The Impacts of On-the-Job Training on Labor Market Outcomes Dual Training System in the Philippines

Working Paper Series 2017-039

By: Futoshi Yamauchi , Taejong Kim , Kye Woo Lee , and Marites Tiongco

The Impacts of On-the-Job Training on Labor Market Outcomes

Dual Training System in the Philippines[1]

Futoshi Yamauchi[2], Taejong Kim[3], Kye Woo Lee[4], Marites Tiongco[5]

May 25, 2017

Abstract

This paper estimates the impacts of the Philippine Dual Training System (DTS) on labor market outcomes using a recent survey that tracked graduates from DTS and non-DTS programs provided by vocational training institutes. DTS programs partner with local employers to combine on-the-job training (OJT) with the conventional school- or center-based instructions, while non-DTS programs consist solely of the latter. The estimation results in Fuzzy Regression Discontinuity Design show a significantly positive impact on the most-recent monthly earnings. Quantitatively, the impact on the most-recent monthly earnings attributable to DTS is large, that is, more than 75% increase relative to the average non-DTS program graduate earnings, and the impact significantly increases with the OJT intensity, measured by the number of hours of in-

[1] We would like to thank Aniceto Orbeta, Felipe Barrera-Osorio, Dhushyanth Raju, Elmer Talavera, Raja Bentaouet Kattan, Marissa Legaspi, Ursula Mendoza and seminar participants in the 2016 ASEAN+3 HRD Forum (Seoul), the 13th National Convention on Statistics (Manila), TESDA and the World Bank for useful comments and suggestions. We owe thanks to Irene Isaac, Marissa Legaspi, Ursula Mendoza, and their colleagues at the Planning Office of TESDA for their wholehearted support for the project and guidance. We are grateful to Imelda Pagtolun-an (Research Institute for Mindanao Culture at Xavier University) for her leadership and insights that guided our data collection in the field. Special thanks go to the survey team, especially Ninosa Nuque, Jhat Palma, Rowena Maximo, Lita Sealza and the Sustainable Development Solutions for their efforts to track former trainees. We thank KDI School of Public Policy and Management for financial support. The opinions and conclusions expressed in this paper are ours and do not necessarily reflect positions of the World Bank and its member governments. Any remaining errors are ours.
[2] Corresponding author. Development Research Group, The World Bank, 1818 H Street, NW, Washington DC 20433; Email: fyamauchi@worldbank.org; Phone: +1-202-473-2065.
[3] KDI School of Public Policy and Management
[4] KDI School of Public Policy and Management
[5] De La Salle University, Manila

company training and work. The above results indicate that the OJT part of DTS is the essential contributor to higher earnings of the DTS graduates.

Keywords: Dual training, On-the-job training, Labor market, Philippines

JEL Classifications: J24, O15, M53

It has been increasingly recognized that vocational training has to be responsive to skill needs in the economy so that those who are trained in vocational training programs can readily contribute to the production, narrowing the existing skill gaps. When particular skills required in production are not readily available from the labor market, companies need to train their employees (or hire those who are trainable and train them) to develop their own human capital specific to their production technology. This often happens through on-the-job training (OJT). In developed economies, companies often work with vocational training institutions to provide OJT for their trainees to more effectively secure skills well-tuned to their technological needs, in an arrangement that might be termed Dual Training System (DTS). However, such DTS arrangements are relatively new in developing countries, and often face challenges in its adoption and expansion. In this paper, we conduct an impact evaluation of such a dual training system provided by vocational training institutions in the Philippines.

The accumulation of human capital is crucial in productivity growth at both firm and aggregate levels. Among various types of the investments in human capital, training and learning in the workplace play important roles in the accumulation of human capital. While schooling investment mainly contributes to the accumulation of general human capital, training investments in the workplace aim to enhance skill formation attuned to specific production technologies (Becker, 1962; Mincer, 1962). Although qualitative case studies are available to report the importance of skill formation and training investment in the context of productivity growth in developing countries (Inoki & Koike, 1990, for instance), quantitative evidence on the returns to on-the-job training remains scant.[6]

More recently, empirical studies of OJT have tried to directly identify returns to training using data mainly from the US and UK (Bartel, 1995, for instance). Though the necessity of firm-level training seems to be more urgent for industrial development in developing countries, identifying returns to such training is rare in the studies of such countries (see, e.g., Schaffner, 2001; Yamauchi, Poapongsakorn, & Srianant, 2009; Sekkat, 2011).[7] Yamauchi et al. (2009) showed evidence from workers in Thai manufacturing firms that (a) returns to informal on-the-job training are robust and significant, contrary to findings from developed countries; (b) technical change induces both on-the-job and off-the-job training; and (c) controlling for technical change makes returns to OJT even larger. The findings of the paper suggest that OJT enjoys advantages over general vocational training in the face of rapid technical change. Based on these studies, one may argue that there is a scope that government sponsored vocational

[6] The main reason for the paucity of econometric assessment of OJT and other workplace-based skills formation is the necessary diversity in contents and modalities of training due to heterogeneity in production and organizational structure. Bypassing this problem, labor economics has traditionally focused on tenure effects in wage regressions, with an interpretation that years of tenure represent the accumulation of firm-specific human capital (Altonji & Shakotko, 1987; Topel, 1991).

[7] In the context of developed countries, studies such as those of Bartel (1995), Booth, Francesconi, and Zoega (2003), Booth and Brian (2002), Lynch (1992), Veum (1995), Blundell, Dearden, and Meghir (1996), Loewenstein and Spletzer (1999), and Loewenstein (1998), estimate returns to training using individual earnings data. The first five studies use the first-differenced fixed effect estimation of wage equations, estimating the effect of training on wage change or growth. Black and Lynch (1996), Lynch and Black (1998), and Barrett and O'Connell (2001) used establishment or firm-level data to estimate the effect of training on productivity. There are recent studies on vocational training (e.g,, Attanasio, Kugler, & Meghir, 2011, Card, Ibarrarán, Regalia, Rosas-Shady, & Soares, 2011, Hicks, Kremer, Mbiti, & Miguel, 2013; Hirshleifer, McKenzie, Almeida, & Ridao-Cano, 2015; Kugler, Kugler, Saavedra, & Prada, 2015) but OJT is not directly analyzed.

training programs could benefit from partnerships with firms through incorporation of workplace-based training to have access to more frontier technologies used in the workplace.

One example is the DTS in the technical and vocational institutions (TVIs) managed by the Technical Education and Skills Development Authority (TESDA) in the Philippines.[8] The DTS is officially defined as an instructional mode for technology-based education and training in which learning takes place alternately in two sites, the school or the training center on the one hand and the company on the other (Republic Act No.7686, known as the Dual Training System Act of 1994). For instance, about 50% of its trainees at the Jacobo Z. Gonzales Memorial School of Arts and Trade, one of the training institutions that pioneered the DTS,[9] are placed in the DTS during the second (and last) year of their training. Generally, the DTS track is popular and oversubscribed among the trainees.

For employers who participate in the DTS program, it promises availability of future employees trained to their specific needs and standards. Employers pay 75% of the minimum wage to DTS trainees through TVIs (when employers pay less than 75%, it is called DTP: Dual Training Program).[10] For training institutions, the DTS track means maximized use of limited facilities and equipment and less need for expensive investments in sophisticated equipments.

[8] TESDA is the government agency mandated to manage and supervise technical education and skills development in the Philippines. As the nation's premier TVET authority, the agency sets the direction of the TVET policy through plans and regulations, issues certificates for workers and training providers, and provides for TVET indirectly through training scholarships and directly through the 122 TESDA Technical and Vocational Institutes (TVIs) under the direct TESDA management. In 2011, the number of enrollees at the TTIs was about 157,000 and the number of graduates about 140,000. These figures account for about 10% of the total number of trainees supported by TESDA's provision, but in terms of intensity and duration of the training, the TVIs represent a key component in the TESDA's TVET provision. The remaining enrollees and graduates belong to vocational training centers of various duration and much more diverse occupations.

[9] Actual lengths of DTS and instructional trainings vary across majors and institutions. The impact evaluation focuses on gap in earnings and employment incidence between DTS and non-DTS trainees within each institution/enrollment year. Observations are not used in estimation if the length of OJT in DTS was less than 20 weeks.

[10] This waiver from the minimum wage regulation entails a danger whereby a company hires low-skilled workers without paying the otherwise mandated minimum wage. This danger is noteworthy in sectors that do not require sophisticated skills.

