical-vocational education course "($hour\_wage_i$ ($edutec_i$ = 1)" is independent from the group ($edutec_i$) in which the individual is included.[5] X is the vector of observable variables of individual i. Another important assumption to identify the effect of technical-vocational education on wages (for matching) is known as the common support assumption - there is no value that the explanatory variables contained in vector X may assume for which one can say with certainty to which group (control or treatment) the individual belongs. By defining p(x_i) = *Probability* ($edutec_i$ = 1 | $X = x_i$), known as the propensity score ("*p-score*"), this condition can be written as follows:

$$0 < p(x_i) < 1 \ \forall \ x_i \qquad (2)$$

The combination of conditions (1) and (2) is known as strong ignorability.

Equation (3) below, based on the p-score known as "propensity-score matching", uses the result where, under ignorability, the independence between the potential results and the choice of treatment is maintained only when conditioned to the propensity score (Rosenbaum and Rubin, 1983). That is, in subpopulations with the same p(X) value, the explanatory variables are independent of the choice of treatment and therefore cannot cause bias. In this study, this condition can be written as:

[5] If the conditional independence condition is not met, robust methods should be used for selection on non-observables. We performed regressions with instrumental variables with OLS estimations in two stages to control for these non-observable characteristics. However, the tests performed did not reject the exogeneity of the effect of technical-vocational courses on hourly wages. See Annex.

$log\ (hour\_wage_i\ (edutec_i = 1)), log\ (hour\_wage_i\ (edutec_i = 0)) \perp edutec_i \mid p(X)$ (3)

where all of the variables are defined as above. In practice, however, the true p(X) is not known, so we must estimate a model for it. The p(X) function was estimated from a logit model where the dependent variable is $edutec_i$, and the control variables are the same as used in the matching. Based on the estimated p-score ($\hat{p}(X)$), we performed matching with the Nearest-Neighbour method. We used matching with a single neighbor and with replacement, *i.e.*, we can consider the same control individual ($edutec_i$ = 0) in several matching cases with treatment individuals ($edutec_i$ = 1). We also used the common support condition that restricts the sample of individuals in the control group to only those that are comparable with the treatment group (Dehejia and Wahba, 1999; Caliendo and Kopeinig, 2008).

We estimate the propensity score using a logistic regression in which the *edutec* binary variable is a dependent variable. In the logistic model, we assume that the probability of completing a technical-vocational education course follows the following model:

$$\Pr[edutec_i = 1 \mid X] = \frac{\exp(x\beta)}{1+\exp(x\beta)} \quad (4)$$

where all of the variables are as defined earlier.

In both estimation models, by ordinary least squares and propensity-score matching models, we used the same vector of control variables (*X*). This vector includes experience in the labor market, potential experience in the labor market, a binary variable indicating whether the individual is self-employed or is an employer, a binary variable indicating whether the individual's main job is in the agricultural sector, a binary variable for each economic activity sector, and a binary variable for each occupation. We also included as controls a binary variable indicating whether the individual is male, the age and squared age of the individual, a binary variable indicating whether the individual is white, a binary variable indicating whether the individual is pursuing a tertiary education, and a binary variable indicating whether the individual has completed a tertiary education course. The housing control variables include a binary variable indicating whether the individual lives in an urban center, a binary variable indicating whether the individual lives in a metropolitan area, and a binary variable indicating whether the individual lives in each Brazilian region (North, Northeast, Central-West, Southeast, and South).

3. Data and Sample

3.1. Descriptive Data and Statistics

We used the *Pesquisa Nacional por Amostra Domiciliar* database – PNAD – (National Household Sample Survey) published by *Instituto Brasileiro de Geografia e Estatística* – IBGE - (Brazilian Institute of Geography and Statistics) annually in Brazil. The PNAD collects socioeconomic data on individuals in a sample of households in Brazil. In addition to the collection of permanent variables (work characteristics, education, income, and housing), the PNAD periodically conducts additional research to include other topics such as healthcare characteristics and characteristics of other education types (technical-vocational education, for example). The PNAD is a sample survey but is representative of Brazil. In 2007, the PNAD conducted a supplementary survey that sought to verify the technical-vocational education of the Brazilian population. Hence, we can examine the portion of the population who attends or has attended any technical-vocational course, as well as the course type and other features. A significant portion (23.8%) of the Brazilian population[6] was attending or had already attended technical-vocational education in 2007.

We consider three types of technical-vocational education that we can observe in the data: i) technical education at the upper secondary level; ii) technical educational at the tertiary level; and iii) short term training courses. Technical education courses at the upper secondary level (which will be called TEC for the remainder of the paper) can be attended by students who are pursuing or have completed a general education course and are further divided into subsequent, concurrent and integrated courses. Subsequent courses are technical courses that require the completion of general upper secondary education for attendance. Concurrent courses are technical courses that take place during the same period in which the individual pursues general upper secondary education, but they usually take place at different schools. Integrated courses include general upper secondary education and technical education courses in the same curriculum and at the same school.[7] Short term training courses refers to a short technical course that aims to prepare the student to carry out a professional activity without a specific concern for regular education. Thus, short term training courses do not require a minimum educational level, can be provided by any institution, and include a wide variety of courses. Short term training courses are also called Initial and Continuing Education courses (for the remainder of the article, we will refer to such courses as FIC [*Formação Inicial e Continuada*]).

In sum, in the empirical work we consider 5 different groups:[8] 1) Individuals who have completed a general TEC course (including all types of TEC courses); 2) individuals who have

[6] Population age 14 or older.

[7] See Almeida, Amaral and Felicio (forthcoming) for more detail on the structure of technical-vocational education in Brazil.

[8] The PNAD considers only the most important technical-vocational course that the person has completed, so there is a possibility of data sub-measurement because we have no information whether the person pursued only one or more than one technical-vocational course.

completed a TEC course after completion of general secondary education (subsequent); 3) individuals who have completed a TEC course concurrently with general secondary education (concurrent or integrated); 4) Individuals who have completed a technical education at the tertiary level; and 5) Individuals who have completed an FIC course.

Regressions are conducted on each of the five groups so that each represents a different treatment group. We also specifiy different control groups for each treatment group. For the first (1st), second (2nd), and third (3rd) treatment groups, we use as controls individuals who have completed general upper secondary education and never pursued a technical-vocational education. For the fourth (4th) group, we use individuals who have completed only academic education (tertiary level) and have not pursued technical-vocational education. For the fifth (5th) group, we use individuals who was working in 2007 and never pursued a technical-vocational education. We restrict the attention to the group of individuals aged fourteen or older who worked during the reference week.

In the descriptive analisis reported here, we grouped the categories "Completed TEC", "Completed TEC after general education" and " Completed TEC concurrently with general education " and they all have the same control group, "Completed general education only". The category "Completed technical education at tertiary level" has the control group "Completed academic tertiary education". The category Completed FIC" has the control group "Worker without technical-vocational education", in which “Worker” refers to the employed individual, who worked during the reference week. We performed t-tests of mean differences between the analysis groups and the control groups, and the symbol “*” represents a mean difference at 10% significance. To interpret the data, we used the separation described below. First, we show the results for the control group, followed by the results for the treatment group. Again, groups 2, 3, and 4 have the same control group (1).

Table 2 shows the mean values of the hourly wage logarithm and the variables used in its construction for the different groups. Hourly wages were obtained based on the individual’s monthly salary from his or her main occupation divided by the number of hours worked per week, adjusted by a 30/7 factor.

Table 2 – Mean Wages by Group

	Individuals with general upper secondary education (1)	Individuals with TEC (at upper secondary) (2)	Inidividuals with TEC *after* general education (at upper secondary) (3)	Individuals with TEC *concurrently* with general education (at the upper secondary level (4)	Indiviudals with academic tertiary education (5)	Individuals who completed a technical course at the tertiary level (6)	Worker without technical-vocational education (7)	Inidiv. who finished FIC (8)
Mean hourly wage logarithm:	1.7	1.8*	1.8*	1.9*	2.5	2.4	1.1	1.4*
Mean monthly wage (R$):	1,496.5	1,518.1	1,346.8*	1,668.4*	2,817.9	3,092.1	837.7	996.5*
Average working hours in a week:	40.3	40.5	40.8*	40.3	38.3	40.4*	41.3	41.0*
Mean hourly wage (R$):	9.7	10	8.6*	11.2*	18.5	18.4	5.4	6.4*
No. of observations:	35,564	7,213	3,370	3,843	10,380	189	114,457	31,782

Note: * Mean values diferences statistically significant at 10%. The sample includes individuals with 14 years of age or more and who was working at the reference week. R$ stands for Brazilian currency (Real).

Table 3 reports means in observable characteristics for the different groups. The characteristics related with work status, include average working experience in the labor market, average potential experience in the labor market, the proportion of individuals who were self-employed or employers, and the proportion of individuals whose main job was in the agricultural sector.[9] We also considered the sector and occupation of the individual's main job as controls in the estimations. Sectors were divided into 14 categories according to the *Classificação Nacional de Atividades Econômicas Domiciliar* – CNAE – (National Classification of Economic Activities - Households). Occupations are divided into 11 categories according to the *Classificação Brasileira de Ocupações Domiciliar* – CBO – (Brazilian Classification of Occupations – Households).

Personal charcateritsics include the proportion of males, average age (and its square), proportion of white individuals, average education level, proportion of individuals attending tertiary education, and proportion of individuals who completed tertiary education.

