

Are Apprenticeships Programs Effective? Lessons for Latin America and the Caribbean

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Are Apprenticeships Programs Effective? Lessons for Latin America and the Caribbean¹

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July 2017

Abstract

The purpose of this paper is to provide information that contributes to the decision to implement apprenticeships in the region. To this end, we present global evidence of the effectiveness of apprenticeships. In particular, we present a review of the impact evaluations of these programs on labor outcomes, taking into account the different applied methodologies and their according level of rigor. Overall, the results suggest that apprenticeships –whether integrated into the country’s education systems or not- show positive effects on individuals and firms. However, the evidence of rigorous evaluations is scarce, particularly in Latin American and the Caribbean countries. While the implementation of apprenticeships in the region is potentially beneficial, especially if the lessons learned from other countries with a long tradition of implementing these programs are integrated, there is a need to generate more evidence regarding their effectiveness.

Keywords: Apprenticeships, effectiveness, training, skills.

JEL Codes: I38; J24; M53

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Content

Executive summary	3
1. Introduction.....	5
2. Introduction to apprenticeships	6
2.1. What is an apprenticeship?.....	6
2.2. How do apprenticeships differ from on-the-job training or traditional vocational education?6	
2.2.1. Apprenticeships within the vocational education system.....	6
2.2.2. Apprenticeships under the scheme of on-the-job training.....	7
2.3. Summary of apprenticeships in the world	9
3. What do we know about the impact of apprenticeships?	10
3.1. Impact on the labor market.....	11
3.1.1. Impact on the transition to the labor market (employment, unemployment and duration) ...	11
3.1.2. Impact on wages.....	13
3.1.3. Impact on labor stability, mobility and other labor market variables.....	15
3.2. Impact on skills transferability and skills-occupation match	18
3.3. Impact on firms: incentives, productivity and costs	18
3.4. Cost-Benefit Analyzes.....	19
4. Policy discussion.....	21
References	23
Annex A – The methodology of apprenticeship impact evaluations	28
Annex B – Summary of main apprenticeship evaluations	36

Executive summary

This paper compiles global evidence about the effectiveness of apprenticeships with the purpose of contributing to the decision of implementing apprenticeships in the region. To this end we identified 40 quantitative evaluations that analyze apprenticeships under the definition of Fazio et al. (2016) in countries where apprenticeships are integrated into the educational system as well as in countries where they are implemented from a perspective closer to on-the-job training. These studies analyze several variables in order to estimate the impact of apprenticeships on apprentices (employability, unemployment, wage, wage growth, skills and job match, among others), training firms (productivity, earnings, costs), and on society (net benefits).

While there is evidence of the effects of apprenticeships, there are two conditions that impose challenges so we can learn from them directly: (i) the evidence is concentrated in developed countries with a broad experience in this type of interventions, while the evidence in developing countries and the region is practically non-existent; and, (ii) there are no experimental evaluations that estimate the causal effect of apprenticeships without the need to relay that the assumptions used in the methodologies will hold. In this scenario, we present the evidence classifying it according to its potentiality to identify causal effects, starting with the quasi-experimental evaluations and then presenting descriptive models that do not directly address the potential endogeneity in the apprentices' participation.

Our review shows that there is evidence that apprenticeships – whether they are integrated into the countries' educational systems or not- have positive effects for apprentices and firms. Several studies, quasi-experimental and based on descriptive models, show that one of the main benefits of apprenticeships is to ease the school-to-work transition, which can be translated into a higher probability of finding a job (including formal and non-temporary jobs) in the future. Results in the same vein include a lower probability of unemployment, and a shorter duration of unemployment.

Another variable that has been extensively studied is the increase in the wage level or the wage growth rate, for which we find that apprenticeships have a positive effect in the wage increase of participants versus non-qualified workers, but not versus academic education. On the other hand, results regarding job turnover, the transferability of skills to other firms, and the match between skills and occupation are ambiguous with some studies showing positive results and other negative or even non-significant. The exception is Germany where evidence on skills transferability seems to be concrete throwing positive results.

Firms do not only seem to recoup investment costs but there is also evidence that their productivity rises when the participation of apprentices increases. While costs are higher for firms introducing training plans for the first time, moderate subsidies can help to cover these costs and have an effect on the number of apprentices' vacancies. Finally, cost-benefit analyses seem to indicate that these programs bring net benefits for firms and society.

In conclusion, this review presents a series of lessons that should be considered in the design of apprenticeships for Latin America and the Caribbean, and other developing regions. However, given the question of how effective the apprenticeships are in Latin America and the Caribbean,

there is still a need to generate more evidence based on rigorous methods. A good practice is to introduce experimental methods that allow reliable and generalizable results, which is why it is critical to consider an impact evaluation when designing an apprenticeship.

1. Introduction

Faced with high unemployment rates –especially among youth²- and the existence of skills gaps affecting productivity, apprenticeships have drawn the attention of several countries in Latin America and the Caribbean as a good alternative to increase employment and strengthen ties with employers. Apprenticeships - also called as dual education systems - are defined as structured programs that seek to develop a set of general and specific skills from a combination of classroom and workplace training, and where the skills are certified and recognized by the industry.

The evidence suggests that these programs show positive results as they improve access to higher quality and better paid jobs (Heckman and Kautz, 2013; European Commission, 2013). To a lesser extent and in a qualitative manner, it has been found that apprentices improve soft or social-emotional skills (Rose, 2004; Halpern, 2009). However, these evaluations have been concentrated in developed countries with a long tradition of implementation. In addition, due to the absence of experimental evaluations, the validity of the results depends on the assumptions of the methodologies used to estimate the causal effects of the programs holding true.³ This absence makes it relevant to analyze the rigor and the results of the existing evidence on apprenticeships in different scenarios.

The main objective of this document is to provide information to policy makers that will contribute to their decision to implement apprenticeships in the region. To this end, we present a comprehensive review of apprenticeships evaluations. The selection criteria are as follows: (i) the studies should focus on programs that meet the formal definition according to Fazio et al. (2016); (ii) the evaluations should follow a clear quantitative methodology; and (iii) the aim of the studies should be on the results of apprenticeships- or vocational training including apprentices - thus studies analyzing the participation,⁴ implementation,⁵ and the funding⁶ of these programs are discarded.

² The unemployment rate in the Latin America and the Caribbean region is estimated at 4% for adults between age 25 and 64, while the youth unemployment rate (age 15-24) is 14% according to the Labor Market and Social Security Indicators System (Inter-American Development Bank, 2017).

³ While there is an experimental evaluation in Ghana where each apprentice is placed randomly in a firm (Hardy and McCasland, 2015), the apprenticeship system in this country does not meet the formal definition used in this review.

⁴ However, the studies analyzed in this paper present evidence about individual characteristics associated with participation in these programs. For instance, in the case of the US, there is evidence that non-white (Lynch, 1989) and lower educated (Booth et al., 1991) individuals are less likely to be apprentices. Also, Parey (2012) finds that the number of places influences the decision between being an apprentice or a full-time vocational student in Germany. In East Germany the quality of the general school certificate has an impact on the access to the program and on the later transition of the apprentice (Büchel, 2002). Finally, in France the participation is determined by not having obtained the Bepc (1st general school diploma) and having a father who was an independent or manual worker (Bonnal et al., 2002).

⁵ There is evidence that apprentices are more effective in medium-sized firms with a favorable opportunity structure, meaning with available places to be employed after the training (Kalleberg and Witte, 1995). A 10% increase in the wage received during training seems to increase the retention rate by 2-16 percentage points (Wilkelmann and Euwals, 2004).

⁶ Schweri et al. (2007) indicate through a simulation of subsidies for Switzerland that these should be modest, covering only the required amount so that the training cost won't be prohibitive. They should also be targeted at firms that do not provide training in order to have an impact on increasing the number of places available.

The first part of this paper presents a formal definition of an apprenticeship and its main differences from full-time vocational training and other forms of on-the-job training. The second section describes the main results of the analyzed evaluations, which include the impact for graduates, for firms and for society in general. The third section classifies the set of evaluations according to their capacity to identify causal effects. The conclusions section discusses learning for Latin America and the Caribbean and other developing countries. Finally, two annexes are presented: Annex A – The methodology of apprenticeship impact evaluations analyzes and classifies the methodologies used in the revised evaluations and Annex B – Summary of main apprenticeship evaluations presents a table summarizing the main characteristics of the 40 evaluations analyzed in this document.

2. Introduction to apprenticeships

2.1. What is an apprenticeship?

According to the document "Apprenticeships for the XXI Century: A Model for Latin America and the Caribbean" (Fazio et al., 2016), apprenticeships are defined as jobs that include structured on-the-job training combined with a share or related technical off-the-job training to learn a skilled occupation that is certified and recognized by the industry. Specifically, according to the document, apprenticeships have the following distinctive characteristics (page 1):

“(i) the apprentice has a job with structured training; (ii) the training plan combines on-the-job training with a professional master and in-class training; (iii) there is a written employment contract between the employer and the apprentice, where the rights and responsibilities on both sides are established; and (iv) the apprentice takes an assessment to receive an industry recognized certification of acquired qualifications upon completion.”

In order to differ and properly identify the several programs implemented as apprenticeships, we must first understand their differences with other forms of skills development programs.

2.2. How do apprenticeships differ from on-the-job training or traditional vocational education?

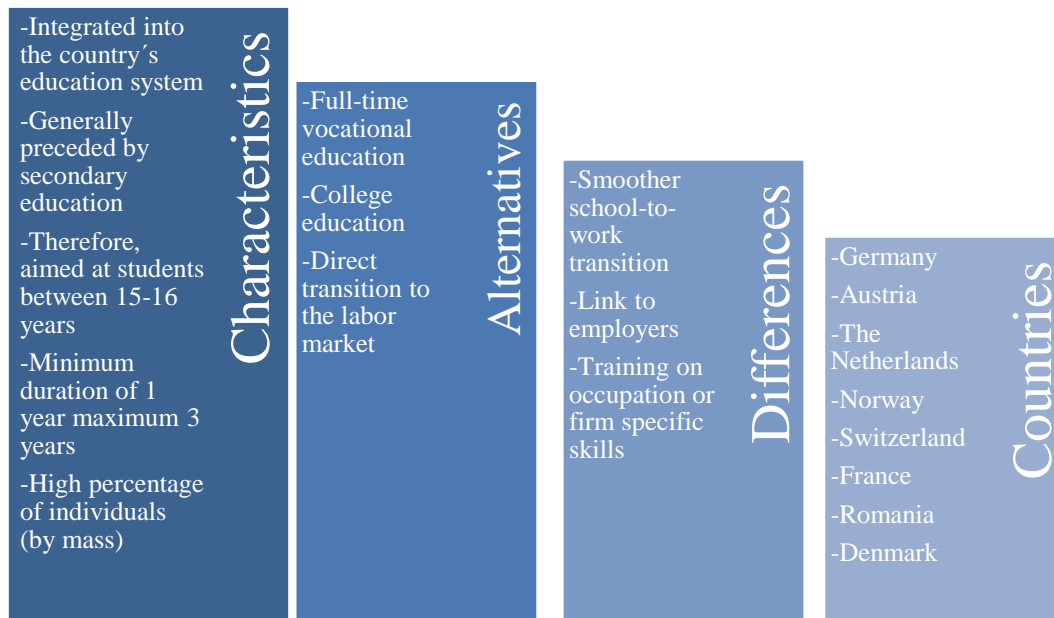
Apprenticeships, unlike on-the-job training programs, are developed within a legal framework that defines the apprentice as an employee of the firm where they work and are trained (Fazio et al., 2016). And unlike classroom-based full-time vocational education, apprentices develop specific occupational skills by having a direct connection with the employer through part-time workplace experience. By having a component of vocational training and on-the-job training, apprenticeships can be analyzed under both perspectives. In the next section we take a deeper look into the characteristics of each perspective.