More than anything, the DTS is intended to benefit the trainees. TESDA envisages that the DTS beneficiaries enjoy quality training and acquire proper skills, work attitude,[11] and knowledge leading to improved employability and better labor market outcomes. While the apparent popularity of the DTS track among trainees may be taken as a prima facie evidence for significant advantages DTS accords them, no systematic evaluation has been carried out to assess the impacts of the DTS on labor market outcomes. Thus, a rigorous impact evaluation is required to establish the DTS program effectiveness.

This paper uses a stochastic version of the regression discontinuity design, known as the Fuzzy Regression Discontinuity Design (FRD) to estimate the impacts of DTS on labor market outcomes relative to (non-DTS) regular programs. Through FRD, we compare labor market outcomes between the DTS and regular program graduates from the same institution. The critical assumption of FRD is that the probability of enrollment in DTS/DTP discretely increases when a certain threshold is crossed (Section 5 provides clear evidence that supports this assumption). The DTS program has a significantly positive impact on labor market earnings relative to regular programs. The magnitude of its impact increases with the intensity of OJT received during DTS, which provides corroborating evidence that the OJT component of DTS is a critical factor that explains higher labor market earnings among the DTS graduates. The impact on current employment incidence is found significant only when OJT is intensive enough.

The paper is organized as follows: The next section describes the DTS in the Philippines. . We then proceed to describe our econometric approach. Survey and sample are described afterwards. We end with the empirical results. A simple model of on-the-job training to provide theoretical underpinnings to the empirical investigation can be found in the Appendix.

[11] The importance of work attitude and ethics is emphasized in Dualtech, one of the most active DTS implementers.

Dual Training System and TESDA in the Philippines

This section describes the DTS and some related issues before discussing our impact evaluation methodology. TESDA was established in 1994 and mandated by law. The TESDA Board is mandated to formulate coordinated and fully integrated technical education and skills development policies, plans, and programs (Republic Act No.7796, also known as the TESDA Act of 1994). TESDA implements competency assessment and certification of workers in pursuit of professionalization of skilled workers. It develops competency standards and qualifications, coupled with training standards and assessment instruments, which serve as the basis for the registration, accreditation, and delivery of the various programs. As well, TESDA provides equitable access and provision of programs to the growing number of TVET clients. It also funds programs and projects for technical education and skills development. It supports TVET institutions (TVIs) through trainer's development program, curriculum and materials development, career guidance and placement, and scholarship programs. The training delivery is conducted under three modes of training, namely: institution-based (school-based and center-based); enterprise-based; and community-based.

Among the three modes, there seem to be a very small proportion of enrollment and graduation in the enterprise-based programs (Table 1). The composition of enrolment and graduation in 2014 shows that the institutions-based training (i.e., school-based and center-based training) accounts for 51% and 47% of the total enrollment and graduates, respectively. There was an upward trend in enrollment from 2005 to 2014 compared to the enterprise-based mode, which has declined by 21% from 2010 to 2014. A similar pattern was observed for graduates, where the institution-based mode increased by 17.7%, while the enterprise-based programs declined by 5.6%. The increase in enrollment and graduates in institution-based mode may be attributed to the increase in the number of TVIs, which accounts for 4,733 in 2013 (57% increase from 2001), a preponderance of them accounted for by private TVIs (TESDA, 2008-2013).

Table 1

Enrolment and Graduation by Mode of Delivery

	2005		**2010**		**2014**	
Delivery mode	**Number**	**%**	**Number**	**%**	**Number**	**%**
Enrolled	1,683,382	100	1568617	100	2003417	100
Institution-based	487,086	28.9	860919	54.9	1028005	50.6
Enterprise-based	59,003	3.5	86978	5.5	69138	3.4
Community-based	1,137,293	67.6	620720	39.6	936274	46
Graduates	1,154,333	100	1344371	100	1785679	100
Institution-based	334,757	29	671488	49.9	833659	46.7
Enterprise-based	101,550	8.8	73352	5.5	57417	3.2
Community-based	718,026	62.2	599531	44.6	894603	50.1

Sources: Planning Office, TESDA; TVET Statistics (TESDA, 2008-2013). In 2005, both institution-based and enterprise-based modes show the number of graduates larger than that of enrollers. This occurred due to the fact that those who graduated in a particular year started in previous years.

Under the enterprise-based mode is an instructional delivery system called DTS, implemented in partnership between TVIs and private companies. DTS differs from other enterprise-based modes, for example, apprenticeship and learnership programs, in that trainees learn alternately in the TVI and the partner company.

The Philippine DTS was adopted from the German model and was first introduced in the Philippines in the 1980s through a joint project of the Southeast Asian Science Foundation and the Hans Seidel Foundation, first implemented in the Dualtech Training Center. The Dualtech experience was deemed successful and satisfactory, and began to see a nationwide expansion in 1991. In 1994, the DTS was institutionalized through the enactment of Republic Act No.7686 (also known as the Dual Training System Act of 1994). Under the DTS Act, TESDA is mandated to promote, coordinate, and administer the DTS.[12]

In DTS, the school and the partnering companies share the responsibility of providing trainees with well-coordinated learning experiences. Trainees typically spend about 40% of the training/learning time in school and 60% in companies for hands on training in the workplace. They also receive allowance of up to 75% of the minimum wage rate. This is one of the likely reasons why DTS is preferred among TVI trainees.

To encourage participation of companies or firms, the government offers tax incentives. As stated in Republic Act No.7986, "they shall be allowed to deduct from their taxable income the amount of fifty percent (50%) of the actual system expenses paid to the Accredited Dual Training System Educational Institution for the establishment's trainees, provided that such expenses shall not exceed five percent (5%) of their total direct labor expenses but in no case to exceed twenty-five million pesos (P25 million) a year". In 2009, there were 348 TESDA accredited companies and 57 TVIs/schools in the DTS program. In addition to tax breaks, companies can also reduce recruitment and training costs, and maintenance costs.

Some of these TVIs state that DTS provides a smoother transition from training to employment with absorption rates ranging from 80% to 90%, with graduates getting employed in the companies where they received OJT (our communications with some TVIs, such as MFI, Dualtech, Don Bosco Tech, and JZGMAST). Skills mismatch in training can be avoided as training investments are directly responding to the needs of industries. On the trainee side, the advantages of DTS are to gain access to state-of-the-art technologies in industries as well as

[12] Dualized Training Program (DTP) relaxes some legal requirements on the company side such as the compliance with the 75% of minimum wage payment, so that private companies can more easily adopt a nearly-identical enterprise-based training with TVIs. For example, MFI in NCR uses DTP, not DTS. The analysis in this paper covers both DTS and DTP under the rubic of DTS, while most of the programs under consideration are of DTS variety, MFI is providing the single case of DTP in the sample.

earnings during training. The importance of DTS is expected to intensify with rapidly changing technologies in the workplace, as TVIs have to constantly catch up with technological changes and update their training equipments and trainers' skills, which is often difficult under tight resource constraints and administrative rigidities.

Empirical Method

In the analysis we compare labor market outcomes between the DTS graduates and regular program graduates. One challenging issue for this purpose is selective enrollment in the DTS programs. For example, those who enter the DTS-specialized institutions are clearly a selected group, which does not represent the population of vocational trainees in general. To compare the DTS and regular program graduates, we use a sample of institutions that offer both the programs so that comparison is feasible within an institution. One critical fact that enables us to identify the DTS impact (relative to the regular programs) is that (i) DTS are usually more popular than regular programs and therefore tend to be oversubscribed, and (ii) TVIs want to send "good trainees" to private companies for OJT.

The above setup naturally accommodates the regression discontinuity design. In an actual application below, we adopt a stochastic version of the regression discontinuity design, that is, Fuzzy Regression Discontinuity (FRD) using a forcing variable. In FRD, we need a discontinuity in the probability of receiving treatment (i.e., enrollment in DTS in our context) given the forcing variable.