Table 3 – Descriptive statistics

	Individuals with general upper secondary education (1)	Individuals with TEC (at the upper secondary level (2)	Inidividuals with TEC after general education (at the upper secondary level	Individuals with TEC concurrently with general education (at the upper secondary level	Indiviudals with academic tertiary education (5)	Individuals who completed a technical course at the tertiary level	Worker without technical-vocational education (7)	Inidividuals who finished FIC (8)

[9] Experience in the labor market was calculated based on the individual's age in the reference year by subtracting the age when the individual started working. Potential experience was obtained from the individual's age in the reference year and subtracting the schooling years and years before the individual started school (we consider that an individual starts school at the age of seven in the 1st grade, so we subtracted seven years)

			(3)	(4)		(6)		
Average age of entrance into the labor market (in years):	16.6	16.3*	16.4*	16.2*	18.0	16.6*	14.4	15.2*
Average working experience in the labor market (in years):	18.5	19.9*	19.0*	20.7*	22.0	21.6	23.1	20.0*
Average potential experience in the labor market (in years):	15.6	16.9*	16.5*	17.3*	17.5	16.1	23.3	18.3*
Proportion who were self-employed/employers:	0.21	0.20*	0.17*	0.22	0.22	0.22	0.30	0.26*
Proportion who had agriculture job:	0.02	0.02*	0.12*	0.02	0.01	0.02	0.14	0.03*
Sector of activity:								
Agriculture	0.02	0.02*	0.01*	0.02	0.01	0.02	0.14	0.03*
Extractive industries	0.00	0.01*	0.01*	0.01*	0.00	0.01	0.00	0.00
Manufacturing	0.12	0.15*	0.16*	0.15*	0.07	0.17*	0.14	0.17*
Construction	0.03	0.03	0.02	0.03	0.02	0.04*	0.09	0.05*
Commerce and repair	0.22	0.16*	0.16*	0.17*	0.10	0.13*	0.19	0.21*
Lodging and food	0.03	0.02*	0.02*	0.02*	0.01	0.02	0.04	0.04
Transportation, warehousing and communications	0.05	0.04*	0.05	0.04*	0.03	0.03	0.05	0.06*
Financial services	0.03	0.03	0.02*	0.03	0.05	0.05	0.01	0.02*
Real estate activities and service activities	0.10	0.12*	0.12*	0.11*	0.13	0.15	0.06	0.10*
Public administration	0.11	0.10*	0.09*	0.12	0.15	0.09*	0.05	0.07*
Education	0.14	0.13*	0.07*	0.17*	0.27	0.17*	0.05	0.07*
Health and social services	0.06	0.14*	0.22*	0.08*	0.12	0.06*	0.03	0.05*
Others collective, social and personal services	0.04	0.04*	0.03*	0.04	0.03	0.05	0.04	0.08*
Household activities	0.03	0.01*	0.01*	0.02*	0.00	0.00	0.10	0.05*
Occupation:								
Management	0.10	0.10	0.09*	0.11*	0.16	0.19	0.05	0.06*
Sciences and arts professional	0.19	0.15*	0.10*	0.19	0.52	0.39*	0.07	0.08*
Technician with secondary level of education	0.13	0.31*	0.38*	0.25*	0.13	0.18*	0.06	0.12*
Administrative services	0.17	0.15*	0.15*	0.15*	0.10	0.12	0.08	0.13*
General services	0.12	0.08*	0.09*	0.08*	0.02	0.03	0.23	0.22*
Sales and commerce services	0.12	0.08*	0.07*	0.08*	0.03	0.04	0.11	0.11
Farming	0.02	0.01*	0.01*	0.02	0.01	0.01	0.14	0.03*
Production/manufacturing	0.12	0.09*	0.09*	0.08*	0.02	0.04*	0.24	0.20*
General maintenance and repair	0.01	0.02*	0.03*	0.02*	0.00	0.01	0.02	0.03*
Military	0.02	0.01*	0.01*	0.01*	0.01	0.01	0.01	0.01*
Others	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Proportion of male:	0.50	0.51	0.5	0.52*	0.44	0.56*	0.62	0.55*
Average age (in years):	35.2	36.2*	35.4	36.9*	40.0	38.2*	37.5	35.2*
Average squared age (in years):	1,371.3	1,420.9*	1,362.6	1,472.0*	1,729.4	1,577.8*	1,586.5	1,383.7*
Proportion of white:	0.59	0.59	0.57*	0.61*	0.73	0.75	0.45	0.50*
Average of years of education:	12.6	12.3*	12.0*	12.6	15.5	15.0*	7.3	9.9*
Proportion who was attending tertiary education:	0.12	0.14*	0.13*	0.15*	0.00	0.00	0.04	0.07*
Proportion who completed tertiary education:	0.29	0.22*	0.15*	0.28	1.0	1.0	0.09	0.11*

No. of observations:	35,564	7,213	3,370	3,843	10,380	189	114,457	31,782

* Mean values diferences statistically significant at 10%. The sample includes individuals with 14 years of age or more and who was working at the reference week.

In table 4 we also compare composition of groups regarding the distribution of individuals across quintiles of per capita income.

Table 4 – Quintiles of family income

Groups of average per capita family income:	Individuals with general education at the upper secondary level only (1)	Individuals with TEC (at the upper secondary level (2)	Inidividuals with TEC after general education (at the upper secondary level (3)	Individuals with TEC concurrently with general education (at the upper secondary level (4)	Indiviudals with academic tertiary education (5)	Individuals who completed a technical course at the tertiary level (6)	Worker without technical-vocational education (7)	Inidividuals who finished FIC (8)
1 to 20% (poorest)	0.02	0.01*	0.01*	0.01*	0.00	0.01	0.12	0.04*
21 to 40%	0.08	0.04*	0.04*	0.04*	0.01	0.01	0.19	0.12*
41 to 60%	0.16	0.12*	0.13*	0.12*	0.04	0.03	0.23	0.21*
61 to 80%	0.24	0.25*	0.28*	0.23	0.12	0.11	0.23	0.28*
81 to 100% (richest)	0.50	0.57*	0.54*	0.60*	0.83	0.84	0.24	0.35*
No. of observations:	34,803	7,096	3,317	3,779	10,098	186	112,507	31,267

* Mean values diferences statistically significant at 10%. The sample includes individuals with 14 years of age or more and who was working at the reference week.

Housing features include the proportion of individuals living in urban centers, the proportion who lived in metropolitan areas, and the proportions who lived in each of the five Brazilian regions (table 5).

Table 5 - Housing

	Individuals with general education at the upper secondary level only	Individuals with TEC (at the upper secondary)	Inidividuals with TEC after general education (at upper secondary)	Individuals with TEC concurrently with general education (at the upper secondary level	Indiviudals with academic tertiary education	Individuals who completed a technical course at the tertiary level	Worker without technical-vocational education	Inidividuals who finished FIC
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Proportion who lived in urban centers:	0.96	0.96*	0.97*	0.96	0.98	0.97	0.84	0.94*
Proportion who lived in metropolitan areas:	0.47	0.46*	0.46	0.45*	0.51	0.41*	0.36	0.44*
Proportion who lived in North region:	0.12	0.10*	0.11	0.09*	0.09	0.05*	0.13	0.11*
Proportion who lived in Northeast region:	0.25	0.21*	0.22*	0.20*	0.21	0.14*	0.30	0.26*
Proportion who lived in Central-West region:	0.12	0.10*	0.09*	0.11*	0.15	0.12	0.12	0.13*
Proportion who lived in Southeast	0.35	0.38*	0.36	0.40*	0.38	0.47*	0.30	0.30*

region:								
Proportion who lived in South region:	0.15	0.21*	0.21*	0.20*	0.17	0.22*	0.15	0.20*
Nº de observações:	35,564	7,213	3,370	3,843	10,380	189	114,457	31,782

* Mean values diferences statistically significant at 10%. The sample includes individuals with 14 years of age or more and who was working at the reference week.

Results reported in tables 2, 3, 4 and 5 show that the groups used in our analysis report differences in all these characteristics, which will likely also affect differences in wages. We explore propensity-score matching to construct good control groups.

3.2. Propensity-Score Estimation

We compute the propensity-score for individuals completing a technical-vocational education course for different modalities. The propensity-score estimation is important as we do not know the true likelihood of individuals pursuing a technical-vocational education course and this is likely to vary depending of individual characteristics also correlated with wages. Table 6 presents the results of estimating equation (4) in section 2, considering the different modalities.