2.2.1. Apprenticeships within the vocational education system

An analysis of subsidies in Denmark found that the size of the subsidy does indeed affect the demand for apprentices. In addition, this may have a 7% increase in demand for apprentices in the manufacturing and trade sectors alone, with no significant effect on the others (Westergaard-Nielsen and Rue Rasmussen, 1997).

Countries such as Germany, Switzerland, the Netherlands, among others, have integrated apprenticeships into their educational system and therefore a significant percentage of young people adopt them as an educational option.⁷ In Germany, for instance, from the age of 10, young people can choose between three paths within the secondary education level: the *Gymnasium* if they wish to pursue an academic education; or, if they wish to aspire to vocational training, the *Realschule* or the *Hauptschule*. Young people who choose a technical education must then decide between the ages of 15 and 16 whether they choose a full-time vocational education, a dual system comprised of part-time vocational school combined with an apprentice position in a firm, or the labor market directly (Kalleberg & Witte, 1995). Austria has a similar structure where young people can opt for a general secondary school (*Hauptschule*) which is mostly followed by vocational education. At this level, students can enter vocational school on a full-time basis, choosing between an intermediate vocational school that prepares them for a profession, or an upper vocational school that combines training for a profession with the preparation for the university entrance exam. On the other hand, those who want to pursue an apprenticeship carry out a year of pre-vocational school before leaving the full-time schooling (Festerer et al., 2008). The following illustration shows the main characteristics of apprenticeships analyzed under the perspective of vocational training within the education system; the most common alternatives for apprentices within these countries; their differences compared to the other alternatives; and some countries with this type of programs.

Figure 1. Apprenticeships under the perspective of dual vocational education



2.2.2. Apprenticeships under the scheme of on-the-job training

⁷ There is a tendency in the literature of these countries to define as a system (of apprenticeships) or a dual system of vocational education. However, this document will refer in a general way as apprenticeships to all training given in all countries.

Although several studies have analyzed apprenticeships from the perspective of on-the-job training, for Fazio et al. (2016) apprenticeships have very distinctive elements. Specifically, unlike on-the-job training programs, apprentices follow a structured training program, combined with classroom learning, which may include the development of complementary skills such as negotiation, communication, and so on. Other differences include certification of qualifications and its recognition by the industry. This type of scheme is present in the apprenticeship systems of the United Kingdom (UK), the United States (US), Australia⁸ and Brazil.⁹

In the case of the United Kingdom, there is a sophisticated qualification certification structure accompanying apprenticeships. Among the different certifications we can find one from the City and Guilds institute that offers entrance level qualifications (for beginners), level 1 (basic knowledge), level 2 (in an occupational area such as engineering technician, health care, construction, etc.) and level 3 (complex activities and supervision skills). Within the qualifications framework of City and Guilds lies the National Vocational Qualifications (NVQs) offered at levels 2 and 3.

The Business and Technology Education Council (BTEC) is another provider of certifications whose levels are: BTEC first diploma, BTEC subsidiary diploma, BTEC diploma and BTEC extended diploma. These certificates are equivalent to levels 1 and 2 of the General Certificate of Secondary Education (GCSE).¹⁰ However, BTEC also offers the Ordinary National Certificates and Diplomas (ONC and OND) which are equivalent to a vocational qualification of level 3 of the National Framework of Qualifications.¹¹

The main features of apprenticeships under the on-the-job training scheme are described below; along with the most common alternatives to apprenticeships for firms and for the apprentices; their differences versus these alternatives; and some countries that implement them.

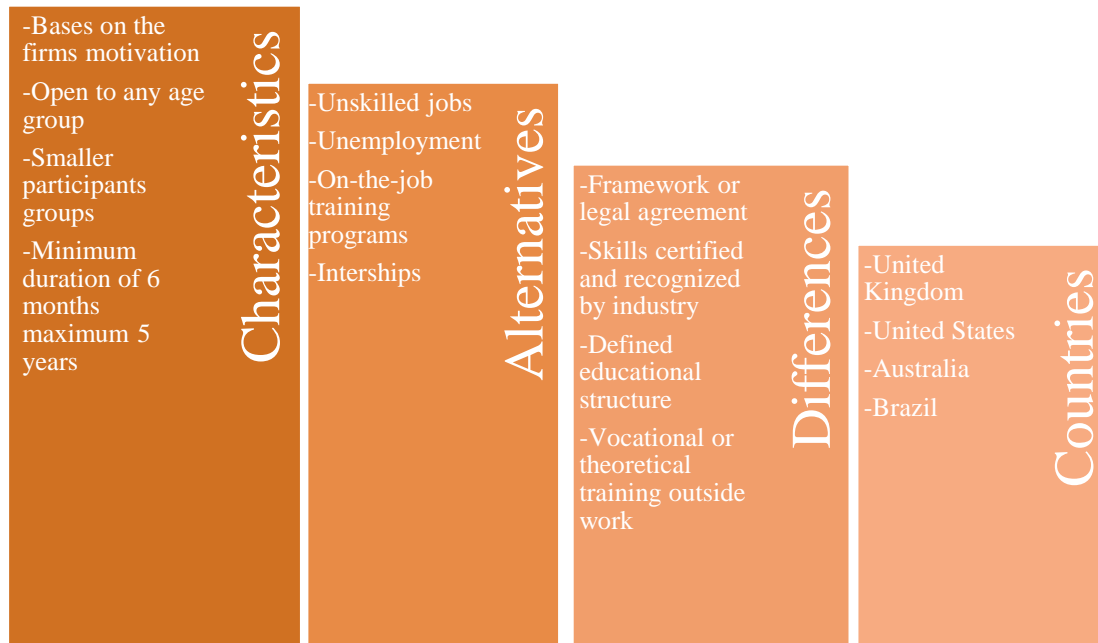
⁸ Australia has a nationally recognized qualifications framework where the apprentice can undertake full-time, part-time, or school-based training. Although there is an option where the apprentice can undertake a part-time job and carry out his secondary studies at the same time while being participant of a vocational training implemented by a registered organization, we classify it into this category since the program is available to all working age population, not necessarily secondary graduates. For more information on the apprenticeship system in Australia see: <https://www.australianapprenticeships.gov.au>.

⁹ According to Fazio et al. (2016), the Brazilian system has three out of the four aspects of the formal definition of apprenticeships. It has a contract between the employer and the apprentice, structured training, and training both inside and outside the workplace. However, it does not have a qualification certification that is recognized by the industry.

¹⁰ The GCSE is part of a national qualifications framework and is awarded to students in secondary education, ranging from 1 (lowest) to 9 (highest).

¹¹ To better understand the equivalencies between the different certifications refer to: <http://www.cityandguilds.com/qualifications-and-apprenticeships/qualifications-explained/qualification-comparisons>.

Figure 2. Apprenticeships under the on-the-job training scheme



2.3. Summary of apprenticeships in the world

As mentioned earlier, this paper presents a review of quantitative impact evaluations of apprenticeships globally. To this end, Table 1 below presents the main characteristics of the apprenticeships that have been evaluated and which are the main study object of this document.

Table 1. Evaluated apprenticeships

Country	Target groups	Number of beneficiaries	Duration	Integrated to the education system	Evaluations (#)
Germany	<i>Realschule</i> or <i>Hauptschule</i> graduates, students age 15-16	1,391,900 in 2013 according to the Apprenticeship Toolbox	Minimum 2 years Maximum 3 years Average 3 years	Yes	17
Australia	Working age population	278,500 as of September 2016 according to the National Center for Vocational Education Research	Minimum 1 year Maximum 4 years Average 2 years	No, but counts with a school-based Apprenticeship	1
Austria	<i>Hauptschule</i> graduates beginning at age 16	29,164 apprentices in 2015 according to the Apprenticeship Toolbox	Minimum 2 years Maximum 4 years Average 3 years	Yes	2
Brazil	Youth between age 14 and 24 in elementary or secondary education	837,000 between 2000 and 2010 according to the OIT	Maximum 2 years	No	1
Denmark	Youth from age 17 studying secondary level, or adults older than 25	74,456 up to February 2014 according to the Apprenticeship Toolbox	Average 3 years	Yes	1

United States	Individuals older than age 16	450,000 in 2012 according to Apprenticeships of the XXI Century	Minimum 1 year Maximum 6 years	No	6
France	Apprentice contract: between age 16-25	435,000 in 2014 according data from the Euroguidance	Minimum 1 year Maximum 3 years Average 20 months	Yes	1
	Professional contract: adults		Minimum 6 months Maximum 24 months		
The Netherlands	Graduates from the pre-vocational secondary school or the general secondary school since beginning at age 16 without an age limit	142,020 aprox. in according to the European Centre for the Development of Vocational Training	Minimum 6 months Maximum 4 years	Yes	2
Italy	Aimed at youth between age 15-18 years, but open to individuals up to age 29	550,000 aprox. in 2009 according to Comi & Grasseni (2014)	Minimum 18 months Maximum 4 years	Yes	1
Norway	Students in the vocational school path at the secondary level, beginning at age 16	35,257 in 2011 according to the Education and Research Ministry (2013)	Average 2 years	Yes	1
Switzerland	Students in the vocational school path at the secondary level, beginning at age 16	57,637 (<20 years) according to the American Institute for Contemporary German Studies	Minimum 3 years Maximum 4 years	Yes	4
United Kingdom	Older than age 16 not in full-time education	509,400 in 2015 and 2016 according to a Parliament's report	Minimum 1 years Maximum 5 years	No	2 ¹²
Romania	From age 16-25 in the vocational Education program	504 for 2014 according to a report from the Work, Family, Social Protection and the Eld Ministry	Minimum 6 months Maximum 3 years	Yes	1

Fuente: Fazio et al., 2016 and the Apprenticeship Toolbox Initiative (European Alliance of Apprenticeship, 2014)

3. What do we know about the impact of apprenticeships?

In order to understand the benefits that apprenticeships confer versus other policy alternatives available to individuals and firms, it is important to analyze the differences of these systems under the perspectives mentioned in the previous section (i.e., on-the-job training and technical vocational education) (Ryan, 1998). This section describes the main results found in the review of 40 studies (see Table 2) on apprenticeships, focusing on the results in the labor market and other key dimensions for firms' productivity. Annex A – presents more detail on the estimates found by these studies.