The actual estimation problem in FRD is translated into an instrumental variable estimation (Wooldridge, 2009; Hahn, Todd, & Van der Klaauw, 2001). Let w be the indicator that takes the value of one if the trainee is in DTS and zero in a regular program. In this setting,

$$\Pr(DTS \mid x) = F(w = 1 \mid x) \qquad (1)$$

depends on the forcing variable x and there is a point at which the probability discontinuously jumps. Let c define the point in x where $F(w = 1 \mid x)$ discretely jumps. Once casted in the instrumental variables estimation, the specification is written as:

$$y_i = \alpha_0 + \tau w_i + \beta_j (x_i - c) + d_j I[x_i \geq c](x_i - c) + \mu_{jt} + v_i \qquad (2)$$

where y is labor market performance indicator such as logarithm of most-recent monthly earnings and current employment incidence, *i*, *j* and *t* are trainee, institution and enrollment year, respectively, τ measures the average treatment effect of DTS, $I[x_i \geq c]$ is the indicator function that takes the value of one if $x_i \geq c$ and zero otherwise, μ_{jt} is the institution-year fixed effects, and v_i is an error term. The domain of x is restricted to $c - h < x < c + h$ for local estimates, where h is the window band, c is the threshold point at which $F(w = 1 \mid x)$ discretely changes. Let $z = I[x_i \geq c]$ be the IV for w. Institution-specific effects are allowed in β_j and d_j, and institution enrollment-year dummies are included (thus, the inference is based on within-institution-year variations).

Average High School Grade as Forcing Variable

From our field interviews, it is evident that TVIs look at both academic and behavioral aspects of each trainee when they choose “good” trainees who are sent to private companies under DTS. For academic part, some TVIs use assessment exams, which can be standard exams on mathematics and career fitness or TVI’s own exam. However, it was always emphasized at our interviews that the behavioral side of trainee characteristics is very important. All of them told us that attitudes are often more important than academic ability since they will be working with regular workers in the company. Trainees in DTS are expected to be diligent, humble, trustworthy, organized, and harmonious to be a good team member in the production setting.

This setup leads to a formula that scores both academic and behavioral aspects of a trainee to implicitly score him/her: $q_{jt} Academic_i + (1 - q_{jt}) Behavioral_i$ where q_{jt} is a weight in *(0,1)*, specific to TVI and cohort. The weight q_{jt} can change from year to year due to changes in needs of the DTS companies. Assume that $Academic_i = f(g_i)$ and $Behavioral_i = r(g_i)$ where g is high school grade (GPA) and both *f(.)* and *r(.)* are strictly increasing. Therefore, we assume that "good students" in high school immediately prior to TVI are good in both academic and behavioral aspects. The score is also strictly increasing in grade. If both *f(.)* and *r(.)* are linear in *g*, the score is also linear in *g*. There exist g^*_{jt} above which TVI assigns trainees for DTS.[13]

The forcing variable used in the analysis is the average high school grade (*g*). The average grade is normalized by using residuals after controlling institution enrollment-year dummies, gender, and the current age, so that the normalized grade is centered at zero in each institution enrollment-year cell. The normalized average grade is hereafter denoted by *x*. The above normalization makes g^*_{jt} comparable across institutions and enrollment-years.

We use a data-driven method to determine the cutoff point *c* in *x* following Card, Mas, and Rothstein (2008); Chay, McEwan, and Urquiola (2005); and Bertrand, Hanna, and Mullainathan (2010). In these studies, the cutoff point was chosen based on the goodness of fit. Details will follow in the next section.

Data

[13] This line of conjecture helps the government to improve targeting. The average high school grade is a measure observable to all at the final stage of high school.

Survey and Sample

For this study, a tracking survey was conducted to evaluate the DTS impacts on labor market outcomes. The survey was conducted in January to March 2016 covering Regions 3 and 4A and National Capital Region (NCR), collecting information from 958 respondents who enrolled in DTS or regular programs in nine TVIs from the regions starting from 2008 and subsequently completed.[14] The sampling followed clustered random sampling, randomly selecting former trainees from each of the chosen clusters or TVIs.

The following four criteria are used to chose TVIs: (a) both DTS (or DTP) and regular programs are in operation in the same institution, (b) they assess trainees objectively when selecting trainees for DTS, (c) records are kept under good conditions for the past several years, and (d) they are located in Region 3, 4A, or NCR.[15] The first condition is essential because we estimate the impact of DTS relative to regular programs controlling institution-specific factors. The second condition of implementing an objective assessment (e.g., own exam or career orientation test) in the screening process and the third are also important for obvious reasons. Careful investigations identified nine TVIs that satisfy the four criteria above.[16] For each TVI/enrollment cohort cell, the sampling randomly chose 20 trainees from DTS and additional 20 from regular programs. If a trainee did not complete their program (i.e., not graduated), such a case was replaced randomly.

The survey modules were designed to collect information on former trainees' background, schooling, vocational training, DTS details, work history before and after training, and others.

[14] Those who did not complete the programs in which they initially enrolled were replaced.

[15] Historically DTS was first adopted in Regions 3 and 4A, which results in the setup where there are relatively many TVIs that implement DTS in these regions.

[16] The survey included National College of Science and Technology (NCST) in Cavite, but the analysis dropped observations from NCST since we later found that the institution only has DTS. Non-DTS courses were part of their college program, which is not comparable to DTS.

Since the survey aimed to track those who were already in the labor market, tracking activities involved a substantial amount of efforts in contacting and locating and, if successful, interviewing our sample. Simultaneously, we conducted an institution survey to collect information from the sample institutions on enrollment records, programs and institutional costs, and so forth.

Table 2

Sample Institutions

Region	TVI	Type	Size	Years	n1	n2
Region III	Provincial Training Center Mariveles	Public	Large	2009-14	194	140
Region III	Provincial Training Center Orion	Public	Large	2011-14	160	150
Region III	Provincial Training Center Tarlac	Public	Large	2010-14	112	106
Region III	Jocson College	Private	Small	2012-14	49	43
Region III	Gonzalo Puyat School of Arts and Trades	Private	Small	2013	29	28
Region IV-A	Jacobo Z. Gonzales Memorial School of Arts And Trades	Public	Large	2009-14	150	134
Region IV-A	Provincial Training Center Rosario	Public	Medium	2012-14	85	80
Region IV-A	Quezon National Agricultural School	Public	Medium	2012-13	18	10
NCR	MFI Foundation	Private	Large	2008/09-13/14	145	142
Total					**942**	**833**

Note: n1 is the tracked sample size. n2 is the sample size after trimming with the condition that programs in the master list and actual respondents' answers concur. A large reduction from n1 to n2 is observed in PRC Mariveles.

Table 2 lists the sample institutions. After triming the sample by imposing a basic screening conditions based on consistency between actual and reported programs in which they enrolled, the effective sample size turned out to be 847 (n2) with 367 DTS trainees and 475 regular program trainees. A large reduction is observed in Provincial Training Center Mariveles in Bataan (from 194 to 140), where the implementation of the tracking survey also faced some difficulties (the record management was also not perfect at the institution).

Table 3

Program Type and Enrollment Year

	Enrollment year						
Program type	2009	2010	2011	2012	2013	2014	Total
DTS	33	26	44	78	99	82	362
Regular	38	25	52	107	136	113	471
Total	71	51	96	185	235	195	833

Based on n2, Table 3 tabulates the sample by enrollment year. The balance between DTS and regular programs is relatively stable across enrollment years.

Table 4

Mean Comparisons Between DTS and Regular Programs

	DTS	Regular	Diff	t value No cluster	t value TVI cluster*
High school average grade	83.222	82.062	1.1604	3.31	1.11
Ln most-recent monthly earnings	9.1817	9.0893	0.0914	1.81	1.14
Currently employed or not	0.7277	0.6830	0.0446	1.09	1.10

Sample: age between 20 and 40, enrolled after 2009. * t values are calculated allowing for correlations within TVI (cluster).

Next, log of most-recent monthly earnings, average high school grade, and current employment incidence are compared between DTS and regular program graduates (Table 4). In earnings and average high school grade, DTS trainees have significantly higher values (t values) if the within-cluster correlations are ignored. The probability of being currently employed also shows a higher value among DTS graduates but the difference is statistically insignificant.[17] Interestingly, all of the above mean comparisons render insignificant results if correlations within TVI clusters are allowed.