Table 6 – Logistic Regression for the Propensity-Score

Dependent variable:	Technical Education Dummy									
	TEC-geral		TEC – after general education		TEC – concurrently with general education		Technical education at the tertiary level[1]		FIC	
	(1)		(2)		(3)		(4)		(5)	
	coef	se	coef	se	coef	se	coef	se	coef	**se**
Experience	0.019	(0.004)***	0.011	(0.005)**	0.023	(0.004)***	0.058	(0.020)***	0.018	(0.002)***
Potential experience	0.078	(0.016)***	0.139	(0.025)***	0.033	(0.020)	0.580	(0.096)***	-0.188	(0.003)***
Self-employed / employers	-0.063	(0.038)*	-0.143	(0.055)***	0.036	(0.049)	-0.366	(0.213)*	0.053	(0.018)***
Agriculture job	1.099	(0.240)***	1.494	(0.333)***	0.857	(0.309)***	0.527	(1.014)	0.570	(0.104)***
Activity - extractive industries	1.277	(0.198)***	1.598	(0.259)***	0.951	(0.265)***	0.247	(1.087)	0.939	(0.104)***
Activity - manufacturing	0.731	(0.121)***	0.842	(0.173)***	0.623	(0.159)***	0.426	(0.378)	0.967	(0.040)***
Activity - construction	0.608	(0.143)***	0.653	(0.207)***	0.579	(0.185)***	0.644	(0.498)	0.519	(0.050)***
Activity - commerce and repair	0.100	(0.122)	0.122	(0.175)	0.043	(0.161)	-0.059	(0.403)	0.684	(0.040)***
Activity - lodging and food	0.289	(0.137)**	0.447	(0.195)**	0.118	(0.182)	-0.197	(0.685)	0.659	(0.045)***
Activity - transportation, warehousing and communications	0.331	(0.131)**	0.551	(0.185)***	0.112	(0.174)	-0.360	(0.531)	0.761	(0.047)***
Activity - financial services	0.316	(0.141)**	0.101	(0.212)	0.368	(0.179)**	-0.495	(0.476)	0.847	(0.063)***
Activity - real estate activities and service activities	0.625	(0.120)***	0.835	(0.172)***	0.416	(0.158)***	0.063	(0.379)	0.997	(0.040)***
Activity - public administration	0.380	(0.121)***	0.342	(0.176)*	0.360	(0.159)**	-0.790	(0.418)*	0.689	(0.044)***
Activity - education	0.292	(0.120)**	-0.136	(0.178)	0.441	(0.157)***	-0.835	(0.386)*	0.744	(0.043)***
Activity - health and social services	1.206	(0.119)***	1.770	(0.169)***	0.508	(0.162)***	-0.595	(0.441)	0.966	(0.046)***
Activity - others collective, social and personal services	0.309	(0.130)**	0.389	(0.187)**	0.200	(0.171)			1.351	(0.041)***
Activity - household activities										
Occupation - sciences and arts professional	-0.063	(0.059)	-0.256	(0.092)***	0.040	(0.072)	-0.100	(0.234)	-0.086	(0.039)**
Occupation - technician with secondary level of education	0.734	(0.053)***	0.939	(0.075)***	0.549	(0.067)***	0.245	(0.256)	0.360	(0.035)***
Occupation - administrative services	-0.203	(0.058)***	-0.316	(0.085)***	-0.111	(0.073)	-0.013	(0.291)	0.134	(0.035)***
Occupation - general services	-0.440	(0.069)***	-0.514	(0.098)***	-0.369	(0.090)***	0.388	(0.472)	0.155	(0.035)***

Occupation - sales and commerce services	-0.215	(0.068)***	-0.265	(0.098)***	-0.166	(0.086)*	-0.329	(0.443)	-0.053	(0.036)
Occupation - farming	-1.164	(0.232)***	-1.849	(0.344)***	-0.823	(0.291)***	-0.769	(1.175)	-0.623	(0.103)***
Occupation - production/manufacturing	-0.707	(0.067)***	-0.759	(0.095)***	-0.673	(0.086)***	0.020	(0.446)	-0.046	(0.035)
Occupation - general maintenance and repair	0.543	(0.107)***	0.668	(0.140)***	0.430	(0.142)***	0.102	(1.071)	0.577	(0.050)***
Occupation - military	-0.636	(0.136)***	-0.688	(0.208)***	-0.582	(0.170)***	-0.535	(1.058)	-0.035	(0.077)
Occupation - other	0.486	(0.880)	0.538	(1.167)	0.310	(1.130)			0.415	(0.511)
Male	0.064	(0.030)**	0.028	(0.043)	0.106	(0.039)***	0.327	(0.167)**	-0.147	(0.016)***
Age	0.044	(0.0184589	-0.034	(0.028)	0.103	(0.023)***	-0.636	(0.103)***	0.187	(0.004)***
Squared age	-0.002	(0.000)***	-0.001	(0.000)***	-0.002	(0.000)***	0.000	(0.000)	0.000	(0.000)***
White	-0.143	(0.030)***	-0.148	(0.043)***	-0.137	(0.039)***	-0.069	(0.186)	-0.134	(0.015)***
Attend tertiary education	0.091	(0.049)*	-0.037	(0.070)	0.223	(0.063)***			-0.398	(0.030)***
Completed tertiary education	-0.287	(0.078)***	-0.449	(0.119)***	-0.183	(0.097)*			-1.300	(0.031)***
Urban	0.228	(0.075)***	0.501	(0.119)***	0.042	(0.090)	-0.210	(0.445)	0.160	(0.029)***
Metropolitan	-0.133	(0.028)***	-0.130	(0.040)***	-0.133	(0.037)***	-0.397	(0.159)**	0.024	(0.014)
Northeast	0.036	(0.051)	0.001	(0.071)	0.089	(0.069)	0.369	(0.378)	0.109	(0.024)***
Central-West	0.059	(0.060)	-0.072	(0.085)	0.179	(0.078)**	0.412	(0.388)	0.264	(0.027)***
Southeast	0.372	(0.049)***	0.243	(0.068)***	0.492	(0.065)***	0.762	(0.350)**	0.054	(0.024)**
South	0.635	(0.055)***	0.580	(0.076)***	0.683	(0.073)***	0.879	(0.372)**	0.473	(0.027)***
Constant	-3.181	(0.364)***	-2.602	(0.543)***	-4.875	(0.458)***	10.089	(2.281)***	-5.080	(0.090)***
Sample Size (N)	42,777		38,934		39,407		10,555		146,239	
Total Number of individuals who completed technical-vocational education:	7,213		3,370		3,843		189		31,782	

Note: table reports the estimates from a logit model where the dependent variable is a technical education dummy that assumes the value 1 for different groups across columns. In column (1) it equals 1 when individuals take any type of technical education at the secondary level. In column (2) it assumes the value 1 when individuals take technical education after secondary education has been completed. In column (3) it assumes the value 1 when technical training is taken simultaneously with general secondary education and in column (4) it assumes the value 1 for the tecnhinal education completed at the terciary level (tecnologico) and column (5) assumes the value 1 for the shorter term courses. Robust standard errors are reported in columns (se) in parenthesis. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%. [1] 14 observations dropped beacause of the lack of value variation in “activity – household activities” and “occupation – others”.

3.3. Sample Balancing

In this section, we report the mean values for the variables used in the propensity-score matching and the balancing of these features. Table 7 reports the differences in treatment and control groups, for several observable characteristics before the matching. Table 8 reports the same results after the matching. T tests were performed to detect the mean differences of the variables between the two groups (control and treatment) before and after matching. If the quality of the matching is good, we expect a lack of statistically significant differences after matching. This is reported in table 8 suggesting that the matching method presents robust results. At the end of Tables 7 and 8, we include the number of observations that were effectively used in the matching.

Table 7 – Balancing results of the sample *before* matching - mean values

	TEC-geral			TEC - after general education			TEC - concurrently with general education			Technical education at the tertiary level			FIC		
	(1)			(2)			(3)			(4)			(5)		
	treat.	contr.	Mean dif.	treat.	contr.	Mean dif.	treat.	contr.	Mean dif.	treat.	contr.	Mean dif.	treat.	contr.	Mean dif.
Experience	19.9	18.5	***	19.0	18.5	**	20.7	18.5	***	21.6	22.0		20.0	23.1	***
Potential experience	16.9	15.6	***	16.5	15.6	***	17.3	15.6	***	16.1	17.5		18.3	23.3	***
Self-employed / employers	0.20	0.21	***	0.17	0.21	***	0.22	0.21		0.22	0.22		0.26	0.30	***
Agriculture job	0.02	0.02	**	0.01	0.02	***	0.02	0.02		0.02	0.01		0.03	0.14	***
Activity - extractive industries	0.01	0.00	***	0.01	0.00	***	0.01	0.00	***	0.01	0.00		0.00	0.00	
Activity - manufacturing	0.15	0.12	***	0.16	0.12	***	0.15	0.12	***	0.17	0.07	***	0.17	0.14	***
Activity - construction	0.03	0.03		0.02	0.03		0.03	0.03		0.04	0.02	**	0.05	0.09	***
Activity - commerce and repair	0.16	0.22	***	0.16	0.22	***	0.17	0.22	***	0.13	0.10	*	0.21	0.19	***
Activity - lodging and food	0.02	0.03	***	0.02	0.03	**	0.02	0.03	***	0.02	0.01		0.04	0.04	
Activity - transportation, warehousing and communications	0.04	0.05	***	0.05	0.05		0.04	0.05	***	0.03	0.03		0.06	0.05	**
Activity - financial services	0.03	0.03		0.02	0.03	***	0.03	0.03		0.05	0.05		0.02	0.01	***
Activity - real estate activities and service activities	0.12	0.10	***	0.12	0.10	***	0.11	0.10	**	0.15	0.13		0.10	0.06	***
Activity - public administration	0.10	0.11	***	0.09	0.11	***	0.12	0.11		0.09	0.15	**	0.07	0.05	***
Activity - education	0.13	0.14	**	0.07	0.14	***	0.17	0.14	***	0.17	0.27	***	0.07	0.05	***