¹²Data is for the United Kingdom; however, this review includes an evaluation for England and one for Great Britain.

To the best of our knowledge, there is no experimental impact evaluation of an apprenticeship defined according to the criteria established in this document.^{13,14} According to the strategy used to deal with potential endogeneity bias, the methodologies used in these studies can be classified into quasi-experimental methods and descriptive models. Annex B – Summary of main apprenticeship evaluations presents more detail on the methodological classification used in this document.

The present section is divided into four subsections, and each one presents the results according to the methodology's capacity to identify causal effects (i.e. quasi-experimental evaluations and descriptive models). First, we describe the effects on the labor market measured through the transition to the labor market (employment, unemployment, and their duration), wages, and labor turnover and mobility. Likewise, the results regarding the transferability of skills and the match between skills and occupation are described. Third, evidence of the impact on firms measured through productivity, profits and costs indices is presented. Finally, the results of a set of cost-benefit analyzes are presented.

3.1. Impact on the labor market

About 80% of the studies analyzed show the results of apprenticeships on variables related to the labor market (See Table 2). Overall, evidence indicates that apprenticeships: on one hand, increase the probability of employment, the first employment length, wages and subsequent wage growth; and, on the other hand, reduce the probability of unemployment, among others. These advantages are present when apprentices are compared to graduates of full-time vocational education, workers that are unskilled or with other qualifications, although not when compared to graduates of academic education. In several studies, the results show to be positive for males only, even reaching negative effects for females.

3.1.1. Impact on the transition to the labor market (employment, unemployment and duration)

Several studies show that one of the main benefits of apprenticeships is to improve the work transition, which can lead to a higher probability of finding work in the future (European Commission, 2013). The maximum effect found in a quasi-experimental evaluation estimates that the probability for young people to have formal and non-temporary employment increased by 7 percentage points (pp) after the introduction of the apprenticeship law in Brazil (Corseuil et al., 2014). In Italy, where a reform was implemented to facilitate the recruitment of apprentices,

¹³ Experimental methods are the best option when attempting to measure the impact of any program, since randomization ensures that the group of individuals receiving the program (treatment) and those that do not (control) are fully comparable. This, in turn, ensures that there are no differences in unobservable variables (e.g., motivation) that affect both program participation and labor outcome of interest (e.g., wages). For example, in the case of endogeneity, we cannot say whether the positive results on wages of an apprenticeship are due exclusively to the program or whether it is also due to individual motivation (which leads people to apply for the program and, for example, be more active in wage negotiations). For more information see Annex B – Summary of main apprenticeship evaluations

¹⁴ Recently the case of Ghana has been analyzed through an experimental evaluation (Hardy & McCasland, 2015). However, for the purpose of this review, it has not been included since apprenticeships in Ghana do not require a legal framework between the apprentice and the employer.

Cappellari et al. (2012) found that the level of employment of apprentices increased by 5.2 pp, while the level of employment of other types of contracts fell by 6.5 pp. In contrast, in Rumania Malamud y Pop-Eleches (2010) did not find any effect.¹⁵

Hampf and Woessmann (2016) use data from the Programme for the International Assessment of Adult Competencies (PIAAC) classifying countries according to the intensity of their vocational systems.¹⁶ Their results indicate that in Austria, Denmark and Germany, apprentices generally have a higher probability of employment than those with general education until they reach the age of 44 when the trend reverses.

The results of the evaluations that use descriptive models point in the same direction. In Switzerland it is estimated that the probability of an apprenticeship graduate finding an adequate job¹⁷ can be 15 pp higher if he was an apprentice in a high-intellectual occupation (Bertschy et al., 2009).¹⁸ In France, evidence indicates that male apprentices are more likely than graduates of full-time vocational education to find work immediately after training (90% versus 55% respectively). For females, the difference in the odds of finding a job is lower (65% for apprentices versus 56% for vocational education graduates) (Bonnal et al., 2002). In England, apprentices are estimated to have 2 pp of more probability to find work, 1.5 pp for anyone who has a BTEC level 3 certification, 2.5 pp if the certificate is City and Guilds level 3 and 1.5 pp if is ONC / OND. Low-level apprentices or Level 2 RSAs did not show significant results, and the other level 2 certificates had very low or even negative impacts (Greenwood et al., 2007). Unlike the cases above, apprenticeships have shown no effect on employment in the Netherlands (Groot & Plug, 1998).¹⁹

Another aspect analyzed in the apprenticeship evaluations is the effect on the employment duration. Bellman et al. (2000) use data on new entrants to the labor market in Germany to estimate that the first employment duration of apprentices is 1.9 higher than those with other qualifications.²⁰ In the same vein, Winkelmann and Euwals (2004) estimate that after five years of completing the training, apprentices who decide to stay with the training employer are 11% more likely to remain on their first job than those who leave.

¹⁵ This study analyzed the impact of a reform that directed a large proportion of students from vocational training (including apprentices) to general education, not finding a significant impact on employment or unemployment. The only observed effect is that the males affected by the reform were less likely to work as manuals or artisans.

¹⁶ The classification is as follows: (i) countries with limited vocational systems (Ireland, Japan, Korea, Spain, UK and EU); (ii) countries with a high proportion of apprenticeships, with a combination of in-class and on-the-job training (Austria, Denmark and Germany); (iii) countries with vocational education based on the workplace (Czech Republic); y, (iv) countries with classroom-based vocational systems (Australia, Finland, France, the Netherlands, Norway and Sweden).

¹⁷ The authors define that a job is adequate when the occupation in which they work is the same for which they were trained, or when it requires a specific training diploma to that occupation.

¹⁸ The study separates high-level intellectual apprentices and low-level intellectual apprentices based on the six categories of the longitudinal survey of participants from PISA 2000 “Transitions from Education to Employment Survey (TREE)”.

¹⁹ Nor were there any significant results on wages or wage growth for apprentices.

²⁰ Both studies also use data from East Germany over a period from 1975 to 1995 and 1975 to 1990 respectively.

On the other hand, a successful transition to work can also be measured through lower unemployment. The quasi-experimental evaluation of Parey (2012) estimates that one year of apprenticeship training in Germany reduces the probability of unemployment by 0.11 pp. This result is reinforced by the findings of the descriptive models. Winkelmann (1996) finds that apprentices in Germany have a lower probability of unemployment than university students and graduates of the full-time vocational school. In a similar way, Hofer and Lietz (2004) find a lower risk of unemployment for apprentices than for those who did not receive higher education after compulsory schooling in Austria. In Denmark, an evaluation of the subsidies given to apprenticeship positions shows that the unemployment rate for apprentices is about 33% lower than those that do not go through the training (Westergaard-Nielsen & Rue Rasmussen, 1997).

Comparing the German and US systems, Buechtemann et al. (2001) find that 10% of US graduates in this type of system reported being unemployed and looking for work compared to 4% in Germany. An evaluation financed by the US Education Department (Booth et al., 1991) compares the post-school training experiences of young men in the US, Great Britain, and Australia using longitudinal survey data. For all three countries, the training based on the workplace had a greater impact on unemployment than off-the-job or school-based training.

There is evidence in the literature about the positive impact of apprenticeships on reducing the duration of unemployment in France (Bonnal et al., 2002) and Germany (Franz et al., 2000). In this last study the authors find that failure to complete the training has a negative impact on subsequent work outcomes, since 40% of a sub-sample of those who did not complete the training (because they decided not to show up, they canceled it or did not pass the test) were unemployed. In addition, to give up the program implied a reduction of 12% of the posterior wage, 13% in the case of the females.

3.1.2. Impact on wages

A significant proportion of the evaluations measure the impact on the wage levels and the wage growth rate of apprentices. Results are heterogeneous (see Table 2) obtaining the highest impacts for apprentices in Germany and for the highest-level certifications in the United Kingdom. Two of the three quasi-experimental evaluations that assess the impact on wages show positive results. In Brazil the impact was reflected in an hourly wage increase of 62% at two years and 50% at five years (Corseuil et al., 2014). With data from East Germany for the period 1975-1996, Adda et al. (2006) estimate that the lifelong return of being an apprentice is 14% and argue that the wage profile of non-apprentices grows at a lower rate, but for a longer period. However, Parey (2012) finds no evidence.

Descriptive models also show positive wage outcomes for apprentices, especially versus unskilled workers. With panel data from Germany, Winkelmann (1994) finds that any kind of post-secondary training (vocational or academic) increases wage growth, while the general school does not have any significant effect. Hofer and Lietz (2004) conclude that Austrian apprentices earn more than unskilled workers, but less than high school graduates. Lynch (1989) shows that in the US being an apprentice significantly increases the probability of having a higher wage for men.

Werwatz (1997) estimates that German apprentices earn between 3% and 5% more than workers without vocational training in skilled jobs and up to 20% more than workers without vocational training in unskilled jobs. Clark and Fahr (2002) estimate that apprentices' wages are between 6% and 8% higher than others' workers. In Denmark, Westergaard-Nielsen and Rue Rasmussen (1997) estimate that the wage gap between apprentices and other workers in low-sophisticated occupations is 10%. In Austria, the estimated return to apprentices ranges from 3% to 5% (Fersterer et al., 2008). In the US, those who complete the training can achieve total earnings of up to \$240,037 over the course of their working lives (Reed et al., 2012).

A study by Bougheas and Georgellis (2004) provides evidence that apprentices suffer an initial loss but then profit from a higher wage growth rate. They also find that in general the highest returns are for men and those trained in large-sized firms. In addition, Wilkelmann and Euwals (2004) analyze apprentices who move to another firm when completing the training to find that they earn less (than those who remain in the training firm) but then their wage growth rate is also greater. In this study the researchers estimate that moving to a larger firm implies a wage gain of 14.9 logarithmic points; while moving to a smaller one consists of a loss of 10.7 logarithmic points.