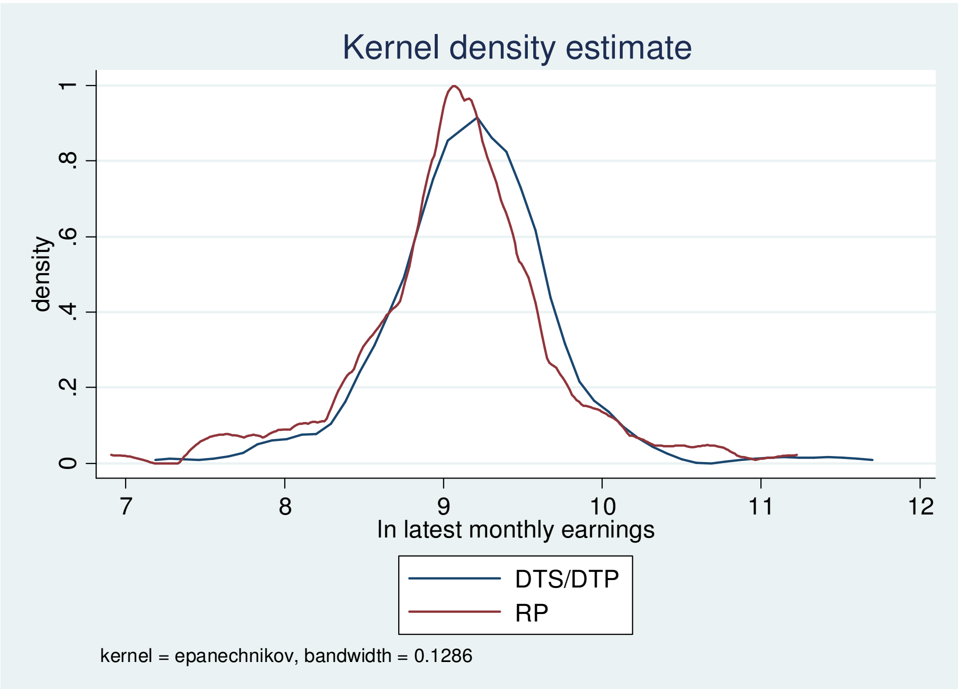

***Figure 1*. LDistrbutuion of Ln most-recent monthly earnings.**

[17] In addition, the preliminary analysis of the average high school grade shows that females are performing significantly better than males, but their average earnings are significantly lower than males. In all aspects, it is important to control gender in the average high school grade equation (to define the forcing variable) and the fuzzy regression discontinuity IV estimation.

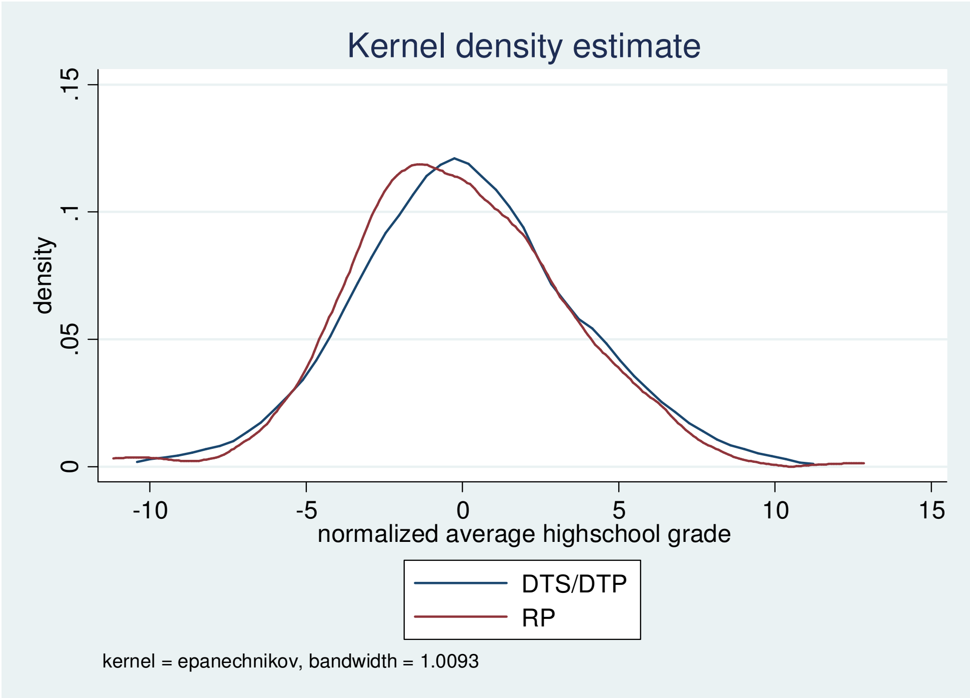

***Figure 2*. Distribution of normalized average high school grade.**

Note: Normalized average high-school grade is defined as the residuals of the average high school grade after controlling for institution dummies, enrollment year dummies, their interactions, female dummy, and age.

Figures 1 and 2 show distributions of log of most-recent monthly earnings and the normalized average high school grade (defined as the residuals of the average high school grade after controlling for institution dummies, enrollment year dummies, their interactions, female dummy and age), respectively. Both measures demonstrate stochastic dominance by DTS trainees. It is clear that academically better performing students at high school are likely to be selected into DTS.

Probability of Being in DTS

This sub-section establishes the relationship between the probability of being enrolled in DTS and the proposed forcing variable of the (normalized) average high school grade.[18] As proposed in Card et al. (2008), Chay et al. (2005) and Bertrand et al. (2010), we adopt a data-driven method based on the goodness of fit to select the optimal cutoff point.

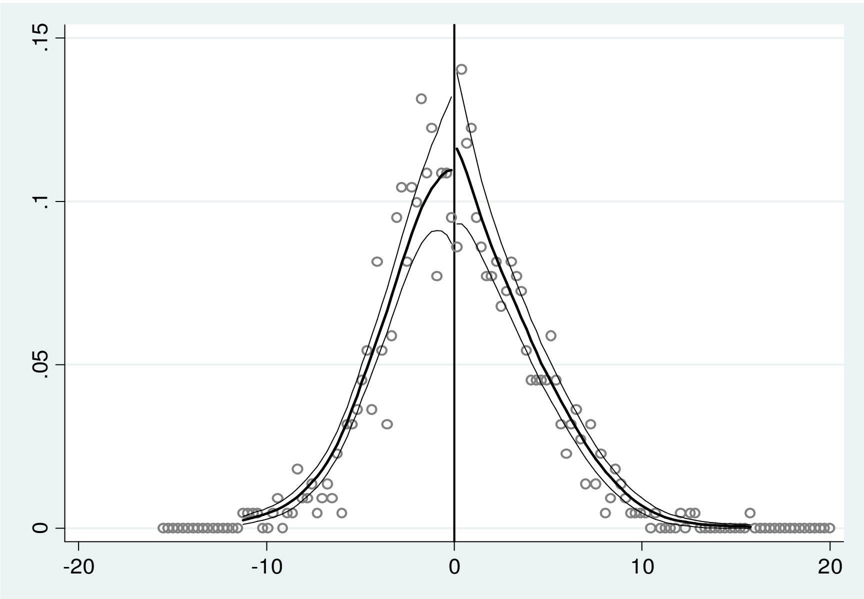

***Figure 3*. Smoothness test on the forcing variable.**

Smoothness of the forcing variable is tested at c=0.0. McCrary test was conducted and displayed in Figure 3. The test concludes that the normalized average high-school grade is statistically smooth in its density though we observe a small increase from below to above the cut-off point.

[18] We initially planned to use exams adopted by TVI to conduct the FRD analysis, but later it was discovered that TVIs implement different types of exams. This setup raises a serious concern on their comparability. It is very difficult to standardize scores too. Another serious issue is that TVIs are not solely relying on their exams, but weigh heavily on trainees' behavioral aspects. Since they are sent to companies to work (though they are still officially as TESDA trainees), TVIs have to select "good trainees" who can be "good workers".