Activity - health and social services	0.14	0.06	***	0.22	0.06	***	0.08	0.06	***	0.06	0.12	**	0.05	0.03	***
Activity - others collective, social and personal services	0.04	0.04	**	0.03	0.04	**	0.04	0.04		0.05	0.03		0.08	0.04	***
Activity - household activities	0.01	0.03	***	0.01	0.03	***	0.02	0.03	***	0.00	0.00		0.05	0.10	***
Occupation - sciences and arts professional	0.15	0.19	***	0.10	0.19	***	0.19	0.19		0.39	0.52	***	0.08	0.07	***
Occupation - technician with secondary level of education	0.31	0.13	***	0.38	0.13	***	0.25	0.13	***	0.18	0.13	**	0.12	0.06	***
Occupation - administrative services	0.15	0.17	***	0.15	0.17	***	0.15	0.17	***	0.12	0.10		0.13	0.08	***
Occupation - general services	0.08	0.12	***	0.09	0.12	***	0.08	0.12	***	0.03	0.02		0.22	0.23	***
Occupation - sales and commerce services	0.08	0.12	***	0.07	0.12	***	0.08	0.12	***	0.04	0.03		0.11	0.11	
Occupation - farming	0.01	0.02	***	0.01	0.02	***	0.02	0.02		0.01	0.01		0.03	0.14	***
Occupation – production / manufacturing	0.09	0.12	***	0.09	0.12	***	0.08	0.12	***	0.04	0.02	**	0.20	0.24	***
Occupation - general maintenance and repair	0.02	0.01	***	0.03	0.01	***	0.02	0.01	***	0.01	0.00		0.03	0.02	***
Occupation - military	0.01	0.02	***	0.01	0.02	***	0.01	0.02	***	0.01	0.01		0.01	0.01	***
Occupation - other	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00	
Male	0.51	0.50		0.50	0.50		0.52	0.50	**	0.56	0.44	***	0.55	0.62	***
Age	36.2	35.2	***	35.4	35.2		36.9	35.2	***	38.2	40.0	**	35.2	37.5	***
Squared age	1,420.9	1,371.3	***	1,362.6	1,371.3		1,472.0	1,371.3	***	1,577.8	1,729.3	**	1,383.7	1,586.5	***
White	0.59	0.59		0.57	0.59	**	0.61	0.59	*	0.75	0.73		0.50	0.45	***
Attend tertiary education	0.14	0.12	***	0.13	0.12	**	0.15	0.12	***				0.07	0.04	***
Completed tertiary education	0.22	0.29	***	0.15	0.29	***	0.28	0.29					0.11	0.09	***
Urban	0.96	0.96	***	0.97	0.96	***	0.96	0.96		0.97	0.98		0.94	0.84	***
Metropolitan	0.46	0.47	***	0.46	0.47		0.45	0.47	***	0.41	0.51	***	0.44	0.36	***
Northeast	0.21	0.25	***	0.22	0.25	***	0.20	0.25	***	0.14	0.21	**	0.26	0.30	***
Central-West	0.10	0.12	***	0.09	0.12	***	0.11	0.12	***	0.12	0.15		0.13	0.12	***
Southeast	0.38	0.35	***	0.36	0.35		0.40	0.35	***	0.47	0.38	**	0.30	0.30	*
South	0.21	0.15	***	0.21	0.15	***	0.20	0.15	***	0.22	0.17	*	0.20	0.15	***
No. of observations effectively used in the matching:	7,205	5,751		3,368	2,753		3,843	3,457		188	175		31,782	23,773	

Note: Table reports the mean values for the treatment group (treat.) and the mean values for the control group (contr.) for different observable characteristics in the sample. Mean values for the control groups are reported before the matching of individuals. Mean difference test results (Mean dif.). ***Mean difference statistically significant at 1%. **Mean difference statistically significant at 5%. *Mean difference statistically significant at 10%.

Table 8 – Balancing results of the sample *after* matching - mean values

	TEC- geral			TEC - after general education			TEC - concurrently with general education			Technical education at the tertiary level			FIC		
	(1)			(2)			(3)			(4)			(5)		
	treat.	contr.	Mean dif.	treat.	contr.	Mean dif.	treat.	contr.	Mean dif.	treat.	contr.	Mean dif.	treat.	contr.	Mean dif.
Experience	19.9	19.9		19.0	18.6		20.7	20.7		21.6	20.6		20.0	20.1	
Potential experience	16.9	17.0		16.5	16.2		17.3	17.3		16.2	15.2		18.3	18.4	
Self-employed / employers	0.20	0.19		0.17	0.16	**	0.22	0.21		0.22	0.23		0.26	0.25	***
Agriculture job	0.02	0.01		0.01	0.01		0.02	0.02		0.02	0.02		0.03	0.03	*
Activity - extractive industries	0.01	0.01		0.01	0.01		0.01	0.01		0.01	0.01		0.00	0.00	
Activity - manufacturing	0.15	0.14		0.16	0.15		0.15	0.15		0.17	0.17		0.17	0.17	
Activity - construction	0.03	0.03		0.02	0.02		0.03	0.03		0.04	0.07		0.05	0.05	
Activity - commerce and repair	0.16	0.17		0.16	0.16		0.17	0.16		0.13	0.12		0.21	0.22	*
Activity - lodging and food	0.02	0.02		0.02	0.02		0.02	0.03		0.02	0.01		0.04	0.04	
Activity - transportation, warehousing and communications	0.04	0.05		0.05	0.04	**	0.04	0.04		0.03	0.04		0.06	0.06	
Activity - financial services	0.03	0.03		0.02	0.02		0.03	0.04		0.05	0.02	*	0.02	0.02	
Activity - real estate activities and service activities	0.12	0.12		0.12	0.11		0.11	0.10		0.15	0.12		0.10	0.10	
Activity - public administration	0.10	0.11		0.09	0.09		0.12	0.11		0.09	0.09		0.07	0.07	
Activity - education	0.13	0.12		0.07	0.08		0.17	0.18	***	0.18	0.19		0.07	0.08	*
Activity - health and social services	0.14	0.15		0.22	0.23		0.08	0.08		0.06	0.06		0.05	0.05	
Activity - others collective, social and personal services	0.04	0.03		0.03	0.03		0.04	0.04		0.05	0.09		0.08	0.07	***
Activity - household activities	0.01	0.02		0.01	0.01		0.02	0.01		0.00	0.00		0.05	0.05	

Occupation - sciences and arts professional	0.15	0.15		0.10	0.11		0.19	0.20		0.39	0.45		0.08	0.09	**
Occupation - technician with secondary level of education	0.31	0.31		0.38	0.38		0.25	0.25		0.18	0.15		0.12	0.11	***
Occupation - administrative services	0.15	0.15		0.15	0.14		0.15	0.15		0.12	0.11		0.13	0.14	
Occupation - general services	0.08	0.08		0.09	0.08		0.08	0.08		0.03	0.04		0.22	0.21	**
Occupation - sales and commerce services	0.08	0.08		0.07	0.08		0.08	0.09		0.04	0.02		0.11	0.11	*
Occupation - farming	0.01	0.01		0.01	0.01		0.02	0.02		0.01	0.01		0.03	0.03	
Occupation – production / manufacturing	0.09	0.09		0.09	0.09		0.08	0.08		0.04	0.03		0.20	0.21	
Occupation - general maintenance and repair	0.02	0.03		0.03	0.02		0.02	0.02		0.01	0.01		0.03	0.03	**
Occupation - military	0.01	0.01		0.01	0.01		0.01	0.01	***	0.01	0.00		0.01	0.01	**
Occupation - other	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00	
Male	0.51	0.51		0.50	0.47	*	0.52	0.52		0.56	0.61		0.55	0.55	
Age	36.2	36.3		35.4	35.2		36.9	36.9		38.2	37.2		35.2	35.3	
Squared age	1,420.7	1,425.3		1,362.6	1,347.6		1,472.0	1,467.9		1,581.4	1,523.9		1,383.7	1,393.4	
White	0.59	0.59		0.57	0.55	*	0.61	0.61		0.75	0.79		0.50	0.51	***
Attend tertiary education	0.14	0.13		0.13	0.15		0.15	0.15					0.07	0.08	***
Completed tertiary education	0.22	0.23		0.15	0.16		0.28	0.29					0.11	0.11	*
Urban	0.96	0.97		0.97	0.98		0.96	0.96		0.97	0.95		0.94	0.94	
Metropolitan	0.46	0.45		0.46	0.45		0.45	0.45		0.41	0.43		0.44	0.44	
Northeast	0.21	0.19	***	0.22	0.22		0.20	0.21		0.14	0.17		0.26	0.25	***
Central-West	0.10	0.10		0.09	0.10		0.11	0.11		0.12	0.10		0.13	0.13	
Southeast	0.38	0.41	***	0.36	0.38		0.40	0.41		0.46	0.45		0.30	0.30	*
South	0.20	0.20		0.21	0.21		0.20	0.20		0.22	0.20		0.20	0.20	
No. of observations used in the matching:	7,205	5,751		3,368	2,753		3,843	3,457		188	175		31,782	23,773	

Note: Table reports the mean values for the treatment group (treat.) and the mean values for the control group (contr.) for different observable characteristics in the sample. Mean values for the control groups are reported after the matching of individuals. ***Mean difference statistically significant at 1%. **Mean difference statistically significant at 5%. *Mean difference statistically significant at 10%.

The results reported in tables 7 and 8 suggest a good balance in observable characteristics across treatment and control groups after the matching, with very few characteristics having statistically significant mean differencesa across the treatment and control groups across the different samples. The samples for the overall TEC, TEC after completion of general upper secondary education, TEC performed concurrently with general upper secondary education, and technical education at the tertiary level groups show the best balancing results after matching. The sample covering individuals who completed an FIC course and their control group (individuals who were working in 2007 and who have never pursued a technical-vocational education) presents several unbalenced characteristics. This may naturally affect the robustness of our findings for this sample. The main problem resides in the difficulty of finding a solid control group for this sample as the profile of individuals attending FIC courses and the quality of these courses tends to be very heterogeneous. It is always worth noting, however, that in spite of finding a proper balancing of samples, there may be differences across treatment and control groups arising from unobserved features, which could ultimately affect our estimated wage differentials.

4. Wage Differences between Workers with Technical-Vocational Education and Workers with General Education

In this section, we present the estimates of the differences in hourly wages for individuals with technical education and training, relative to those without it, obtained by exploring OLS and propensity-score matching. The main sample of interest are those who completed a specific type of education (technical-vocational, or regular), who had a job during the reference week, and who were 14 years old or older.