The wage returns of apprenticeships and qualification certificates have also been studied in the United Kingdom. Greenwood et al. (2007) estimate that male apprentices in England have a marginal return of 10% to 16% and that these returns depend largely on the type of certification, level and sector. The marginal return of an NVQ3 certification is up to 29% for workers in professional occupations. For females, the marginal return of NVQ3 operating machines / processes is 18%, 12% in sales and services, and 5% in administrative positions. For males, NVQ3 gives a return of 14% for professional occupations and 15% for machine / process operations. For females, the highest return is given by the energy and water sector (20%) and services (19%). In construction, the return on ONC / OND certification is 34%, BTEC level 3 is 23% and City and Guilds certification is 24%. Similarly, for the UK as a whole, McIntosh and Morris (2016) estimate that the average wage return of apprenticeships in general is approximately 9%. Regarding certifications, their estimations indicate that the maximum return is given by the HNC / HND qualification (13%), followed by BTEC level 3 (7%), and BTEC (2%). The certifications of level 2 and below do not show significant differences. For females, only RSA qualifications appear to be significant. In a previous study, McIntosh (2007) estimated that the wage return of the apprenticeship levels ranged from 16% for NVQ level 2 to 18% for level 3 (14% for females).

In a comparison between the US and UK systems, Blanchflower and Lynch (1994) estimate that the earnings effect for male apprentices in the US reach up to 20%, with no significant effects for females.²¹ In the UK, the male apprentices' wage can increase by 15% and up to 30% when accompanied by a City and Guild Operative certification. Baker et al. (1994) compare the United Kingdom with the Norwegian system and estimate that only male apprentices in the UK show improvements in wages. For females, the coefficient is significant and negative, and for the Norwegian system there is no significant impact.

²¹ The authors find that, despite not finding significant effects on average for females, the results for them in the esthetics and beauty sector is negative.

According to Buechtemann et al. (2001) the gains of apprentices in Germany double those in the US. While in Germany the highest wage growth is for those who choose the academic path and the rest depends on a vocational training to earn more, in the US wage growth is given only for those with a university degree (bachelors or higher). Acemoglu and Pischke (1998) argue that apprentices in Germany have higher premiums because of their high training and low turnover strategy, while low training and high turnover in the US has the disadvantage of a greater tendency to place workers in inadequate positions. It is estimated that in both countries earnings effects are significant only for males, with no significant effects for females (Couch, 1994). Another study estimates that the highest wage impact is in the US (18%), while in Great Britain and Australia the estimates are similar (7% and 7-9%, respectively) (Booth et al., 1991).

3.1.3. Impact on labor stability, mobility and other labor market variables

The evidence regarding labor stability is not concrete. Three quasi-experimental evaluations find contradictory results regarding apprentices' turnover. And while the results so far show that apprenticeships promote better job placement, there is no evidence that apprentices have better vertical mobility later.

In Brazil the apprentice reform decreased job turnover, measured by the number of layoffs and the probability of resignation (Corseuil et al., 2014). On the other hand, in Italy the reform increased apprentices turnover or changes in employment by 3 pp (Cappellari et al., 2012), and in Germany Parey (2012) finds no evidence of changes in these variables. On the side of the descriptive models, Winkelmann (1994) finds that the German apprenticeship reduced job turnover considerably, decreasing the expected number of work changes by 32%.

In Austria, three years after the training, female apprentices were less likely to stay at work (Hofer & Lietz, 2004). In the Netherlands, a comparative analysis of types of vocational education shows that the likelihood of apprentices to level up at work declined once they reached a medium level. In addition, apprentices who ended up unemployed after the training experienced mobility downward or horizontally, but not upwards (van der Velden & Lodder, 1995).

Table 2. Summary of labor market results

Country	Quasi - experimental/ descriptive	Authors	Dependent variables						
			Employment	Unemploy- ment ²²	Employment duration	Unemploye- nt duration	Wage	Turnover	Others
Germany	Quasi- experimental	Parey, 2012		+			ns	ns	na
	Quasi- experimental	Adda et al., 2006		+	+		+ (lyfe-cicle)		na
	Descriptive	Winkelmann, 1994					+	-	na
	Descriptive	Winkelmann, 1996		+	+ (1st job)				na
	Descriptive	Winkelmann & Euwals, 2004 ²³			+ (1st job)		+ (large firms) -(small)		na
	Descriptive	Bellmann et al., 2000			+ (1st job)				na
	Descriptive	Franz et al., 2000				+			na
	Descriptive	Clark & Fahr, 2002					+		na
	Descriptive	Werwatz, 2002					+		na
	Descriptive	Acemoglu & Pischje, 1998					+		na
	Descriptive	Bougheas & Georgellis, 2004					> (big firms, men)		na
Italy	Quasi- experimental	Cappellari et al., 2012	+					+	na
Brazil	Quasi- experimental	Corseuil et al., 2014	+ (formal non- temporary)				+	-	na
Austria	Quasi- experimental	Festerer et al., 2008					+		na
	Descriptive	Hofer & Lietz, 2004		+			+ > non skilled		Stability (-) females
Switzerlan d	Descriptive	Bertschy et al., 2009	+						na
France	Descriptive	Bonnal et al., 2002	+ (males) (1st job)			+			na

²² A positive (+) effect on the unemployment column indicates a lower rate of unemployment or a lower probability of being unemployed

²³ The results are positive for the apprentices who stay in the training firm versus the apprentices who leave for another firm upon completion of the training.

Denmark	Descriptive	Westergaad & Rasmussen, 1997		+			+		Subsidies (+)
UK	Descriptive	McIntosh, 2007					+		na
	Descriptive	McIntosh & Morris, 2016					+		na
England	Descriptive	Greenwood et al., 2007	+ (high certifications)				+		na
US	Descriptive	Lynch, 1989					+		na
	Descriptive	Reed et al., 2012					+		na
The Netherlands	Descriptive	van der Velden & Lodder, 1995							Work growth (-)
	Descriptive	Groot & Plug, 1998	Ns						na
Romania	Quasi-experimental	Malamud & Pop-Eleches, 2010	Ns						na
US, Great Britain and Australia ²⁴	Descriptive	Booth et al., 1991		+			+		na
US and United Kingdom	Descriptive	Blanchflower & Lynch, 1994					+		na
US and Germany	Descriptive	Buechtemann et al., 2001		+			+		na
	Descriptive	Couch, 1994					+		na
United Kingdom and Norway	Descriptive	Baker et al., 1994					+		na

Note: Positive effects (+), negative effects (-), non-significant results (ns), not applicable (na). The blank boxes indicate that there is no evidence because such variable was not analyzed in the study.

²⁴ Data for males only

3.2. Impact on skills transferability and skills-occupation match

Two other variables studied in apprenticeships - in this case, only through descriptive models - are the transferability of the acquired skills, and the match between these skills and the apprentice occupation. Regarding transferability, for the apprentices the importance lies in whether the skills learned are very specific to the firm or they can be used and valued in a different firm. On the contrary, firms may fear that if skills are transferable to other firms, then apprentices can be attracted by them. In this respect, the results are not conclusive. Only in the German case studies find evidence of skills transferability. Regarding the match between acquired skills and occupation, the most pessimistic data indicate that at least 50% of the apprentices end up in a job where they make use of all the skills developed.

Winkelmann's evaluation (1996) points out that the skills learned in the German system are transferable. Clark and Fahr (2002) find evidence that training is transferable to nearby occupations and that approximately two-thirds of apprentices eventually leave the occupation where they were trained (although the rotation of the untrained is even greater). On the other hand, Lynch's analysis (1989) finds no evidence of skills portability in the US system. In the Netherlands apprentices face difficulties in transferring skills learned to sectors other than the training one (van der Velden & Lodder, 1995). And in Great Britain, Australia, and the United States, it seems that firm-specific skills depreciate and are not transferable (Booth et al., 1991).

Bougheas and Georgellis (2004) observe that -over time- apprentices lose the acquired firm-specific skills, making job turnover more expensive. However, apprentices who move from the firm tend to accumulate skills with the new employer at a faster rate than those who stay. Büchel (2002) estimates that about 10% of apprentices accepted jobs for which they were overqualified. Kalleberg and Witte (1995) find that about half of the apprentices do not have jobs that match the skills they acquired. In fact, being an apprentice reduces the possibility for males to find an adequate job while for females this factor seems to have an impact on their wages. Compared to the US, the German system presents a better match between the skills obtained and those required for the job according to Buechtemann et al. (2001). Switzerland also shows positive results in the match of apprentices with their first job (Bertschy et al., 2009). Werwatz (1997) finds that 64% of the apprentices who moved from the occupation where they received training found jobs that required the skills developed.

3.3. Impact on firms: incentives, productivity and costs

One of the biggest barriers to investing in this type of training is the incentive for firms to open places for apprentices. As a result, some evaluations have focused on measuring the impact of apprenticeship on the firms' productivity and on the net costs of this type of training. As Lerman (2014) indicates, the fact that some estimates show modest returns to training, and the fear that they will go to other firms, causes firms to perceive low returns. In view of this, the author asserts that although firms incur certain costs in training apprentices, the contribution they make to production counteracts those costs. In addition, the firm reduces recruiting and training costs, improves innovation and counts with a group of apprentices that master a relevant set of skills. The results support this; firms appear to recover investment costs. In addition, there is evidence that the firm's

productivity increases when the participation of the apprentices is increased, and even more when they are placed in productive activities.

Evaluations with quasi-experimental methods suggest that firms have incentives to train apprentices. In Italy, the results seem to indicate that the reform generated an increase in the productivity of firms in general, possibly explained by an increase in the motivation of the workers with a greater expectation of training and of wage growth. Among the different measures used for productivity, there was an increase in the value added per worker of 1.5 pp; in the ratio of sales per worker of approximately 1 pp; and in Total Factor Productivity (TFP) of 1.7 pp. On the other hand, there was no evidence of incentives for capital investment, or improvements in the investment ratio on skills (Cappellari et al., 2012).

Zwick (2007) does not find an impact of apprenticeships on the profits of German firms. However, the study by Mohrenweiser and Zwick (2009) estimates that a 1% increase in apprentice's participation increases gross profit in the commercial sector (by 1%) and craft and construction (by 1.4%). However, it reduces gross profits by 1.2% for the manufacturing sector.²⁵ For Dionisius et al. (2008), the costs faced by firms in Germany are higher than in Switzerland, despite they are fully recovered in both countries. The differences, they explain, are due to three factors: (i) wage differentials are lower in Germany than in Switzerland (hence, there is also less motivation); (ii) regulations in Germany promote training oriented towards the investment of skills while in Switzerland regulation is laxer looking for greater production; and, finally, (iii) in Switzerland they seek that the apprentice is employed in truly productive activities for the firm.