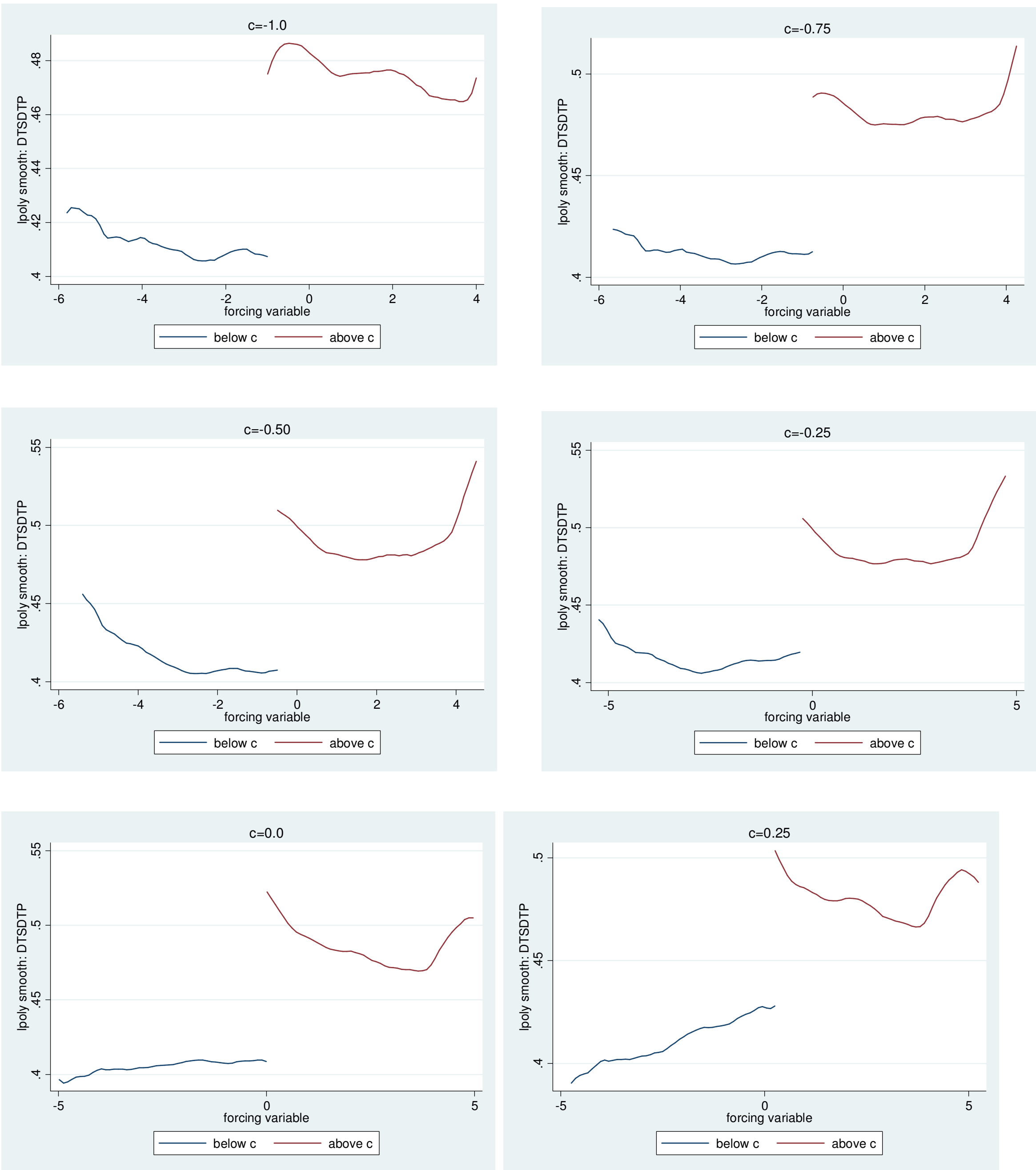

Figure 4**. DTS enrollment probability with chosen cutoff points**.

Figure 4 shows the non-parametrically estimated probability of being in DTS based on a different cutoff point of the forcing variable (*x*). The graphs seem to display a clear discrete point between -0.5 and 0.0. The cumulative distribution of *x* shows that $F(x< -2)$ = 28.39% and $F(x < 2)$ = 68.89%, that is, about 40% of the observations are in the interval (-2, 2).[19]

Table 5

Cutoff Point Selection

Dependent: DTS Indicator						
Cutoff (*c*)	-1.0	-0.75	-0.50	-0.25	0.0	0.25
$z=I(x>c)$	0.0642	0.0706	0.0776	0.0708	0.0866	0.0710
	(1.66)	(1.84)	(2.03)	(1.85)	(2.27)	(1.86)
R sq	0.0041	0.0050	0.0061	0.0051	0.0071	0.0051
N obs	666	674	674	678	677	678

Numbers in parentheses are absolute t values using robust standard errors. The window was chosen with plus and minus 5 from cutoff point.

The results of a simple goodness of fit analysis are shown in Table 5. The choice of $c = 0.0$ gives us the highest value of R squared, followed by $c = -0.50$. The following analysis is conducted under the condition of the cutoff point at $c = 0.0$.

Table 6

Comparison of Characteristics Between Below and Above the Cut-Off Point

	x range	t value	p value

[19] The calculation of the cumulative distribution uses the unrestricted sample in which no conditions are imposed. Thus, the distribution can differ from those used in the impact estimation.

Female	(-1,1)	0.4563	0.6490
	(-2,2)	0.4186	0.6759
	(-3,3)	-0.7635	0.4457
Age	(-1,1)	0.7602	0.4488
	(-2,2)	0.4882	0.6258
	(-3,3)	-1.1137	0.2662
Father’s years of schooling completed	(-1,1)	1.0021	0.3184
	(-2,2)	0.5307	0.5961
	(-3,3)	-0.4655	0.6419
Mother’s years of schooling completed	(-1,1)	0.2023	0.8400
	(-2,2)	-0.8344	0.4049
	(-3,3)	-1.2309	0.2192

Two-sided tests allowing for unequal variances.

To have more confidence in similarity of trainee characteristics below and above the cut-off point, several variables are compared (t test). Table 6 shows mean comparisons of female indicator, current age, mother’s and father’s years of schooling completed. Note that the latter two variables are typically unobservable to TVIs and employers. The results confirm that these characteristics are statistically not different (i.e., the equality is not rejected on both sides).

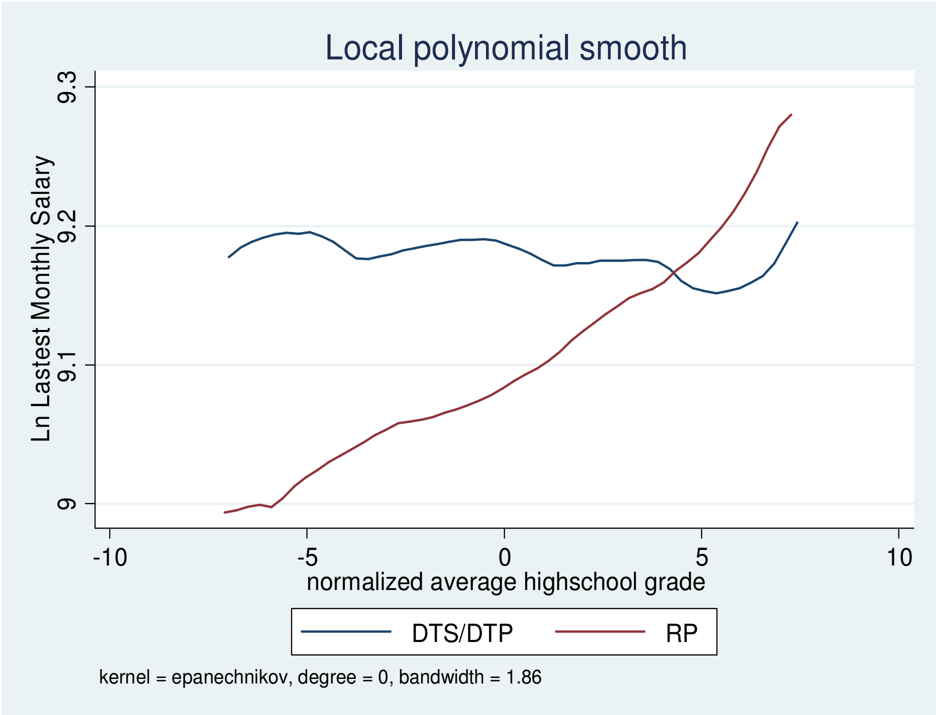

***Figure 5*. Relationship between average high school grade and ln latest monthly earnings.**

At this stage it is important to check the relationship between earnings and the normalized average high school grade by program type. Figure 5 shows that earnings of the DTS graduates do not increase significantly with the normalized average high school grade. In contrast, earnings of the regular program graduates monotonically increase. This observation is quite interesting in its own since, in the case of DTS, training seems to disconnect the relationship between ability (proxied by the average grade) and earnings, while the (positive) relationship remains strong in the case of regular programs. In this sense, DTS seems to effectively transform trainees through OJT, which makes their eventual earnings more independent of their initial condition prior to training. In contrast, the effectiveness of regular programs is questionable since the initial condition, that is, high school grade, still significantly impacts earnings even after training.