Table 9 presents the results of estimating equation (a) in section 3 by ordinary least squares (OLS). Table 10 reports the exploring the propensity-score matching. Column (1), presents the results for those who have completed a general TEC course in relation to individuals who completed only general upper secondary education. Column (2) presents the results for the sample of individuals who completed a TEC course after completion of general upper secondary education compared with those who completed only general upper secondary education. Column (3) presents the results for individuals who completed a TEC course concurrently with general upper secondary education in relation to individuals who completed only general upper secondary education. Note that these three control groups (individuals who completed only general upper secondary education) are identical, and the individuals have never pursued technical-vocational education. Column (4) includes individuals who completed a technical education course at the tertiary level compared with individuals who completed only academic education at the tertiary level and never pursued

technical-vocational education. Column (5) presents the results for individuals who completed an FIC course compared with individuals who was working during the reference week and have never attended a technical-vocational course.

4.1. Wage Premia with Ordinary Least Squares

Results in table 9 provide a comparative basis for the results obtained by propensity-score matching, which we will present in the next section.

Table 9 – Wage Premia for tecnhical Education using OLS

	TEC - general	TEC - after general education	TEC - concurrently with general education	Technical education at the tertiary level	FIC
	(1)	(2)	(3)	(4)	(5)
Tecnhical Education and Training Dummy	0.077	0.083	0.075	0.064	0.045
	(0.009)***	(0.012)***	(0.012)***	(0.059)	(0.004)***
N	42,777	38,934	39,407	10,569	146,239
R^2	0.50	0.51	0.51	0.34	0.47
No. of observations for those who completed technical-vocational education:	7,213	3,370	3,843	189	31,782

Note: Dependent variable is log(hour_wage). Table reports the hourly wage premia, using OLS, for those individuals with completed tecnhical education or training relatively to their control group. Robust standard error in parenthesis. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%.

We observe that individuals who have completed a general TEC course had an average hourly wage that was 7.7% higher than that of individuals who had completed a general upper secondary education course. The results for the TEC courses, when separated into two categories, show that individuals who completed a TEC course after completion of a general upper secondary education had on average a higher hourly wage differential compared with the control group. Individuals who completed a technical education course at the tertiary level had statistically nonsignificant results, which may indicate that the completion of a technical course at the tertiary level has, on average, the same impact on hourly wages as an academic course at the tertiary level. However, this result for a technical education course at the tertiary level requires caution in its interpretation due to the low number of observations of individuals who completed such a course.

4.2. Wage Premia Estimates Using Propensity-Score Matching

Table 10 - Wage Premia for TEVT using Propensity-score matching

	TEC - general	TEC - after general education	TEC - concurrently with general education	Technical education at the tertiary level [1]	FIC
	(1)	(2)	(3)	(4)	(5)
Tecnhical Education and Training Dummy	0.097 (0.016)***	0.115 (0.023)***	0.081 (0.021)***	-0.029 (0.098)	0.022 (0.008)***
N	42,777	38,934	39,407	10,555	146,239
No. of observations who completed technical-vocational education:	7,213	3,370	3,843	189	31,782

Note: Dependent variable is log(hour_wage). Table reports the hourly wage premia, using propensity-score matching results, for those individuals with completed tecnhical education or training relatively to their control group. Robust standard error in parenthesis. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%. [1] 14 observations dropped beacause of the lack of value variation in "activity – household activities" and "occupation – others".

Table 10 shows that individuals who completed a general TEC course had, on average, a 9.7% higher hourly wage compared with their control group. Individuals who had completed a TEC course after general upper secondary education had, on average, an 11.5% higher hourly wage compared with individuals who completed only general upper secondary education. Individuals who completed a TEC course concurrently with general upper secondary education had, on average, an 8.1% higher hourly wage compared with their control group. Those who completed an FIC course had, on average, hourly wages that were 2.2% higher in relation to their control group.

Results in table 10 are similar to those obtained with LS but show a positive bias for almost all of the modalities. The only exception is the result for individuals who had completed an FIC course, where the estimate generated by OLS (+4.5%) is higher than that generated by matching (+2.2%). The result for individuals who had completed a technical education course at the tertiary level is not statistically significant, which may indicate that this type of education has a similar impact to academic education at the tertiary level on the hourly wages of the individuals, *i.e.*, technical tertiary education is as good as academic tertiary education when considering their impact on hourly wages. However, this result requires caution in its interpretation due to the low number of observations of individuals who have completed such a course.

Table 11 shows two results that help to better understand the impact of these tertiary level courses on the hourly wages of the individuals. In the first column (1), we compared individuals who completed a technical education course at the tertiary level with individuals who completed only general upper secondary education (and who never pursued a tertiary or technical-vocational education). Our intention here is to observe the impact on hourly wages of completing a technical education course at the tertiary level rather than completing a general upper secondary education and ceasing one's formal education. In the second column (2), we compared individuals who completed academic education at the tertiary level with individuals who completed only general

upper secondary education (and never pursued a tertiary or vocational education). The goal is to verify the impact on hourly wages of pursuing an academic tertiary education rather than completing a general upper secondary education and ceasing formal education.

Table 11 - - Wage Premia for TEVT at the tertiary level, relatively to academic tertiary education

	Technical education at the tertiary level (control = completed only general upper secondary education)	Academic tertiary education (control =completed only general upper secondary education)
	(1)	(2)
Tecnhical Education and Training Dummy	0.714 (0.081)***	0.734 (0.023)***
N	19,447	47,611
Of which completed technical or academic education at the tertiary level	220	10,466

Note: Dependent variable is log(hour_wage). Results are obtained through propensity-score matching estimation. Robust standard error in parenthesis. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%.

The impact of completing a technical education course at the tertiary level is high (+71.4% on average) because we used a control group composed of individuals who have completed general upper secondary education but who never attended higher level education. The result shows that completing a technical education course at the tertiary level is much more beneficial than simply completing general upper secondary education and ceasing formal education. In column (2) of table 11, we can see the impact on hourly wages of pursuing an academic tertiary education compared with individuals who only completed upper secondary education (technical-vocational, or regular) and who never attended academic tertiary education. This impact is positive and high (+73.4% hourly wages on average). These results corroborate the result obtained in table 10, where a technical education course at the tertiary level is as good as academic education when considering their impact on hourly wages.

5. Heterogeneity of Wage Impacts

In this section, we present the effects of technical-vocational education on the hourly wages across a number of different types of courses. We are especially interested in observing the results for different types of institutions, sectors of activity, type and duration of courses, the levels of education, gender, age, area of residence for the student/trainee. Because of the low number of observations of individuals who completed a technical education course at the tertiary level, we do not analyze the heterogeneity for this group. The analysis for technical education at the upper

secondary level considers only the category that includes all types of technical education at the upper secondary level (TEC).

Table 12 reports the heterogeneity analysis with interactions between $edutec$ and different variables of interest (e.g., type opf provider, sector of course/work, Day/Night courses) for both TEC general and FIC courses, respectively in columns (1) and (2). In panel A we use the same sample as in table 10, but where each observation is weighted by sample weights obtained from the matching. Reassuringly, the results reported for $edutec$ are the same as those reported in table 10. In Pabel B through J, we consider the intereaction between $edutec$ and the different variables of interest and use weighted least squares where the weights are given by propensity score matching.[10] We discuss next the results obtained.

Table 12 – Heterogeneity of impacts on hourly wages, using Weighted Least Squares

TEC general		FIC	
(1)			(2)
Overall estimates (Comparable to Table 10)			
Overall Sample	9.7%	Overall Sample	2.2%
Panel A. Institution Type - section 5.01			
Public	9.4%	Public	-11.2%
Sistema S	12.3%	Sistema S	7.8%*
Private	9.1%	Private	4.2%*
Other type	46.5%*	Other type	-5.3%*
Panel B. Professional sector of the vocational course - section 5.02			
Other	12.8%	Other	0.4%[1]
Health	-12.7%*	Health or welfare	15.4%*
Manufacturing	32.9%*	Technology of information	-4.7%*
Management	10.0%	Construction	2.8%
Technology of information	5.0%*	Manufacturing or maintenance	11.6%*
Agriculture	11.8%	Aesthetics or personal image	-18.9%*
		Commerce or management	11.3%*
Panel C. Professional sector of the course (and sector of the work) - section 5.03			
Other	10.8%	Other	-4.2%
Health (same)	-8.9%*	Health or welfare (same)	38.7%*
Health (different)	-17.0%*	Health or welfare (different)	4.8%*
Manufacturing (same)	34.5%*	Construction (same)	3.0%*
Manufacturing (different)	31.8%*	Construction (different)	2.7%*
		Manufacturing or maintenance (same)	17.8%*
		Manufacturing or maintenance (different)	8.0%*

[10] Underlined results represent omitted groups in the regression models. The symbol "*" represent result statistically different from the omitted group (underlined) at the significance level of 10%.

		Commerce or management (same)	7.6%*
		Commerce or management (different)	13.1%*
Panel D. Course timing - section 5.04			
Night	6.0%	Night	14.1%
Day	14.3%*	Day	-4.0%*
Panel E. Indivduals' educational level - section 5.05 [2]			
Stopped at upper secondary education level	15.0%		
Stopped at tertiary education level	-1.0%*		
Panel F. Working conditions - section5.06			
Military	13.4%[1]	Military	-17.2%[1]
Without formal employment agreement	2.5%	Without formal employment agreement	8.3%*
With formal employment agreement	11.5%	With formal employment agreement	0.8%
Self-employed	0.1%	Self-employed	-0.6%
Employer	-4.2%	Employer	-12.4%
Panel G. Gender - section 5.07			
Female	1.8%[1]	Female	-2.1%
Male	17.8%*	Male	5.8%*
Panel H. Age (in years) - section 5.08			
Under 20 years old	19.5%	Under 20 years old	5.8%
Between 20 and 30 years old	17.3%	Between 20 and 30 years old	4.3%
More than 30 years old	7.3%*	More than 30 years old	1.3%*
Panel I. Housing area - section 5.09			
Non-metropolitan	8.3%	Non-metropolitan	7.9%
Metropolitan	11.6%	Metropolitan	-4.7%*
Panel J. Geographic region - section 5.10			
North	14.6%	North	5.1%
Northeast	15.6%	Northeast	6.9%
Central-West	29.6%*	Central-West	-2.9%*
Southeast	4.8%*	Southeast	-0.3%*
South	5.2%*	South	3.9%
No. of observations	14,410	No. of observations	63,564

Note: Underlined results represent omitted groups in the regression models. * Results statistically different from the omitted group (underlined) at the significance level of 10%. [1] Statistically non-significant at 10%. We used weighted LS to estimate the parameters of interest. [2] No. of observations is smaller compared to the other results because we considered only individuals who completed a upper secondary education/tertiary education. [2] Furthermore we did not consider those who were attending these courses in 2007.