The results of the descriptive models support the motivation of firms to invest in apprenticeships. Backes-Gellner and Mohrenweiser (2010) divide firms into those that offer apprenticeships as an investment strategy, expecting a large majority to remain in the firm (44%); and those that follow a substitution strategy motivated by the unit labor costs of apprentices (18.5%).²⁶ In Switzerland, there is evidence that costs have an impact on the decision to give training, but not on the number of places awarded (Schweri et al., 2007). For Schweri et al. (2006), firms that do not offer training may have a higher cost when introducing apprentices because of the lack of a workforce qualification structure or because unskilled workers have wages that are so low that they do not differ from those of apprentices. However, Bougheas and Georgellis (2004) indicate that the acquisition of firm-specific skills causes both workers and firms to share costs and increases the opportunity cost of changing jobs for the apprentice.

3.4. Cost-Benefit Analyzes

In this paper, we include Cost-Benefit Analyzes (CBAs) to measure whether apprenticeships are cost-effective from a social point of view for apprentices, firms, government, and society in general. The first CBA analyzed is a study commissioned by the US Department of Labor to review apprenticeships in 10 different states of the country (Florida, Georgia, Iowa, Kentucky, Maryland,

²⁵ According to the authors' reflection, in manufacturing occupations, apprentices are more expensive because unskilled or semi-skilled workers are potential substitutes.

²⁶ According to the researchers, the likelihood of a firm following a substitution strategy is correlated with: having lower capital equipment, having a work absentee board, a higher proportion of white collar workers, the firm being small, and in the service sector.

Missouri, New Jersey, Ohio, Pennsylvania, and Texas). This CBA examines the perspective of several stakeholders. It includes benefits for apprentices (wages and benefits granted by the employer); sponsors and employers (assuming net benefits to employers are zero), government (perceived as a transfer between the apprentices' taxes and any support from the government to the programs, resulting in a net gain of zero), and society (savings on the administrative costs of public programs). The only costs accounted for are the government's. This CBA estimates that the social benefits exceed the costs by an average of US\$49,000, and that those who complete the training can achieve a profit of up to US\$240,037 in the whole working life, although these benefits are reduced between six and nine years after admission (Reed et al., 2012).

We also find some studies that complement the econometric analysis of the apprenticeships returns with ACBs to estimate the net benefits for the firms mainly. For the United Kingdom, McIntosh (2007) analyzes the costs incurred by the employer and the predicted earnings for apprentices to estimate that the Net Present Value (NPV) of the apprenticeship is GBP 105,000 at level 3 and GBP 73,000 at level 2. The Internal Rate of Return (IRR) is 35% for level 3, and 39% for level 2. In their analysis of the incentives of employers to offer apprenticeship training, Schweri et al. (2006) perform a preliminary CBA for firms where there are net benefits for two-thirds of the apprentices hired. In another study comparing the difference in costs incurred by firms between the German and Swiss systems, Dionisius et al. (2008) find that the net difference of a three-year program is EUR 25,323 (Germany above Austria).

4. Policy discussion

Currently, apprenticeships have acquired great relevance for Latin American and Caribbean countries as an alternative to counteract low productivity and high unemployment rates, particularly among young people. However, existing evidence on the benefits of the dual apprenticeship system has been concentrated in developed countries with a long tradition of implementing it. In addition, the absence of fully experimental evaluations makes the validity of the results dependent on the methodology used to solve endogeneity problems that compromise the estimation of the real effect of apprenticeships. Experimental methods have challenges in their implementation, such as the use of lotteries to decide who receives the training, which can generate resistance from policymakers. However, if there is an excess demand for participation, the exclusion of participants due to the limited quota could be made randomly. This would also imply that each individual would have the same probability of being part of the program. With the objective of basing the decision to implement apprenticeships on robust evidence, it is particularly relevant to analyze the rigor and results of existing evidence on these systems in different environments, as well as to promote the implementation of new methodologies to expand the knowledge about apprenticeships.

In this paper, we have analyzed the results of apprenticeships from two perspectives. There are countries such as Germany, Switzerland and the Netherlands where apprenticeships are integrated into the country's education system, while countries such as the UK, the US, and Australia have apprenticeships for workers or jobseekers who decide to become apprentices instead of other types of training or employment programs. The advantages of the first case are that there is a better school-to-work transition by having a connection with the employer; and that skills are developed specifically to the occupation that is exercised or to the firm where one works. In the second, the advantages are summarized in having a legal framework between the apprentice and the employer, and a defined training structure with recognized and certified skills.

Studies comparing education systems seem to agree that apprenticeships deliver better outcomes in the labor market than full-time vocational training, but not than academic education. And when the analysis is done comparing apprentices with other workers with low or no skills, returns appear to be very high. Evidence tells us that apprenticeships are a good alternative to full-time vocational training, and to occupations that require a low level of skills. The benefits of apprenticeships are evidenced in better probabilities of finding a job, less likelihood to fall into unemployment or to have a lower period of unemployment. There are other variables studied that show ambiguous results as in the case of labor turnover. Likewise, while there are studies that show that apprentices have better opportunities to find a job where they use the acquired skills (i.e., an adequate job), other evidence indicates that only 50% of apprentices will achieve that match between skills and occupation.

Another widely analyzed aspect is the gain of being an apprentice in terms of wages. When there is a structured credential system, the highest returns are given by the highest certifications, or those related to high-level intellectual job positions. For both firms and society, the benefits of apprenticeships outweigh the costs involved. The results regarding the firms' returns tell us that they recover the costs of the investment as a whole, and that the profits they derive from the apprentices depend on whether they are put into productive activities and follow an investment strategy in human capital rather than a substitution one, which seems to occur with greater tendency

in small firms. The costs are high when the firm makes the decision to train for the first time. Therefore, subsidies should be to encourage those who have not decided to offer apprenticeships. The largest gains appear to be in large-sized firms and production industries.

Differences by gender stand out in the results review as well. In the studies that distinguish gender impact, women do not achieve the same results than men. In some cases, the impact on wages for women is negative. Among the analyzed reasons we have the occupational segregation that exists where women are segmented into the usual traditional occupations (e.g; esthetics); in addition to the low access that women have to training opportunities. Recommendations on this aspect include promoting the insertion of women into apprenticeships with high and/or general skills; greater rapprochement and information for them; support for the development of basic skills; assistance with child care; and awareness for employers.

The review of all the evidence presented in this document helps us to answer if it is convenient to introduce or expand apprenticeships in Latin America and the Caribbean and other developing countries. The results of existing evaluations, with different levels of rigor, seem to tip the balance in favor of the implementation of apprenticeships, even if they are not integrated into the education system. However, the positive results found by these studies may include biases that go beyond the actual effect of programs (e.g., the positive effects found for apprenticeships on employment may be reflecting the actual effect of the program, but also the fact that highly motivated individuals are those who put more effort into the search for work). Therefore, the absence of completely rigorous evidence for the case of Latin American and Caribbean countries makes does not allow us to make a conclusive recommendation.

The two evaluations carried out in developing countries (Brazil and Romania) have not found an impact at the same level as those carried out in Germany or the United Kingdom. In addition, there remains the factor of institutional differences that allow dual apprenticeship education to be recognized and valued by apprentices as well as by firms. For this reason, it is crucial that we invest in generating rigorous evidence to estimate the causal effect of these programs, especially in the case of Latin America and the Caribbean.

References

- Acemoglu, D., & Pischke, J.-S. (1998). Why Do Firms Train? Theory and Evidence. *Quarterly Journal of Economics*.
- Adda, J., Dustmann, C., Meghir, C., & Robin, J.-M. (2006). Career Progression and Formal versus On-the-Job Training. *IZA*.
- Backes-Gellner, U., & Mohrenweiser, J. (2010). Apprenticeship Training- What for? Investment in Human Capital or Substitution of Cheap Labour? *International Journal of Manpower*, 31(5), 545-562. Obtained from <http://dx.doi.org/10.1108/01437721011066353>
- Bellman, L., Bender, S., & Hornsteiner, U. (2000). Job Tenure of Two Cohorts of Young German Men. *IZA*.
- Bertschy, K., Cattaneo, A. M., & Wolter, S. C. (2009). PISA and the Transition into the. *Labour economics*.
- Blanchflower, D. G., & Lynch, L. M. (1994). Training at work: a comparison of US and British youths. *National Bureau of Economic Research*.
- Bonnal, L., Mendes, S., & Sofer, C. (2002). School-to-work transition: Apprenticeship versus vocational school in France. *International Journal of Manpower*.
- Booth, A., Chapman, B., Peterson, C., & Tan, H. (1991). Youth training the United States, Britain and Australia. *RAND*.
- Bougheas, S., & Georgellis, Y. (2004). Early Career Mobility and Earning Profiles of German Apprentices:. *Labour Economics and Industrial Relations*.
- Büchel, F. (2002). Successful Apprenticeship-to-Work Transitions: On the Long-Term Change in Significance of the Significance of the. *IZA*.
- Buechtemann, C. F., Schupp, J., & Soloff, D. (2001). Roads to work: school to work transition patterns in Germany and the United States. *Industrial Relations Journal*.
- Caliendo, M., Künn, S., & Schmidl, R. (Diciembre de 2011). Fighting Youth Unemployment:. *IZA*.
- Cappellari, L., Dell'Aringa, C., & Leonardi, M. (2012). The Effects of Youth Labor Market Reforms: Evidence from Italian Apprenticeships. *IZA*.
- Clark, D., & Fahr, R. (2002). The promise of workplace training for non-college bound youth: theory and evidence from German Apprenticeship. *Centre for Economic Performance*.
- Comi, S., & Grasseni, M. (2014). The reform of apprenticeship in Italy: winners and losers. *Working paper*.
- Corseuil, C. H., Foguel, M., Gonzaga, G., & Pontual Ribeiro, E. (2014). Youth Turnover in Brazil: Job and Worker Flows and An Evaluation of a Youth-Targeted Training Program. *CEDLAS. Documento de Trabajo No. 155*.