Though we use an instrumental variable method to estimate the local impact, it is also appealing to have a non-parametric counterpart following Wooldridge (2009, p. 39). The impact estimate is derived as the difference in ln earnings between DTS and regular programs at the cutoff point divided by the gap in the probability of being in DTS at the cutoff point. From Figures 3 and 4, that is the ratio of 0.1 to 0.15 at c = 0.0. The value is approximately 0.75. Incidentally, this is almost the same as the estimate in Column 1 of Table 6. The next section shows the results using FRD (IV estimation).

Estimation Results

As described in the previous section, the actual estimation problem in FRD is translated into an instrumental variable estimation (Woolridge, 2009; Hahn et al., 2001). We consider two outcome variables: ln most-recent monthly earnings and current employment. The most-recent monthly earnings come from the most recent employment even though he or she may not be currently employed. For example, a former trainee may have experienced a few jobs after completing training, but currently is temporarily unemployed in transition to the next employment. In this case, the last employment is considered to compute the most-recent monthly earnings.

The specifications include the forcing variable: the normalized average high school grade (x), its interaction with $z = I(x>0)$, age, female indicator (all of which interacted with institution dummies), and institution-enrollment-year dummies. The identifying instruments are z interacted with institution dummies. The forcing variable x is defined as the residuals of the average high school grade after controlling institution dummies, enrollment year dummies, their interactions, female dummy, and age. The sample consists of the respondents trained in company more than

20 weeks, aged between 20 and 40, and enrolled after 2009. As indicated above, the following estimation accommodates potential heterogeneity specific to each institution by including interactions with institution dummies (not shown in tables).

Table 7

DTS Impacts on Ln Most-recent Monthly Earnings (c = 0.0)

Sample: x in (-8,8)		Hours per week > 40
DTS	0.7532	1.0775
	(3.75)	(4.92)
Number of obs	446	411

Numbers in parentheses are absolute t values using robust standard errors allowing for within institution correlations. The specifications include the forcing variable: the normalized average high school grade (x), its interaction with z = I(x>0), female dummy, age (all of which interacted with institution dummies), and institution-enrollment-year dummies. The identifying instruments are z interacted with institution dummies. The forcing variable x is defined as the residuals of the average high school grade after controlling institution dummies, enrollment year dummies, their interactions, female dummy, and age. Sample: number of weeks in company larger than 20 if DTS, age between 20 and 40, and enrolled after 2009.

Table 7 summarizes key results on the most-recent monthly earnings using the sub-sample in which the enforcing variable is relatively close to the cutoff point, that is, *x* is in the range between -8 and 8. Since the discontinuity is observed when the normalized average high school grade is around zero, the local estimates using its neighborhood are more reliable. The fuzzy regression discontinuity design estimation shows significantly positive impacts on the most-recent monthly earnings (Column 1).

Column 2 presents the impact estimate when the DTS trainees are restricted to those who work for 40 hours or more per week in in–company OJT. The impact is much larger when the sample is restricted this way (five days if they worked eight hours per day). The result clearly indicates that more intensive OJT creates a larger impact.[20]

Table 8

Direct Absorption Right After DTS

Dependent: Ln most-recent monthly earnings		
Sample: x in (-8,8)		Hours per week > 40
DTS	1.4670	1.4821
	(2.10)	(2.19)
Number of obs	328	318

Numbers in parenthesis are absolute t values using robust standard errors with institution clusters. The specifications include the forcing variable: the normalized average high school grade (x), its interaction with $z = I(x>0)$, female dummy, age (all of which interacted with institution dummies), and institution-enrollment-year dummies. The identifying instruments are z interacted with institution dummies. The forcing variable x is defined as the residuals of the average high school grade after controlling institution dummies, enrollment year dummies, their interactions, female dummy, and age. Sample: number of weeks in company larger than 20 if DTS, age between 20 and 40, and enrolled after 2009.

In Table 8, we use only those who were directly absorbed in the same company right after DTS training.[21] This exercise aims to see (i) whether those who continued to work in the

[20] Potentially the impact of the OJT intensity is non-linear and the firms may have chosen the optimal level of the OJT intensity. However, a relatively small sample size did not allow us to test this hypothesis.
[21] The survey data show that 32.9% of the DTS trainees worked in the same company right after DTS training.

same company after DTS earn more later on (again compared to regular program graduates from the same TVI) and (ii) whether or not joining in DTS had an effect that signals their higher ability to the market, so they can easily move to other companies after DTS to enjoy equally high earnings. In the benchmark case (Column 1), the impact estimate is larger than that of Column 1, Table 7. However, the gap between Columns 1 and 2 in Table 8 is negligible, which implies that, in this group, whether they worked long hours in a week during DTS does not matter in determining the latest earnings. This is quite sensible since the direct absorption signals a good outcome of the on-the-job training during DTS. In other words, the above results confirm that signaling effects are not significant in this empirical setting.

Table 9

Alternative Cutoff Point

Dependent: Ln most-recent monthly earnings		
Sample: x in (-8,8)		Hours per week > 40
c = -0.5		
DTS	0.6067	1.0034
	(2.29)	(3.28)
Number of obs	446	411
c = -0.25		
DTS	0.8652	1.2721
	(3.41)	(5.83)
Number of obs	446	411

Numbers in parenthesis are absolute t values using robust standard errors with institution clusters. The specifications include the forcing variable: the normalized average high school grade (x), its interaction with z = I(x>0), female dummy, age (all of which interacted with institution dummies), and institution-enrollment-year dummies. The identifying instruments are z interacted with institution dummies. The forcing variable x is defined as the residuals of the average high school grade after controlling institution dummies, enrollment year dummies, their interactions, female dummy and age. Sample: number of weeks in company larger than 20 if DTS, age between 20 and 40 and enrolled after 2009.

Table 10

Alternative Window in the Forcing Variable

Dependent: Ln most-recent monthly earnings		
Sample: x in (-4,4)		Hours per week > 40
DTS	0.7141	0.9056
	(2.71)	(1.69)
Number of obs	354	324

Numbers in parenthesis are absolute t values using robust standard errors with institution clusters. The specifications include the forcing variable: the normalized average high school grade (x), its interaction with z = I(x>0), female dummy, age (all of which interacted with institution dummies), and institution-enrollment-year dummies. The identifying instruments are z interacted with institution dummies. The forcing variable x is defined as the residuals of the average high school grade after controlling institution dummies, enrollment year dummies, their interactions, female dummy and age. Sample: number of weeks in company larger than 20 if DTS, age between 20 and 40 and enrolled after 2009.

Table 9 shows estimation results when the cutoff point is chosen at -0.5 and 0.25. These cases also showed relatively good fits in Table 5. The results confirm that the impact on the latest earnings remains robust regardless of a small change in the cutoff point. Next, an alternative window on the forcing variable is used. Table 10 shows the results using (-4,4) for the normalized average high-school grade. The results remain qualitatively, though the impact is less significant in the case of weekly working hours larger than 40 (Column 2). The above exercises confirm robustness of the main results against alternative settings on the cut-off point and the forcing variable window.

Based on the estimate on Column 1 of Table 7 and the average most-recent monthly earnings among regular program graduates (PhP8,934.17), an increase of monthly earnings attributed to DTS is PhP9,979. Given that the average earnings among regular program graduates in our sample remain a little above the urban/city minimum wage level (PhP8,100), the estimated increase due to completing DTS is substantial. Quantitatively, the impact on the most-recent monthly earnings that is attributable to DTS is significant.

Our estimation results showed significantly positive impacts on the most-recent monthly earnings. In both monthly earnings and current employment incidence, the impact increases as the length of OJT during DTS increases. Quantitatively, the impact on monthly earnings attributable to DTS is large relative to the average regular program graduate earnings.

Conclusions

Our results show that the DTS has a significantly positive impact on labor market earnings relative to regular programs. The magnitude of its impact increases with the intensity of OJT received during DTS, which provides corroborating evidence that the OJT component of DTS is a critical factor that explains higher labor market earnings among the DTS graduates. This finding may encourage us to promote the dual training to resolve youth unemployment often reported in developing countries.

The government-sponsored dual training through on-the-job training in private companies can have higher rate of return than regular training programs operated only in vocational training institutions, as suggested in Yamauchi et al. (2017). In their work, the calculations of economic internal rate of return incorporated opportunity costs, institutional costs at both vocational training institutions and colleges, and training costs at firms.