5.1. Institution Type

Technical-vocational education courses in Brazil are offered by different types of institutions, and in our sample we can observe the major institutional providers: Sistema S; public institutions; private institutions; and other institutions. “Sistema” is a set of institutions linked to and maintained by industry and business sectors that aims to improve the conditions of Brazilian workers through training, health care, and leisure. Each institution in the Sistema S has its own enrollment criteria and tuition payment terms.[11] Public institutions include municipal, state, and federal technical-vocational education schools, which have enrollment criteria set by the government and do not require the payment of tuition. Private institutions are maintained by private agents and usually require the payment of a monthly fee. Institutions not included in the previous classifications are included in the "other types of institutions" group (for example, religious institutions and non-governmental organizations - NGOs), which makes it very heterogeneous.

Results in panel A show that individuals who completed a general TEC course in a public institution had an average hourly wage that was approximately 9.4% higher compared with individuals who completed only regular education (control group). Individuals who completed TEC education at a Sistema S or private institution had on average the same gain in hourly wages (approximately +9.4%) in relation to individuals who completed only regular education. This result is similar because the estimates of the parameters are not statistically significant. Individuals who completed a technical course at other types of institutions had, on average, a high hourly wage difference (approximately +46.5%) compared with the control group. However, this group has few observations, and we do not have detailed information about these types of these institutions, which complicates the interpretation of this result. In addition, individuals who completed an FIC course in a public institution had, on average, an hourly wage that was approximately 11.2% lower in relation to workers without a technical-vocational education (control group). Individuals who completed an FIC course at an institution from the Sistema S had, on average, an hourly wage differential that was approximately 7.8% higher compared with the control group. Individuals who completed an FIC course at a private institution had, on average, an hourly wage differential that was approximately 4.2% higher than that of the control group. Individuals who completed an FIC course in other types of institutions had, on average, an hourly wage differential that was approximately 5.3% less than that of the control group.

Considering the general TEC and FIC courses, we can observe that the greatest impacts are among those who completed a technical-vocational course at institutions from the Sistema S. Public

[11] See Almeida, Amaral, and Felicio (forthcoming) and Neri (2010) for more details about the main providers of technical-vocational education in Brazil.

and private institutions have lower or equal impacts to the Sistema S. Finally, private institutions have greater impacts on hourly wages than public institutions.

5.2. Professional Sector of the Course

The TEC courses can be divided into the sectors of health, manufacturing, management, technology of information, agriculture, and other (courses not included in the previous five classifications). FIC courses can be divided into the sectors of "health or welfare", "technology of information", "construction", "manufacturing or maintenance", "aesthetics or personal image", "commerce or management", and other (courses not included in the previous six classifications).

Panel B in table 12 shows that individuals who completed genrela TEC in "other" vocational areas had an average hourly wage that was approximately 12.8% higher compared with individuals in the control group. Individuals who completed a TEC education in management or agricultural studies had on average the same gain in hourly wages (approximately 12.8%) in relation to individuals who completed only regular education. This result occurred because the estimates of the parameters are not statistically significant. Individuals who completed a TEC course in healthcare had, on average, an hourly wage differential that was approximately 12.7% less compared with the control group. Individuals who completed a TEC course in the manufacturing area had, on average, an hourly wage differential that was approximately 32.9% higher compared with the control group. Individuals who completed a TEC course in technology of information had, on average, an hourly wage differential that was approximately 5.0% higher compared with the control group.

Examining the results for the FIC courses in column (2), individuals who completed this type of education in "other" vocational areas had an average hourly wage that was similar to the individuals in the control group (the estimate is not statistically significant). individuals who completed an FIC course in the area of construction also showed a statistically nonsignificant estimate. Individuals who completed an FIC course in healthcare had, on average, an hourly wage differential that was 15.4% higher compared with the control group. Individuals who completed an FIC course in technology of information had, on average, an hourly wage differential that was 4.7% less compared with the control group. Individuals who completed an FIC course in the manufacturing sector had, on average, an hourly wage differential that was 11.6% higher compared with the control group. Individuals who completed an FIC course in the aesthetics sector had, on average, an hourly wage differential that was 18.9% less than that of the control group. Individuals who completed an

FIC course in the commerce or management sector had, on average, an hourly wage differential that was 11.3% higher than that of the control group.

We can observe the heterogeneity of the impacts of technical-vocational courses on the hourly wages of the individuals in table 12. The major impacts of technical-vocational courses on hourly wages are in manufacturing-related sectors.

5.3. Professional Sector of the Course and Work

In panel C we investigate differnces in returns depending on the sectors of technical education and the sector of activity where the individual found a job. In particular, we ask whether an individual who pursued technical-vocational education in the manufacturing sector and started to work in the manufacturing sector earned more or less than an individual who graduated in the same area but went to work in another activity sector. As before, the TEC courses can be divided into the sectors of health, manufacturing, management, technology of information, agriculture, and others (courses not included in the previous five classifications). Due to the difficulty of integrating the areas of technical courses and the activity sectors of the individuals, we will perform the analysis only for health and manufacturing courses. The FIC courses are divided into the sectors of "health or welfare", "technology of information ", "construction", "manufacturing or maintenance", "aesthetics or personal image", "commerce or management", and others (courses not included in the previous six classifications). Due to the difficulty of integrating the areas of vocational courses and the activity sectors of the individuals, we will perform the analysis only for the "health or welfare", "construction", "manufacturing or maintenance", and "commerce or management" courses.

Results in Panel C show that individuals who completed a general TEC course in other professional areas had an average hourly wage that was approximately 10.8% higher in relation to individuals who completed only regular education (control group). Individuals who completed a TEC course in healthcare and worked in the same sector had, on average, an hourly wage that was approximately 8.9% less compared with the control group. Individuals who completed a TEC course in healthcare and worked in another area (other than healthcare) had, on average, an hourly wage that was approximately 17.0% less compared with the control group.

Individuals who completed a TEC course in the area of manufacturing and worked in the same area had, on average, an hourly wage that was approximately 34.5% higher compared with the control group. Individuals who completed a TEC course in the area of manufacturing and worked in another area (other than manufacturing) had, on average, an hourly wage that was approximately 31.8% higher compared with the control group. These results may be an indication that individuals

who completed a technical course and worked in the same area of the course benefited the most in terms of wages.

We can see from table 12 that individuals who completed an FIC course in other professional fields (technology of information, aesthetics, and other) had an average hourly wage that was approximately 4.2% lower compared with individuals in the control group. Individuals who completed an FIC course in healthcare and worked in the same area had, on average, an hourly wage that was approximately 38.7% higher compared with the control group. Individuals who completed an FIC course in healthcare and worked in another area (other than healthcare) had, on average, an hourly wage that was approximately 4.8% higher compared with the control group. Individuals who completed an FIC course in the construction area and worked in the same area had, on average, an hourly wage differential that was approximately 3.0% higher compared with the control group. Individuals who completed an FIC course in the construction area and worked in another area (other than construction) had, on average, an hourly wage differential that was approximately 2.7% higher compared with the control group.

Individuals who completed an FIC course in the manufacturing area and worked in the same area had, on average, an hourly wage differential that was approximately 17.8% higher compared with the control group. Individuals who completed an FIC course in the manufacturing area and worked in another area (other than manufacturing) had, on average, an hourly wage differential that was approximately 8.0% higher compared with the control group. Individuals who completed an FIC course in commerce and worked in the same area had, on average, an hourly wage differential that was approximately 7.6% higher compared with the control group. Individuals who completed an FIC course in commerce and worked in another area (other than commerce) had, on average, an hourly wage differential that was approximately 13.1% higher compared with the control group.

These results may be an indication that individuals who have completed an FIC course and worked in the same area of that course benefited with higher impacts on hourly wages.

5.4. Course Timing

In this section, we compare the differences in the wage returns for individuals who completed their technical-vocational education in day or night courses. In column (1) of table 12, the results for general TEC education, show that individuals who completed this type of education through night courses had an average hourly wage that was approximately 6.0% higher than that of individuals in the control group. Individuals who completed their TEC education during the day had

an average hourly wage that was approximately 14.3% higher than that of individuals who completed regular education only.

For the FIC courses, the results reported in column (2) of table 12, show that individuals who completed this type of education with night courses had an average hourly wage that was approximately 14.1% higher than that of individuals in the control group. Individuals who completed a vocational education course during the day had, on average, an hourly wage that was 4.0% less than that of the control group.

The estimates in table 12 show differences between general TEC and FIC courses. For TEC education, the highest hourly wage differentials are for daytime courses, while for the FIC courses, the highest hourly wage differentials are for night courses.

5.5. Individuals' Educational Level

In the analysis by the individuals' educational level, we divided the sample into one group who had completed upper secondary education (technical or not) and did not pursue tertiary education and a second group who continued their studies and completed a tertiary education course. The purpose of this section is to determine the impact of technical courses for individuals who decided to pursue tertiary education and for those who did not pursue further education after the technical courses.