- Couch, K. A. (1994). High school vocational education, apprenticeship and earnings: a comparison of Germany and the United States. *Vierteljahrshefte zur Wirtschaftsforschung*.
- De Coulon, A., Hedges, S., Nafilyan, V., & Speckesser, S. (2017). Young people in low level vocational education: characteristics, trajectories and labour market outcomes. *Centre for Vocational Education Research*.
- Dionisius, R., Muehlemann, S., Pfeifer, H., Walden, G., Wenzelmann, F., & Wolter, S. C. (2008). Cost and Benefit of Apprenticeship Training: A Comparison of Germany and Switzerland.
- Elias, P., Hernaes, E., & Baker, M. (1994). Vocational education and training in Britain and Norway. *National Bureau of Economic Research*.
- European alliance of Apprenticeship. (2014). Obtained from Apprenticeship toolbox: <http://www.apprenticeship-toolbox.eu/>
- European Commission. (2013). *The effectiveness and costs-benefits of apprenticeships: Results of the quantitative analysis*. European Commission.
- Fazio, M. V., Fernández-Coto, R., & Ripani, L. (2016). *Apprenticeships for the XXI Century: A Model for Latin American and the Caribbean?* Washington, DC: Mimeo.
- Festerer, J., Pischke, J.-S., & Winter-Ebmer, R. (2008). Returns to apprenticeship training in Austria: evidence from failed firms. *Scandinavian Journal of Economics*, 110(4), 733-753.
- Franz, W., Inkmann, J., Pohlmeier, W., & Zimmermann, V. (2000). Young and out in Germany: On youths' chances of labor market entrance in Germany. *National Bureau of Economic Research*.
- Fuller, A., & Unwin, L. (2009). Change and continuity in apprenticeship: the resilience of a model of learning. *Journal of Education and Work*, 22(5), 405-416.
- Gertler, P. J., Martínez, S., Premand, P., Rawlings, L. B., Vermeersch, & Vermeersch, C. M. (2017). *Impact Evaluation in Practice. Second edition*. Washington, DC: The World Bank.
- Greenwood, C., Jenkins, A., & Vignoles, A. (2007). The Returns to Qualifications in England: Updating the Evidence Base on Level 2 and Level 3 Vocational Qualifications. *Centre for the Economics of Education*.
- Groot, W., & Plug, E. (1998). Apprenticeship versus vocational education: Exemplified. *TSER/STT Working paper*.
- Halpern, R. (2009). *The Means to Grow Up: Reinventing Apprenticeship as a Developmental Support in Adolescence* (1 ed.). New York, NY: Routledge.
- Hampf, F., & Woessmann, L. (2016). Vocational vs. General Education and Employment over the Life-Cycle: New Evidence from PIAAC. *Centre for Vocational Education Research*.

- Hardy, M., & McCasland, J. (2015). Are Small Firms Labor Constrained? Experimental Evidence . *Working Paper*.
- Heckman, J. J. (1979). Sample Selection Bias as a Specification Error. *Econometrica*, 153-161.
- Heckman, J. J., & Kautz, T. (2013). Fostering and Measuring Skills: Interventions that improve character and cognition. *NBER*. Obtained from <http://www.nber.org/papers/w19656.pdf>
- Hofer, H., & Lietz, C. (2004). Labour market effects of apprenticeship training in Austria. *International Journal of Manpower*.
- Interamerican Development Bank. (2017). *Labor Markets and Social Security Information System*. Washington, DC: IDB.
- Inter-American Development Bank. (2016). *Sectoral Framework Document. Labor Markets and Social Security Division*. Washington, DC: IDB.
- Kalleberg, A. L., & Witte, J. C. (1995). Matching Training and Jobs: The fit between vocational education and employment in the German labour market. *European Sociological Review*.
- Lerman, R. (2014). Do firms benefit from apprenticeship investments? Why spending on occupational skills can yield economic returns to employers. *IZA*(55). doi:10.15185/izawol.55
- Lynch, L. M. (1989). Private sector training and its impact on the earnings of young workers. *National Bureau of Economic Research*.
- Malamud, O., & Pop-Eleches, C. (2010). General Education versus vocational training: Evidence from an economy in transition. *The Review of Economics and Statistics*.
- McIntosh, S. (2007). A Cost-Benefit Analysis of Apprenticeships and Other Vocational Qualifications. *Department of Educations and Skills*.
- McIntosh, S., & Morris, D. (2016). Labour Market Returns to Vocational Qualifications in the Labour Force Survey. *Centre for Vocational Education Research*.
- Mohrenweiser, J., & Zwick, T. (2009). Why Do Firms Train Apprentices? The Net Cost Puzzle Reconsidered. *Labour Economics*, 16(6), 631-637. doi:<https://doi.org/10.1016/j.labeco.2009.08.004>
- Novella, R., & Castrillo, L. (2016). Evaluaciones de Impacto en Capacitación e Intermediación Laboral: Estado y Retos para la División de Mercados Laborales y Seguridad Social. *Mimeo*.
- Parey, M. (2012). Vocational Schooling versus Apprenticeship Training: Evidence from Vacancy Data. *Mimeo*.

- Reed , D., Yung-Hsu, A. L., Kleinman , R., Matri , A., Reed, D., Sattar , S., & Ziegler , J. (2012). An effectiveness assessment and cost-benefit analysis of registered apprenticeship in 10 states. *Mathematica Policy Research*.
- Rose, M. (2004). *The Mind at Work: Valuing the Intelligence of the American Worker*. New York: Viking Books.
- Ryan, P. (1998). Is Apprenticeship better? A Review of the Economic Evidence. *Journal of Vocational Education & Training*, 50(2), 289-329.
- Ryan, P. (2001). The School-to-Work Transition: A Cross-National Perspective. *Journal of Economic Literature*, 39(1), 34-92.
- Schweri, J., Mühlemann, S., & Wolter, S. C. (2006). Why Some Firms Train Apprentices and Many Others Do Not. *German Economic Review*.
- Schweri, J., Mühlemann, S., Winkelmann, R., & Wolter, S. C. (2007). An empirical analysis of the decision to train apprentices. *Labour: Review of Labour Economics and Industrial Relations*.
- Statistics Norway. Division for Education Statistics. (2013). *Facts about education in Norway 2013 - key figures*. Ministry of Education and Research and Directorate for Education and Training.
- The World Bank. (s.f.). Enterprise Survey Data. Washington, DC. Obtained from <http://www.enterprisesurveys.org/data>
- van der Velden, R., & Lodder, B. (1995). Alternative routes from vocational education to the labour market. Labour market effects of full time vs dualized vocational education. *Educational Research and Evaluation*.
- Werwatz, A. (1997). Mobility after Apprenticeship: How effective is the German apprenticeship system? *Konjunkturpolitik*.
- Westergaard-Nielsen, N., & Rue Rasmussen, A. (1997). Apprenticeship training in Denmark - the impacts of subsidies. *Centre for Labour Market and Social Research*.
- Winkelmann, R., & Euwals, R. (2004). Training intensity and first labor market outcomes of apprenticeship graduates. *IZA*.
- Winkelmann, R. (1994). Training, earnings and mobility in Germany. *Centre for Economic Policy Research*.
- Winkelmann, R. (1996). Employment prospects and skill acquisition of apprenticeship-trained workers in Germany. *Industrial and Labor Relations Review*.
- Witte, J. C., & Kalleberg, A. L. (1995). Matching Training and Jobs: The Fit Between Vocational Education and Employment in the German Labour Market. *European Sociological Review*, 11(3).

Zwick, T. (2007). Apprenticeship training in Germany –investment or productivity driven? *Centre for European Economic Research (ZEW)*. Obtenido de <http://ftp.zew.de/pub/zew-docs/dp/dp07023.pdf>

Annex A – The methodology of apprenticeship impact evaluations

According to our research, there are currently no experimental evaluations of apprenticeships that meet the definition used in this paper presented in Section 2. On the contrary, most evaluations are post-participation, largely dependent on the availability of panel data, and use econometric models that attempt to solve selection biases in participation. In recent years, apprenticeships evaluations have made use of quasi-experimental methods; however, most of the studies found use methodologies that do not aim to solve the problem of endogeneity directly. This annex is divided into three sections which classify study methodologies according to their level of rigor. The first section deals with randomized experiments. In the second part we present and briefly describe the different quasi-experimental methods found (differences in differences, discontinuous regression, instrumental variables, and match by propensity score). Finally, we present the studies that are based on descriptive models, identifying those that implement different methodologies to solve the endogeneity.

I. Randomized experiments

The impact evaluation literature tells us that the great advantage of the experimental method is to avoid the problem that the evaluators have when trying to find a valid "comparison group" or "counterfactual", since the evaluators do not have to worry that another "unobserved" factor is influencing the results (Gertler et al., 2017). However, it is also known that its development has a great difficulty since it is not easy to find the opportunities to design an evaluation from the beginning of a program.²⁷

II. Quasi-experimental methods

Quasi-experimental methods are widely used since, unlike experimental methods, they do not require a random assignment, although they try to solve directly the problem of endogeneity. Among these methods we can find those that use explicit rules of the programs such as Discontinuous Regression (DR) and Instrumental Variables (IV). However, in some cases there are no explicit rules (e.g., the age of eligibility to access the program) and therefore it is not possible to use these methodologies, so others are implemented allowing the comparison of groups under certain identification assumptions. These are called Differences in Differences (DD, also known as diff-in-diff) and Propensity Score Matching (PSM).²⁸ In this section we present a description of the studies that used quasi-experimental methods in the following order: Differences in Differences, Discontinuous Regression, Instrumental Variables, and Propensity Score Matching. Table summarizes the main features of these evaluations.

Cappellari et al. (2012) use the change in firms' exposure to an apprenticeship reform to estimate differences (DD) between sectors (i.e., those firms in sectors that were affected compared with

²⁷ As mentioned, no fully experimental evaluation of an apprenticeship has been found that follows the formal definition of Fazio et al (2016). While there is an experimental evaluation in Ghana (Hardy & McCasland, 2015) where each apprentice is randomly placed in a firm, the apprenticeship system in this country does not require a legal framework between the apprentice and the employer. The authors find that each apprentice generated an increase between 7-10% of the revenues and profits of the firms.

²⁸ It should be noted that most of the countries studied in this review have large panel data that contain information on various socio-demographic, labor, etc. variables; and allowing for the construction of a comparison group comparable to the treatment group (i.e. apprentices or apprentices graduates).

firms belonging to non-affected sectors) and over time (firms before being affected by the reform and after their local implementation). Thus, this study corrects the effect that other variables related to the region or changes over time that could have on the apprentices' results. Hampf and Woessmann (2016) use data from the Programme for the International Assessment of Adult Competencies (PIAAC) and a DD design to compare employment rates across the different age cohorts for people with general and vocational - including apprentices- education. To complement their analysis, they include a model based on a PSM design to compare individuals with vocational education and similar individuals with general education. The match is based on age, years of education, reading and writing skills, arithmetic and mother education. They also use skills measures available in the database to estimate potential changes in selectivity over time.

In the RD method, eligibility is determined through a threshold or a cutoff value. In Romania, an educational reform was implemented aimed at increasing general education in 1973. The reform included a cut in the eligibility of apprentices, exploited by the Malamud and Pop-Eleches (2010) evaluation design: those born before 1959 had 8 years of general education required to access vocational education when the reform arrived. However, when those born after 1959 reached the same age, they were asked for two more years of general education, so they could not access vocational education. In the case of Brazil, Corseuil et al. (2014) used a longitudinal dataset to estimate the effects of the programs. In this case the discontinuity was marked by a reform ruling that young people over age 18 would not be eligible to be apprentices, while those between age 14 and 17 could. The authors define it as a diffuse discontinuity because although on one side of the cut-off point there are non-eligible individuals that do not participate, on the other side there are eligible individuals who do participate and others who do not. By including young people who were within the age range allowed to be part of the apprenticeship but did not enroll, the case of Brazil also uses an IV method. In other words, the final evaluation sample includes young people who, although the reform had allowed them to be apprentices, decided not to register.