What hampers wider adoption of DTS among companies despite popularity among trainees in TVIs that implement DTS? In Table 1, we saw a downward trend in recent years. In light of our theoretical model (Appendix), there are several possibilities: (i) ability distribution of TESDA trainees restricts the number of candidates suitable to DTS; (ii) human capita formed in TESDA prior to the DTS assignment is insufficient so trainees are not fully ready to work in production; (iii) the firm's share in the surplus is too small so firms do not have enough incentives to accept trainees; (iv) training cost in firms is high; and (v) human capital formed on the job while in DTS is not sufficient to be productive in production. Ironically since DTS opportunities are rationed in the current setup (i.e., not all candidates are assigned to DTS), labor market returns to DTS (relative to non-DTS) are estimated to be rather very high in our study.

Though more empirical investigations are required especially on the firm's perceptions and decision makings regarding DTS, our study implies that on-the-job training can be a key policy solution to reduce youth unemployment upon completion of vocational training or school graduation often reported in many developing and developed countries.

References

Acemoglu, D., & Pischke, J. (1998). Why do firms train? Theory and evidence. *Quarterly Journal of Economics,* 113, 79–119.

Acemoglu, D., & Pischke, J. (1999). Beyond Becker: Training in imperfect labour markets. *Economic Journal, 109,* F112–F142.

Altonji, J. G., & Shakotko, R. A. (1987). Do wages rise with seniority? *Review of Economic Studies*, *54*, 437–459.

Attanasio, O., Kugler, A., & Meghir, C. (2011). Subsidizing vocational training for disadvantaged youth in Colombia: Evidence from a randomized trial. *American Economic Journal: Applied Economics, 3*, 188-220.

Barrett, A., & O'Connell, P. J. (2001). Does training generally work? The returns to in-company training, *Industrial and Labor Relations Review*, *54,* 647–662.

Bartel, A. P. (1995). Training, wage growth, and job performance: Evidence from a company database. *Journal of Labor Economics*, *13*, 401–425.

Becker, G. S. (1962). Investment in human capital: A theoretical analysis. *Journal of Political Economy*, *70*, 9–49.

Bertrand, M., Hanna, R., & Mullainathan, S. (2010). Affirmative action in education: Evidence from engineering college admissions in India. *Journal of Public Economics, 94*, 16-29.

Booth, A. L., Francesconi, M., & Zeoga, G. (2003). Unions, work-related training, and wages: Evidence from British men. *Industrial and Labor Relations Review*, *57*, 68–91.

Booth, A. L., & Brian, M. L. (2002). *Who pays for general training? New evidence for British men and women* (Discussion Paper 486). Bonn, Germany: Institute for the Study of Labor (IZA).

Black, S., & Lynch, L. M. (1996). Human capital investments and productivity. *American Economic Review*, *86*, 263–267.

Blundell, R., Dearden, L., & Meghir, C. (1996). *The determinants and effects of work-related training in Britain*. London: Institute for Fiscal Studies.

Card, D., Ibarrarán, P., Regalia, F., Rosas-Shady, D., & Soares, Y. (2011). The labor market impacts of youth training in the Dominican Republic. *Journal of Labor Economics, 29*, 267–300.

Card, D., Mas, A., & Rothstein, J. (2008). Tipping and the dynamics of segregation. *Quarterly Journal of Economics,* 123, 177–218.

Chay, K. Y., McEwan, P. J., & Urquiola, M. (2005). The central role of noise in evaluating interventions that use test scores to rank schools. *Americal Economic Review, 95*, 1237–1258.

Chang, C., & Wang, Y. (1996). Human capital investment under asymmetric information: The Pigovian conjecture revisited. *Journal of Labor Economics, 14*, 505–519.

Hahn, J., Todd, P., & Van der Klaauw, W. (2001). Identification and estimation of treatment effects with a regression-discontinuity design. *Econometrica, 69*, 201–209.

Hicks, J. H., Kremer, M., Mbiti, I., & Miguel, E. (2013). *Vocational education in Kenya: Evidence from a randomized evaluation among youth* (Unpublished Manuscript). Vanderbilt University, Nashville.

Hirshleifer, S., McKenzie, D., Almeida, R., & Ridao-Cano, C. (2015). The impact of vocational training for the unemployed: Experimental evidence from Turkey. *Economic Journal, 123*, 2115–2146.

Inoki, T., & Koike, K. (1990). *Skill formation in Japan and Southeast Asia.* Tokyo: University of Tokyo Press.

Katz, E., & Ziderman, A. (1990). Investment in general training: The role of information and labour mobility. *Economic Journal, 100*, 1147–1158.

Kugler, A., Kugler, M., Saavedra, J., & Prada, L. H. (2015). *Long-term direct and spillover effects of job training: Experimental evidence from Colombia* (NBER Working Paper No.21607). Cambridge: National Bureau of Economic Research.

Lee, K.W., Kim, D.H. & Lee, H.K., 2016, Is the meister vocational high school more cost-effective? *International Journal of Educational Development* 51: 84-95.

Loewenstein, M. A. (1998). Dividing the costs and returns to general training. *Journal of Labor Economics. 16*, 142–171.

Loewenstein, M. A., & Spletzer, J. R. (1999). General and specific training: Evidence and implications. *Journal of Human Resources*, 34, 710–733.

Lynch, L. M. (1992). Private sector training and the earnings of young men. *American Economic Review*, *81*, 299–312.

Lynch, L. M., & Black, S. E. (1998). Beyond the incidence of employer-provided training. *Industrial and Labor Relations Review*, *52*, 64–81.

Mincer, J. (1962). On-the-job training: Costs, returns, and some implications. *Journal of Political Economy*, *70*(5), 50–79.

Dual Training System Act of 1994, Republic Act No.7686 (1994). Accessed on May 2, 2016 from this link: http://tesda.gov.ph/about/tesda/91

TESDA Act of 1994, Republic Act No.7796 (1994). Accessed on May 2, 2016 from this link: http://www.tesda.gov.ph/About/TESDA/10

Schaffner, J. A. (2001). *Turnover and job training in developing and developed countries: Evidence from Columbia and the United States* (Unpublished Manuscript). Boston University, Boston.

Sekkat, K. (2011). Firm sponsored training and productivity in Morocco. *Journal of Development Studies*, *47*, 1391–1409.

TESDA (2008 – 2013). TVET Statistics. Accessed on May 2, 2016 from this link: http://www.tesda.gov.ph/Uploads/File/Planning2015/TVETSTAT/Philippine-TVET-Statistics2008-2013-%20FINAL.pdf

Topel, R. (1991). Specific capital, mobility and wages: Wages rise with seniority. *Journal of Political* Economy, *99*, 145–176.

Tullao, T.S. Jr, Cabuay, C.J., Garcia, E., Ang, D.T., & Sayoc, R. (2014). Costing and financing higher education in the Philippines (Unpublished manuscript). De La Salle University Angelo King Institute for Economic and Business Studies.

Wooldridge, J. M. (2009). *Average treatment effect estimation: Regression discontinuity designs* (Note). Michigan State University, Lansit

Wooldridge, J.M. (2010). *Econometric analysis of cross section and panel data*, 2nd Edition, Cambridge: MIT Press.

Veum, J. (1995). Sources of training and their impact on wages. *Industrial and Labor Relations Review*, *48*, 812–826.

Yamauchi, F., Poapongsakorn, N., & Srianant, N. (2009). Technical change and the returns and investments in firm-level training: Evidence from Thailand. *Journal of Development Studies*, *45*, 1633–1650.

Yamauchi, F., Lee, K. W., Kim, T., & Tiongco, M. (2017). Does the government sponsored on-the-job training pay off? Insights from Dual Training System in the Philippines (Unpublished Manuscript). World Bank, Washington D.C.

Appendix

Appendix lays out a simple model to describe incentives faced by training institutions, firms, and trainees and subsequent human capital formation in order to provide a theoretical foundation for the DTS impact evaluation. For simplicity, assume that there are one training institution and one firm.

Human Capital

Human capital is formed through two stages: (i) training at the institution that focuses on acquisition of basic knowledge and skills as well as work ethics in the first stage and (ii) a choice between OJT in the firm that enables trainees to acquire skills specifically demanded by the firm's production technology or another round of training in the institution that aims to provide a similar opportunity but not as well attuned as the one offered by the firm. The second stage in training is offered by either the firm or the TVI. The first stage training is mandatory.