We observe in Table 12 that among the individuals who completed upper secondary education and stopped there, those who completed a general TEC course had an average hourly wage that was approximately 15.0% higher than that of individuals in the control group. Among the individuals who completed tertiary education, those who completed a general TEC course had an average hourly wage that was approximately 1.0% lower than that of the control group. This result may indicate that the positive effect of completing a TEC course on hourly wages is overshadowed by the effect of a tertiary education.

5.6. Working Conditions

This section presents the results of the impact of technical-vocational courses on the hourly wages of the individuals according to their status in the labor market. Status in the labor market is determined by individuals working without a formal employment agreement, working with a formal employment agreement, working as self-employed, acting as employers, or serving in the military.

Table 12 shows the difference in the hourly wages of individuals who completed a TEC course among the various working conditions. We can observe in Table 12 that regardless of the working condition group chosen (military, without employment agreement, with employment agreement, self-employed, or employer), the completion of a TEC course does not seem to generate a wage differential compared with individuals who only completed regular education. The reason for this result is that the "military" estimate is statistically insignificant, *i.e.*, among military officers, those who had completed a TEC course had an average hourly wage that was equal to the control group. Considering the other working condition categories, we observe that the estimates are not significantly different from the omitted group (military), *i.e.*, among the individuals from any one of these categories, those with a completed TEC course had an average hourly wage that was equal to the control group. However, we emphasize that there are wage differences among the individuals with different working conditions. These results may be an indication that there are differences in the hourly wages among individuals in the labor market according to their working conditions. However, we did not observe wage differences between the type of education and the working conditions of the individuals.

Table 12 shows the hourly wage differences of the individuals based on having completed an FIC course among the different working conditions. We note that among military officers, those who had completed an FIC course showed no differences in hourly wages compared with individuals in the control group. Again, this estimate is statistically insignificant. The result is the same among individuals who had a formal employment agreement, worked as self-employed, or acted as employers. Among the individuals who worked without a formal employment agreement, those who had completed an FIC course had, on average, an hourly wage that was approximately 8.3% higher than that of the control group.

Thus, as in the analysis for completion of a TEC course, we can see that among the working condition groups, completion of an FIC course did not generate differences in hourly wages. The exception is among individuals working without a formal employment agreement, in which case those who had completed an FIC course had a higher hourly wage (also there are wage differences among the individuals with different working conditions).

5.7. Gender

The purpose of this section is to determine whether there are impact differences for technical-vocational courses for men and women. Table 12 shows that among women, those who completed a TEC course had no wage differences compared with women who completed regular

education. The estimate is not statistically significant. Among men, those who completed a TEC course had, on average, an hourly wage that was approximately 17.8% higher than that of men who completed regular education. This result indicates that the completion of a TEC course by men can generate a positive hourly wage differential in relation to individuals in the comparison group.

Table 12 shows that among women, those who completed an FIC course had, on average, an hourly wage differential that was 2.1% less than that of women who worked and never pursued technical-vocational education (control group). Among men, those who completed n FIC course had, on average, an hourly wage that was approximately 5.8% higher than that of the control group. This result indicates that the completion of an FIC course by men can generate a positive hourly wage differential in relation to individuals in the comparison group. However, among women, the completion of an FIC course may lead to a lower hourly wage.

5.8. Age

We also analyzed the difference between the impact of technical-vocational courses for individuals between 20 and 30 years of age and individuals 30 years of age and older. The goal of this section is to determine how the impact of technical-vocational courses on hourly wages varies over time.

Table 12 shows the differences in the age groups in the hourly wages of individuals who have completed a TEC course. Among individuals under 20 years of age, those who completed a TEC course had, on average, an hourly wage that was approximately 19.5% higher than that of individuals who completed a regular education. individuals who completed a TEC course and were between 20 and 30 years of age had the same result as the previous group, with an hourly wage differential of approximately +19.5% (the estimate is statistically insignificant). Individuals 30 years of age or older who completed a TEC course, had, on average, an hourly wage that was approximately 7.3% higher compared with individuals who completed a regular education.

These results may be an indication that there is a dissipative effect of the impact of technical courses on the hourly wages of individuals throughout their life. This reduced impact with increasing age may stem from structural changes in the economy because technical education is highly specialized and may not prepare someone for new technologies or production methods.

Table 12 shows the differences in the age groups in the hourly wages of individuals who completed an FIC course. Among individuals under 20 years of age, those who completed an FIC course had, on average, an hourly wage that was approximately 5.8% higher than that of individuals in the control group. Individuals who completed an FIC course and were between 20 and 30 years of

age showed the same result as the previous group, with an hourly wage differential of approximately +5.8% (the estimate is statistically insignificant). Among individuals 30 years of age or older, those who completed an FIC course had, on average, an hourly wage that was approximately 1.3% higher compared with the control group. These results are similar to those found for TEC courses, and we note a dissipation of the impact of FIC courses with increased ages of the individuals.

5.9. Housing Area

The purpose of this section is to determine whether there are differences in the impact of technical-vocational courses among individuals who live in metropolitan areas or non-metropolitan areas. Table 12 shows that among individuals living in non-metropolitan areas, those who have completed a TEC course had, on average, an hourly wage that was approximately 8.3% higher than that of individuals in the control group. Among individuals who lived in metropolitan areas, those who completed a TEC course had an hourly wage differential that was similar to the individuals living in non-metropolitan areas compared with the control group. This estimate was not statistically significant. This result may indicate that the completion of a TEC course had a similar impact on individuals who lived in metropolitan and non-metropolitan areas.

Table 12 shows that among individuals who lived in non-metropolitan areas, those who completed an FIC course had, on average, an hourly wage that was approximately 7.9% higher compared with individuals in the control group. Among individuals living in metropolitan areas, those who completed an FIC course had, on average, an hourly wage that was approximately 4.7% less than those in the control group. This result may indicate that the completion of an FIC course has a greater impact among individuals living in non-metropolitan areas.

5.10. Geographic Region

In this section, we are interested in observing the differences in the impact of technical-vocational courses among individuals from different Brazilian regions (North, Northeast, Central-West, Southeast, or South).

Table 12 shows that among individuals who lived in the North region, those who completed a TEC course had on average an hourly wage that was approximately 14.6% higher than that of individuals in the control group. Among individuals who lived in the Northeast region, those who completed a TEC course had an hourly wage differential that was similar to the individuals who lived in the North region compared with the control group. This estimate was not statistically significant. Among individuals who lived in the Central-West region, those who completed a TEC course had, on

average, an hourly wage that was approximately 29.6% higher compared with the control group. Among individuals who lived in the Southeast region, those who completed a TEC course had, on average, an hourly wage that was approximately 4.8% higher in relation to the control group. Among individuals who lived in the Southern region, those who completed a TEC course had, on average, an hourly wage that was approximately 5.2% higher compared with the control group.

These results may be an indication that the completion of a TEC course had a greater impact among individuals living in the Central-West, North, and Northeast regions. Thus, we would observe lesser impacts in the South and Southeast regions, but the impacts would still be positive.

Table 12 shows that among individuals who lived in the North region, those who completed an FIC course had, on average, an hourly wage that was approximately 5.1% higher compared with individuals in the control group. Among individuals who lived in the Northeast region or in the Southern region, those who completed an FIC course had an hourly wage differential that was similar to individuals from the North region. The estimates of interest for these regions were not statistically significant. Among individuals who lived in the Central-West region, those who completed an FIC course had, on average, an hourly wage that was approximately 2.9% less than that of individuals in the control group. Among individuals who lived in the Southeast region, those who completed an FIC course had, on average, an hourly wage that was approximately 0.3% less than that of the control group.

These results may be an indication that the completion of an FIC course has a greater impact among individuals living in the North, Northeast, and South regions, while the impact among individuals who live in the Central-West and Southeast regions was lower in relation to individuals who worked and never pursued a technical-vocational education.

6. Results for Entry into the Labor Market and in Academic Education

Entry into the labor market is an important factor to be analyzed to determine the impact of technical-vocational courses on individuals' lives. To analyze the probability of entering the labor market, we use a logistic regression equivalent to what we proposed in equation (4) in section 2 to obtain the probability of an individual who completed a technical-vocational course entering the labor market compared with an individual in the control group:

$$\Pr[Labor_i = 1 \mid X] = \frac{\exp(x\beta)}{1+\exp(x\beta)}$$

where $\Pr[Labor_i = 1 \mid X]$ represents the likelihood of individual i working during the reference week (in formal employment, informal employment, or self-employed), and X captures the

observable variables included in equation (b), excluding the experience variable, the potential experience variable, and the binary variables for self-employment, farm work, the activity sectors, and occupation. The sample is not the same as that used in the estimation of equation (b) because the analysis includes individuals who were not in the labor market.

We have also replicated the analysis for the probability of an individual being economically active. By economically active, it is understood that the person was working or was looking for a job during the reference week. The dependent variable is a binary variable that takes the value 1 if the individual is economically active and 0 if otherwise. The independent variables are the same as in equation (b), excluding the experience variable, the potential experience variable, and the binary variables for self-employment, farm work, the activity sectors, and occupation.

Table 13 presents the marginal effects of the estimations of the likelihood of working. Individuals who completed a general TEC course were more likely (+0.6%) to be working in relation to a person in the control group. Those who completed an FIC course had a lower probability (-0.6%) of working in relation to the control group.

Table 13 – Marginal effects for the Likelihood of Working

	TEC - general	TEC - after general education	TEC - concurrently with general education	Technical education at the tertiary level	FIC
	(1)	(2)	(3)	(4)	(5)
Tecnhical Education and Training Dummy	0.006	0.004	0.009	0.010	-0.006
	(0.003)**	(0.005)	(0.004)*	(0.011)	(0.002)***
N	50,360	45,965	46,482	11,883	184,678
No. of observations who completed technical-vocational education:	8,273	3,878	4,395	220	3,8623

Note: Dependent variable is whether an individuals is currently working. Results obtained using a logistic regression. Robust standard error in parenthesis. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%.