There is a group of evaluations that make use of instrumental variables related to the participation of the apprentices in the programs (since the participation or selection of apprentices can be directly related to the results that are sought) to avoid that the estimates include errors by the selection bias. Among the variables used as an instrument we can find: available apprentices vacancies (Parey, 2012); interactions between region and cohort (Adda et al., 2006); lagged variables (Mohrenweiser & Zwick, 2009; Zwick, 2007); and the closing time of the training firms (Festerer et al., 2008). In addition, to estimate the results, researchers in these studies use methods such as Maximum Likelihood or Generalized Moments. Finally, Dionisius et al. (2008) use the propensity score matching method to compare groups of apprentices from Germany and Austria. The control group is identified through an index that helps to weight the inclusion of the individuals in the sample based on several characteristics that make them comparable with the apprentices.

Table A1. Summary – Quasi-experimental Methods

#	Country	Authors	Method	Objective	Comparison groups	Description
1	Italy	Cappellari et al., 2012	DD	To evaluate a reform implemented in Italy where apprentices were introduced.	Firms affected by the reform vs. those that were not.	Uses the variation of firms' exposure to the reform across regions and sectors over time. Introduces controls by time, region, and sector, as well as specific trends to the region and sectors to avoid the effects of variables correlated with the adoption of the reform. The identification strategy is validated by showing that the regions in the two samples behaved the same before the reform.
2	PIAAC	Hampf & Woessmann, 2016	DD, PSM	To analyze the impact of vocational education versus general education on employment during the life cycle.	Individuals who had vocational education versus those with general education.	Uses the differences-in-differences method to compare trends in age-employment workers between the two types of education in each country. Controls by skills (literacy test and arithmetic), education, and workforce composition. Also uses a matching model to compare similar individuals (age, education, test results, mother education).
3	Rumania	Malamud & Pop-Eleches, 2010	DR	To examine the benefits of general education and vocational training (apprentices).	Students who were born before 1959 (and who were not affected) vs. those born after (had less vocational education).	Analyzes a reform that prevented students from entering vocational education (including apprentices) with 8 years of general education. Only those who had 10 years of general education could. Disruption occurs depending on the date of birth (1 = born on or after January 1, 1959, 0 = born on or before December 31, 1958). Estimates through a linear model of probability. The strategy is validated by proving that the composition of men completing secondary level did not change by the reform.
4	Brazil	Corseuil et al., 2014	DR, IV	To evaluate the impact of the Apprenticeship Law.	Labor market incomers age 18 versus age 17.	Uses a diffuse discontinuity by age in eligibility. From 2000-2005, young people between the ages of 14 and 17 were eligible for the program, and those age 18 were not. The sample was formed with youngsters from age 17 to 18, in the treatment group the apprentices and in the control group with other types of contracts. Uses an IV (17-year-olds eligible but who may or may not be apprentices) and 3 estimators: a) matching of observable variables with exogenous variation through an instrument; b) semi-parametric IV; c) Traditional IV or 2SLS.
M	Germany	Parey, 2012	IV	To analyze the effect on the labor market of apprenticeship training compared to the vocational technical school.	Apprentices versus full-time vocational students.	Exploits the variation in the vacancies of apprentices to analyze its effects in the educational decision and in the labor market. Implements an OLS regression and instrumental variables regressing apprentices' duration on wages, employment and mobility. Self-selection bias. Number of apprentices vacancies as IV.
6	East Germany	Adda et al., 2006	IV	To evaluate the German apprenticeship.	Apprentices versus non-apprentices.	It shapes the individual careers since the decision of belonging to that scheme followed by their employment, work-to-work transitions and wages throughout the life cycle. Implements the

						method of maximum likelihood (ML) to verify a theoretical model of training choice, employment and wage growth. Estimates the return in the life cycle. Addresses self-selection bias using interactions between region and cohorts as instrumental variables.
7	Germany	Mohrenweiser & Zwick, 2009	IV	To analyze the impact of apprenticeships on the productivity of firms.	Apprentices matched with their employers in different occupations.	Analyzes the impact of increasing the participation of apprentices at the cost of the participation of skilled or semi-skilled workers on the firms' performance. Uses a Cobb Douglas function for estimating costs, a regression with fixed effects on profits, and a Generalized Moment Method (GMM) system. Addresses selection bias and bias for firms through GMM with lagged variables as internal instruments.
8	Germany	Zwick, 2007	IV	To analyze the impact of apprenticeships on the earnings of firms.	Apprentices matched with their employers in different occupations.	Evaluates whether firms encounter net costs and impact on profits. Uses a cross-sectional regression with fixed effects and a Generalized Method of Moments (GMM) system. Addresses selection bias and bias for firms through GMM with lagged variables as internal instruments.
9	Austria	Festerer et al., 2008	IV	To analyze the returns of apprenticeships.	Firms that offered apprentice places but stopped operating by closure.	Estimates the returns of training by avoiding skills bias using failed firms. Uses OLS, 2SLS, with an instrumental variable of the duration of the training to avoid selection bias (time in which the firm closes).
10	Germany, Austria	Dionisius et al., 2008	PSM	To analyze and identify sources of different net costs of apprenticeships in Germany and Switzerland.	Training costs for apprentices between firms in the German and Austrian systems.	Uses a simple weighting method to identify the counterfactual. Implements a matching by size, industry, categories, if the firm has a training center and if there is a full-time trainer. A counterfactual Cost Benefit Analysis is presented. ²⁹ Analysis is based on the assumption that all bias variables were previously treated (unconfoundedness assumption). Authors assume that the decision to lease the firm is exogenous and not related to the net costs of apprentices.

²⁹ After obtaining the estimates through the matching method of the parameters of interest, a cost-benefit model was estimated using the contractual values. That is, by calculating the average treatment on the treated effect (ATT) interpreted as if a German firm were confronted with the environment of a Swiss firm; and the average treatment effect on the controls (ATC) interpreted as if a Swiss firm were in the environment of the German firm.

III. Descriptive models

In this section, evaluations using descriptive models which do not directly address the possible endogeneity of participation in apprenticeships when analyzing the effects are presented. As already mentioned, the impacts found by these studies potentially include, in addition to the effect of the program, the effect of unobserved characteristics of the apprentices. In this section two groups of evaluations are presented. In the first group (see Table A2), authors make use of various methods to try to address selection in the program, or at least acknowledge their existence and their impact on the accuracy of estimates. Finally, we present a group of studies that do not seek to directly solve this type of bias in the estimates (See Table A3).

Table A2. Summary – Descriptive models with selection bias control

#	Country	Authors	Comparison/observation groups	Description
11	US	Lynch, 1989	Young workers participating in different trainings of the private sector (at work, apprentices, and outside the firm).	Analyzes the conditions that determine the probability of receiving training and its effect on wages and salary growth. Includes linear regressions of different training on wages, including fixed effects; and a probit regression for estimating the probability of receiving training. Addresses self-selection bias. Uses a two-phase least squares method based on Heckman (1979).
12	Germany	Werwatz, 1997	Apprentices who leave the occupation of training (movers) versus those who stay (stayers).	Analyzes the differences between the apprentices who stayed in the occupation and those who left. Uses a "switching" model (multinomial logit, and four wage regressions), and OLS for wages. Addresses self-selection bias with a parameter free of selectivity (allocates wages in each alternative path).
13	The Netherlands	Groot & Plug, 1998	Apprentices versus full-time vocational students.	Analyzes the wage differences in levels and growth rate as well as employment among full-time vocational students and apprentices through a three-stage switching model: (i) probit, (ii) Mill ratios, and (iii) structural equation. Addresses self-selection bias estimated through Mill's ratios.
14	Switzerland	Schweri et al., 2007	Training firms versus non-training firms.	Estimates the effects on net costs of the number of apprentices hired. Uses OLS regression for costs, Poisson-hurdle (PH) and Probit-Poisson-log-normal (PPLN) models for the number of trainees employed. Addresses selection bias in the Heckman-based corrected training decision (continuous latent variable for the training decision).
15	France	Bonnal et al., 2002	Youth who participated in apprenticeships versus vocational education.	Presents a simulation model by maximum likelihood (probabilities) to know the effect on the school-to-work transition of apprenticeships and vocational education. Uses a standard probit and duration models for estimating correlations. Corrects bias by correlation terms (high probability of being hired by the firm, supervisors select those who remain).
16	East Germany	Büchel, 2002	Young apprentices graduates.	Presents a probit regression to estimate the quality of the school-to-apprenticeship and apprenticeship-to-work transitions (successful, unsuccessful). Selection bias is identified (graduates with lower levels of general education are selected for the worst apprentices) and corrected for the quality of general school certification.
17	Switzerland	Bertschy et al., 2009	PISA 2000 test participants.	Analyzes the relationship between PISA results, vocational education and the subsequent employment situation. Uses a probit regression to estimate the probability of finding an adequate job. Controls selection bias using the successful completion of the apprentice, the intellectual level of the apprentice position, the school performance (PISA results), and a motivation index (IV).
18	Germany	Bougheas & Georgellis, 2004	Apprentices who leave the occupation of training (movers) versus those who stay (stayers).	Estimates the effect of apprenticeships on early labor mobility and wages through a probit model and regression of wages to verify the theoretical model of training and labor turnover. Addresses selection bias using two-step estimation. Probit model selectivity terms are created (full-time employment, stay or move) and are included in the wage regression.
19	Germany	Winkelmann, 1996	Graduates of apprenticeships, universities, full-time vocational and high school.	Compares four categories: full-time vocational education, apprenticeship, university and high school. Estimates the effect on the employment probability (probit model). Implements a logit for the transition-to-employment effect. Addresses selection bias for the skill of the trainees and the quality of the places.
20	US, Great Britain, Australia	Booth, et al., 1991	Young people from the 3 countries with different post-school training options.	Compares the results of the three systems. Uses a regression of training specifications on wage, and a probit model for unemployment. Control by levels of education, although is not mentioned this can serve as a partial selection bias control as well.
21	US,	Blanchflo	Young people (non-university	Compares the structures of post-school training for non-college youth in the two countries. Regresses