Human capital components formed at the first and second stages are denoted by h_1 and h_2, respectively. For simplicity, $h_1 = h$ for all trainees. Human capital formed at the second stage is $h_2(K, h_1| a)$ where K is capital that embodies technology and a is ability. Assume that trainees are characterized by their abilities (a), distributed as $F(a)$ bounded by $[\underline{a}, \bar{a}]$. For now, we assume that a is observable to all the agents, including the TVI and the firm. Assume that h_2 is strictly increasing in each input. Assume that $K^{DTS} > K^{TVI}$, that is, the firm has more capital than the institution. Further, assume complementarities between ability and capital, that is, $\frac{\partial^2 h_2}{\partial K \partial a} > 0$, which implies that $\frac{\partial h_2^{DTS}}{\partial a} > \frac{\partial h_2^{TVI}}{\partial a}$ since $K^{DTS} > K^{TVI}$. A single crossing property is assumed for h_2^{DTS} and h_2^{TVI} on a and they intersect at $a = a^*$.

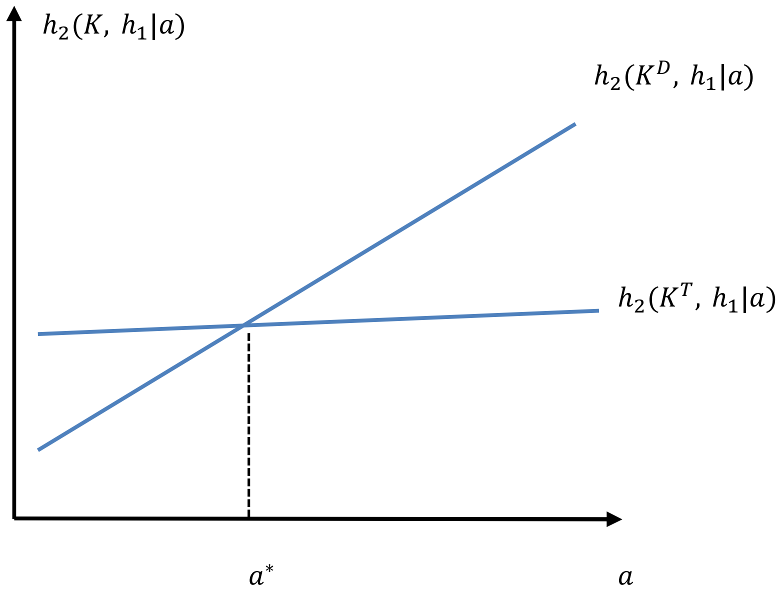

Figure A1. Inherent ability and human capital formation during the second phase: $h_2(K, h_1| a)$.

Why do they cross? We assume that low ability trainees, if assigned to DTS, incur a potentially large cost to the firm by, for example, adversely affecting the entire production (imagine they work as members of a team in production line), so that human capital formed at this stage could be lower than otherwise in the institution. High ability trainees have comparative advantage in DTS.

Productivity

Trainee's marginal productivity is determined by human capital h_1 and h_2. Let $w(h_1, h_2)$ denote the (marginal) productivity. Assume that $w_1 > 0, w_2 > 0$ and $w_{12} > 0$: human capital formed at the first and second stages are complementary. We have $w(h_1, h_2^{DTS}) > w(h_1, h_2^{TVI})$ since $h_2^{DTS} > h_2^{TVI}$. For simplicity, assume that the productivity at the second period is constant during the period even though the trainee usually learns production skills and his/her productivity increases through on the-job training. The second-stage productivity also determines earnings after the training period.

Individual Earnings

The earnings for the DTS trainees are determined as follows:

$$y^{DTS} = \alpha w(h_1, h_2) + \beta w(h_1, h_2)$$

where α is the share of their productive contribution the trainee receives during the on-the-job training ($0 < \alpha < 1$) and β is the absorption rate right after the training ($0 < \beta < 1$). Similarly a trainee in the institution has earnings

$$y^{TVI} = \beta w(h_1, h_2)$$

where his/her income at the second stage is zero (while training in the institution). For simplicity, the same hiring probability β is assumed for trainees in DTS and TVI. Therefore, if (h_1, h_2) is the same, a trainee (of given a) prefers DTS.

Firm's Decision

The firm gains through saving of labor costs when participating in DTS, that is, $(1-\alpha)w(h_1, h_2)\,|_a > 0$. Assume that training cost c is incurred for each trainee. The firm maximizes

$$\max_{a^{**}} \int_{a^{**}}^{\bar{a}} (1-\alpha) w(h_1, h_2) dF(a) - cn^{**}$$

where $n^{**} = \int_{a^{**}}^{\bar{a}} dF(a)$, that is, the number of trainees who can be accepted by the firm. The share parameter α critically determines the firm's profit and the firm's decision on how many trainees to accept in DTS.[22]

TVI's Decision

Finally, we introduce the objective function for the TVI. Assume that the institution maximizes the total amount of human capital by

$$\max_n \int_{\underline{a}}^{\bar{a}} (h_1 + h_2) dF(a)$$

subject to $n \le n^{**} = \int_{a^{**}}^{\bar{a}} dF(a)$. That is, the institution optimally assigns a trainee to DTS or TVI at the second stage. When the constraint does not bind, a^* is the solution: the institution assigns trainees to DTS if $a \ge a^*$ and to TVI if $a \le a^*$. However when, more realistically, n^{**} is relatively small (i.e., $a^* \le a^{**}$), a^{**} is the solution in the trainee assignment decision. The latter situation is described in Figure A2.

[22] This setup assumes that trainees cannot freely move to other firms due to imperfect observability of the second-stage human capital h_2 and/or the ability a. Thus the firm has an incentive to train. See Acemoglu and Pischke (1998, 1999), Katz and Ziderman (1990), and Chang and Wang (1996) on the role of information and imperfect labor markets in determining the firm's incentive to train workers. The institutional setup under DTS differs from the above papers since the DTS trainees at the second stage are still officially under TESDA and the partner firms comply with the agreements with TESDA. The trainees cannot freely move to other companies.

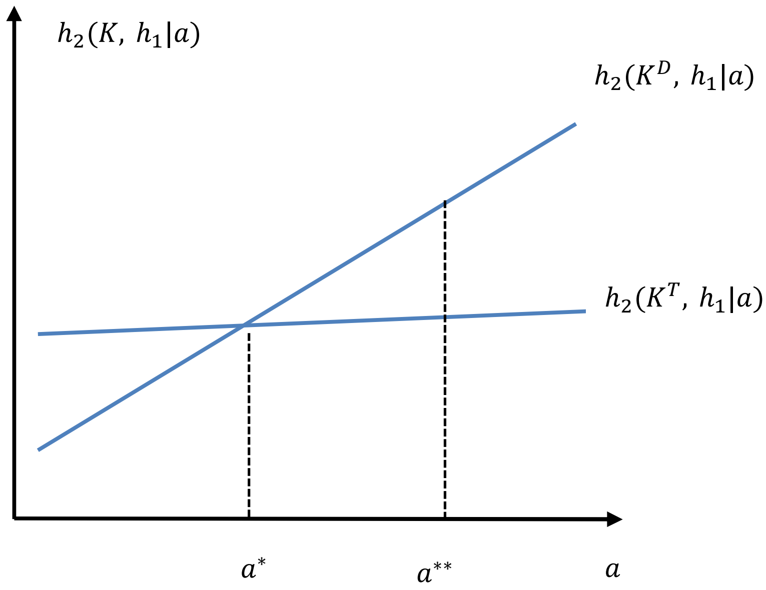

Figure A2. Human capital formation during the second stage and the firm's decision: $a^* < a^{**}$.

a* (n*) and a** (n**) where *n* is the number of trainees in DTS

Observability

To bridge between the above theory and our empirical analysis, a realistic assumption is introduced on the (un)observability of a. That is, the ability is only imperfectly observed or measured. This is true for all the agents above as well as researchers.

$$x = a + v$$

where x is a test score or a measure of the trainee's past academic performance. In the empirical analysis, we observe only x in the data to infer a from. This setup creates a situation where the assignment of trainees to DTS is probabilistic since a^* is not perfectly identifiable. The empirical analysis aims to measure the impact of DTS by

$$\Delta w|_{a=a^{**}} = w(h, h_2^{DTS})|_{a=a^{**}} - w(h, h_2^{TVI})|_{a=a^{**}}$$

where a^{**} is the solution in the trainee assignment decision (Figure A2) and $h_1 = h$ for all trainees independent of a.