Table 14 presents the results for the probability of being economically active. All of the individuals who completed some sort of technical-vocational course were more likely to be working or looking for a job. Those who completed a general TEC course had a 6.7% higher probability of being economically active compared with their control group. A similar result was found for individuals who completed a technical education course at the tertiary level (+7.1%). Individuals who completed an FIC course had an 11.2% higher probability of being economically active compared with their control group.

Table 14 – Marginal effects for the Likelihood of being economically active

	TEC - general	TEC - after general education	TEC - concurrently with general education	Technical education at the tertiary level	FIC
Tecnhical Education and Training Dummy	0.067 (0.004)***	0.089 (0.005)***	0.048 (0.005)***	0.071 (0.018)***	0.112 (0.002)***
N	63,944	58,797	59,587	14,179	27,7470
No. of observations who completed technical-vocational education:	9,504	4,357	5,147	234	48,369

Note: Dependent variable is being economically active. Results obtained using a logistic regression. Robust standard error in parenthesis. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%.

Another important factor in analyzing the impacts of technical education is the likelihood for an individual who completed technical education at the upper secondary level to enter academic education (tertiary education). For this analysis, we use an estimation by propensity-score matching (model b), using as a dependent variable a binary variable that takes the value 1 if the individual is attending or has already attended tertiary education and 0 otherwise. The independent variables are the same as those used in model 1, excluding the binary variables "attending tertiary education" and "completed tertiary education".

Table 15 shows that those who completed a TEC course concurrently with general upper secondary education had a higher probability (+2.7%) of pursuing tertiary education compared with their control group. The other results are statistically insignificant. These results may be evidence that individuals who completed a technical education course at the upper secondary level have a similar probability of pursuing tertiary education in relation to individuals who completed general upper secondary education.

Table 15 – Propensity-score matching results – Entry into Higher Education

	TEC - general	TEC - after general education	TEC - concurrently with general education
Dependent variable:	Dumy for those who attend or attended tertiary education		
Tecnhical Education and Training Dummy	0.009 (0.009)	0.015 (0.013)	0.027 (0.011)***
N	43,918	40,023	40,509
No. of observations who completed technical-vocational education:	7,304	3,409	3,895

Note: Dependent variable is a dummy for those who attend or attended tertiary education. Results obtained using a propensity-score matching. Robust standard error in parenthesis. ***Statistically significant at 1%. **Statistically significant at 5%. *Statistically significant at 10%.

7. Cost-Benefit Analysis

In this section, we estimate the maximum cost of technical-vocational education courses for the courses to remain economically viable.[12] This maximum cost is the amount that equals the value of the benefit generated by pursuing technical-vocational education. It is understood that the benefit should equal the present value of the income flow throughout a person's lifetime that is generated by the completion of the education.

To calculate this income flow (shown in the following formula), we separated the individuals from the previous analyses by their age (in years) and considered the minimum age as 18 years (the age at which one could enter the labor market) and the maximum age as 65 years (the age at which one would retire). Then, we calculated the average income received by the individuals from their main work in each of these 48 age groups. The average income of each age group was considered the income flow. We built these income flows and separated the individuals by the type of technical-vocational course completed, so that it was possible to analyze the maximum cost of each course.

$$Income\ flow: \left(\overline{W}_{18} - \frac{\overline{W}_{18}}{(1+coef)}\right), \left(\overline{W}_{19} - \frac{\overline{W}_{19}}{(1+coef)}\right), \dots, \left(\overline{W}_{65} - \frac{\overline{W}_{65}}{(1+coef)}\right) \qquad (3)$$

where $\overline{W}_i$ is the average income from the main work of the individuals aged i, and $coef$ represents the coefficient of the $edutec$ variable estimated in the matching from section 5. The term $\overline{W}_i$ divided by (1 + *coef*) represents the impact of a regular education course on hourly wages. Hence, each income flow portion represents only the gains from completing a certain technical-vocational course at age i.

We consider that technical-vocational courses last for one year.[13] Thus, an individual who opts for a technical-vocational course would spend one year studying (with income equal to zero) and then would receive an income flow for 48 periods (years). The maximum cost represents the maximum amount that an individual must pay in the year that he or she attends a technical-vocational course so as not to exceed the present value of the future income flow calculated from formula (3).[14] We performed this exercise for the technical undergraduate course while considering the coefficient obtained in the comparison with the control group consisting of individuals who completed only general upper secondary education.

[12] To see possible cost-benefit estimates of technical courses at the upper secondary level. See Vasconcellos et al. (2010).

[13] The many technical-vocational courses have different lengths; however, we assume a period of one year to allow comparison of the results.

[14] To calculate the present value of future income, we used a discount rate of 5% per year.

Table 16 presents the maximum cost values of each of the technical and vocational courses. Observing the monthly costs, we can state that the maximum monthly cost of a general TEC course should be R$ 2,398.3 (assuming the course lasts for one year). Any amount above that would exceed the present value of the benefits provided in the form of income by these courses.

Table 16 – Maximum cost calculation – vocational education

	Maximum annual cost	Maximum monthly cost
TEC general	R$ 28.779,2	R$ 2.398,3
TEC after general education	R$ 25.460,0	R$ 2.121,7
TEC concurrently with general education	R$ 22.002,0	R$ 1.833,5
Technical education at the tertiary level	R$ 196.774,8	R$ 16.397,9
FIC	R$ 7.363,2	R$ 613,6

Source: Authors based on PNAD/IBGE (2007). We used a discount rate of 5%. We assume that vocational courses last 1 year.

Vasconcellos et al. (2010) calculate a proxy for the student-cost in general upper secondary and technical schools using data from INEP[15] and the *Sistema Informacional Custo Aluno* – SICA – (Student-Cost Information System). This database (SICA) contains information on costs submitted by the state schools in the state of Minas Gerais. The authors estimate that the student-cost in general upper secondary education is R$ 2,213.5 per year (in 2009 values) and that the student-cost of upper secondary technical education is R$ 2,550.5 per year (in 2009 values). Thus, the annual student-cost of upper secondary technical education is only 15.22% higher compared with regular education.

The annual student-cost calculated by Vasconcellos et al. (2010), R$ 2,550.5, is much lower than our maximum annual cost shown in Table 16 (R$ 28,779.2). This result may be an indication that the economic benefits of secondary technical education are higher than its costs, which would allow public investment in this educational sector.

8. Conclusion

Technical and vocational education can contribute to the qualification of a workforce with the skills required for inclusion in the labor market. This type of education may have advantages over regular education by providing possibly shorter duration courses and teaching techniques and skills that may be more directly used at work. Vocational education in Brazil is divided into three

[15] INEP stands for Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (National Institute for Educational Study and Research Anísio Teixeira). It is a governmental institute.

modalities - technical education at the upper secondary level (TEC); technical education at the tertiary level; and short term training courses (FIC). TEC courses are divided into integrated, subsequent, and concurrent courses. This paper analyzes the impact on the hourly wage of individuals who complete a technical-vocational education course in relation to individuals who complete more general education modalities. We also analyzed the heterogeneity of these wage returns and the probability of entering the labor market or continuing to higher levels of education. We explore a propensity-score matching methodology which is robust to the selection into TVET on observables. We observe the differences across different modalities: general TEC, TEC after completion of general upper secondary education, TEC concurrently with general upper secondary education, technical education at the tertiary level, and FIC courses.

Our findings are interesting for four reasons. First, we show that the labor market insertion of individuals who completed a technical-vocational course is higher than for individuals who pursued more general types of education.

Second, we show that there are positive and statistically significant impacts of technical education, especially at the upper secondary level. Individuals who completed a general TEC course earn an hourly wage that is 9.7% higher compared with individuals who completed only general upper secondary education. Separating the TEC courses into "TEC course after general upper secondary education" and "TEC course concurrently with general upper secondary education", we find that individuals have hourly wages that are 11.5% and 8.1% higher, respectively, in relation to individuals who only completed general upper secondary education. Interstingly, individuals who have completed an FIC course had a standard annual salary that was only 2.2% higher compared with individuals who were working in 2007 and never completed a technical-vocational course.

Third, there is significant heterogeneity in the returns across different modalities. Returns for TEC tend to be highest for the education provided by Sistema S institutions and in "manufacturing." For FIC courses, returns are highest for the "health or welfare" sectors, "manufacturing or maintenance" (+11.6% on average), and "commerce or management" (11.3% on average). In addition, returns are highest for for individuals who obtained only a secondary level of education. Interestingly, for individuals who obtained a tertiary level of education, the differential impact of technical-vocational courses is null. These results may be an indication that the effect of tertiary courses outweighs the effects of technical-vocational courses at the upper secondary level. Individuals who completed technical education at the tertiary level have, on average, an hourly wage that is 71.4% higher compared with individuals who only completed general upper secondary education. This result indicates that pursuing a technical education at the tertiary level is much more

beneficial than simply completing a general upper secondary education and ceasing one's formal education. In addition, we show that the impact of technical courses at the upper secondary level is lower for older individuals. This is suggestive of the dissipation of the impact of these courses on the hourly wages of individuals.

We assume that TEC courses last for 1 year and calculated the maximum cost for technical-vocational education courses so that the investment would break even. We found that the amount of R$ 2,398.3 per month is the maximum cost for technical courses at the upper secondary level. For technical education courses at the tertiary level, this amount is R$ 16,397.9 per month. For FIC courses, the amount is R$ 613.6 per month.

Fourth, we show that those who completed a technical education course at the upper secondary level have the same (or higher, if the TEC course was completed concurrently with regular education) probability of attending or having already attended tertiary education.

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