	United Kingdom	Werner & Lynch, 1994	graduates) with different forms of training (including apprenticeships) in the two countries.	different type of trainings (in the firm, apprentices and outside the firm) on wages. Uses fixed effects to control possible biases.
22	United Kingdom, Norway	Baker et al., 1994	Young people from both countries with different types of training (including apprenticeships) and qualifications.	Compares the results of both systems. Uses regressions with training, education and work on wage. Addresses sample selection bias controlling for the probability of working full time and having valid salary information.
23	East Germany	Winkelmann & Euwals, 2004	Apprentices who leave the occupation of training (movers) versus those who stay (stayers).	Implements a proportional risk model comparing results between apprentices who stay and those who leave. Controls for the quality of apprenticeship (paid salary and duration).
24	Denmark	Westergaard-Nielsen & Rue Rasmussen, 1997	Firms in different industries that were affected by the subsidy and others that did not.	Researches the possible impact of the subsidy on firms for providing apprenticeships. Uses grouped regression for wages, a tobit for unemployment and a Poisson equation for the apprentices demand. Addresses selection bias and controls by educational level.
25	Germany	Acemoglu & Pischke, 1998	Workers with secondary education who graduated from apprenticeships (without major school-based education), various reasons for retirement, inc. military (quitters).	Uses wages regressions to verify a theoretical model where the firms reach the balance in two scenarios: high number of resignations (endogenous) and low training; or high training and low number of resignations. Addresses selection bias (military retired by skills). Compares learning outcomes with other workers who include military personnel. Controls include variables for: school dropout after the 10th, experience, sector, and size.
26	Switzerland	Schweri et al., 2006	Firms offering apprenticeships and firms that don't.	Research incentives for firms to offer apprenticeships. Uses OLS regression and a Maximum likelihood estimates model to estimate the net cost of training for firms without apprentices. Includes a cost-benefit analysis. Addresses selection bias of firms' sample (including difficulty to recruit).
27	Austria	Hofer & Lietz, 2004	Apprentices versus full-time high school students and uneducated workers.	Examines the labor stability and wages of apprentices. Uses a tobit model for personal unemployment rate and linear regression for wages. Addresses bias for heterogeneity in work experience, industry, among others but does not control by selection bias.
28	East Germany	Bellman et al., 2000	Periods of employment of workers with different levels of qualifications (including apprentices).	Uses a regression to check an accelerated failure time model and estimate the duration of unemployment. Estimates through a Generalized Estimating Equations (GEE) approach. Assumes reliable results when using the information provided by multiple observations of a single person.

Table A3. Summary – Descriptive models without selection bias control

#	Country	Authors	Comparison/observation groups	Description
28	Germany	Clark & Fahr, 2002	Apprentices (who left the occupation to different occupational codes).	Analyzes the occupational matching of the apprentices. Uses a regression for wages, and dummy for participation in apprentices. Addresses bias in the change of occupation decision (displacement being exogenous) but no selection bias since there is no heterogeneity in firms.
30	Germany	Franz et al., 2000	Young people who did not have a transition from school to successful work (including apprentices).	Analyzes the results for "failed" trainees (i.e., who cannot find a place, or do not finish training). Uses a proportional hazard function for the duration of unemployment and a ML-ordered probit for wages.
31	The Netherlands	van der Velden & Lodder, 1995	Young graduates of full-time vocational education and dual system.	Uses a Cox function of proportional hazard to analyze the probability of being promoted and of being unemployed using an analysis of historical events (the race is divided into different periods of work).
32	Germany	Kalleberg & Witte, 1995	Workers with different types of education (including apprenticeships).	Uses a logistic regression to see fit between educ. vocational (apprenticeship) and employment and an OLS for wage.
33	US, Germany	Couch, 1994	Young graduates of vocational education in both countries.	Implements a least squares regression for wages.
34	East Germany	Winkelmann, 1994	Graduates of apprenticeships, universities, full-time vocational and high school.	Analyzes the relationship between training (including apprentices) and subsequent performance (measured in wage and mobility) in the labor market. Implements linear regression for wages and a Poisson and probit model for labor mobility.
35	Germany	Mohrenwieser & Backes-Gellner, 2010	Firms that grant apprenticeships.	Develops a probit regression to determine the firm's strategy in training (1 = substitution, 0 = investment).
36	UK	Greenwood et al., 2007	Individuals with different types of qualification certificates.	Uses an OLS regression for wage, estimating of the average return and the marginal return (of the highest qualification obtained).
37	UK	McIntosh & Morris, 2016	Individuals with different types of qualification certificates.	Uses an OLS regression for wage, estimating of the average return and the marginal return (of the highest qualification obtained).
38	UK	McIntosh, 2007	Individuals who completed a modern apprenticeship.	Analyzes the salary benefits of the 3 levels of the trainee system with an OLS, and a CBA of the system.
39	US, Germany	Buechtemann et al., 2001	Young graduates from high school in both countries.	Compares the results in the transition from school to work of the two systems through statistics.

Annex B – Summary of main apprenticeship evaluations

Table B1. Summary of main apprenticeship evaluations

					Dependent variables							
#	Cat heg ory	Level	Paper	Description	Employment	Unemployment	Employment duration	Unemployment duration	Wage	Turnover	Others	Pro/ Against
1	Quasi-experimental	****	Italy/2004-2007 (Corseuil et al., 2014)	Evaluates a reform implemented in Italy where apprentices are introduced.	(+) 5.2pp	se	se	se	se	(+) 3pp	Productivity (+) AV/worker 1.5pp, sales/worker 1 pp, TFP 1.7 pp	Pro
2	Quasi-experimental	****	PIAAC countries/Aug 2011-Mar 2012 (Hampf & Woessmann, 2016)	Analyzes the impact of vocational education versus general education on employment during the life cycle.	(+) up to 44 years	se	se	se	se	se	na	Pro (initial age)
3	Quasi-experimental	****	Romania/1992,2002,1995-2000 (Malamud & Pop-Eleches, 2010)	Examines the benefits of general education and vocational training (apprenticeship) in Rumania, taking advantage of 1973 educational reform.	0	ns	se	se	se	se	Lower probability of manual and artisans jobs for males	na
4	Quasi-experimental	****	Brazil/2001-2008 (Corseuil et al., 2014)	Evaluates the impact of the Apprenticeship Law.	Δ 10.4% to 17.7% (formal non-temporary)	se	se	se	Δ R\$1.3 to R\$2.1 hourly (2 yrs), and from R\$2 to R\$3 (5 yrs)	se	na	Pro

5	Quasi-experimental	****	Germany/1975-2001 (Parey, 2012)	Analyzes the effect on the labor market of apprenticeships compared to the vocational technical school, exploiting the regional variations in the offer of apprentices' contracts.	se	(+) 0.11pp	se	se	ns	ns	The # of vacants determines the choice between fill time vocational or the dual system	Pro
6	Quasi-experimental	***	East Germany/1975-1996 (Adda et al., 2006)	Evaluates the German Apprenticeship by modeling individual careers from the decision to belong to that scheme and followed by their employment, work-to-work transitions and wages throughout the life cycle.	se	(+) 4pp	(+) 1.5 years more over 20 years		(+) 14% lyfe-cycle	se	Wage profile of non – apprentice grows at a <rate but for> time. Apprentices are> likely to return to work after unemployment (4-5pp)	Pro
7	Quasi-experimental	***	Germany/1997-2002 (Mohrenweiser & Zwick, 2009)	Analyzes the impact on firms' performance of increasing the participation of apprentices at the cost of participation of skilled or semi-skilled workers.	se	se	se	se	se	se	(+) gross profits of + 1% in crafts occupations and + 1.4% of construction. (- 1.2%) (manufacturing occupations	Pro (sectors)
8	Quasi-experimental	***	Germany/1997-2004 (Zwick, 2007)	Analyzes the impact of the increase of the participation of apprentices in the profits of the firms.	se	se	se	se	se	se	Firms profits(ns)	na

9	Quasi-experimental	***	Austria/1975-1998 (Festerer et al., 2008)	Analyzes the returns of the apprentices taking advantage of the different durations due to firms' failures.	se	se	se	se	(+)	se	Returns do not seem to be different from others found for other forms of education.	Pro
10	Quasi-experimental	****	Alemania, Suiza/2000 (Dionisius et al., 2008)	Analyzes and identifies sources of different net costs of apprenticeships in Germany and Switzerland.	se	se	se	se	se	se	Costs Germany> Switzerland (25,323 EUR).	na
11	Descriptive model	***	US/1979-1985 (Lynch, 1989)	Analyzes the conditions that determine the probability of receiving training and its effect on wages.	se	se	se	se	(+) males	se	<training probability for females and non-whites. Portability (se)	Pro (males)
12	Descriptive model	***	Germany/1985 (Werwatz, 1997)	Estimates the wage effects of the occupational mobility of the former apprentices, distinguishing whether they move to jobs that require skills or not.	se	se	se	se	(+) 3%-5% vs no training; 20% vs non skilled	se	Match skills and work (+)	Pro
13	Descriptive model	***	The Netherlands/1985-1994 (Groot & Plug, 1998)	Analyzes the long-term effects on apprentices wages, wage growth and probability of being employed compared to those who choose vocational education.	ns	se	se	se	ns	se	na	na

14	Descriptive model	***	Switzerland/2000 (Schweri et al., 2007)	Estimates the net costs of hiring apprentices, since there is a variation in net costs throughout the firms.	se	se	se	se	se	se	Costs affect the decision to give the training, but not the number of places. The subsidy should be modest to encourage training.	na
15	Descriptive model	***	France/1989-1990 (Bonnal et al., 2002)	Analyzes the effect of apprenticeships on the school-to-work transition and the duration of unemployment, compared to school-based vocational education leading to the same diplomas.	(+) (35pp) males, (9pp) females barely significant	se	(+)	se	se	se	Participation is determined by the general school 1st diploma and occupation of the father	Pro (males)
16	Descriptive model	***	East Germany /1991-1992 (Büchel, 2002)	Analyzes the school-apprenticeships and apprenticeships-work transitions through the years. It controls the selection on the type / quality of training and then assesses the quality of transition to work (i.e. post-apprentice occupation is consistent with training).	se	se	se	se	se	se	Access to good training is largely determined by the quality of the general school certificate (positive selection).	Against (school leavers)

17	Descriptive model	***	Switzerland/2000-2005 (Bertschy et al., 2009)	Examines whether the achievements of the compulsory school (PISA tests) influence the transition and good match in the first job, or whether a successful transition depends more on the type of vocational education (quality of apprenticeship training).	(+) 15pp	se	se	se	se	se	Match skills 1st job (+)	Pro
18	Descriptive model	***	East Germany/1984-2000 (Bougheas & Georgellis, 2004)	Analyzes how apprenticeships affect early labor mobility and the wage profiles of young apprentices.	se	se	se	se	(+) large firms, males. (-) at the beginning but then > growth rate	se	Specific skills are lost and the rotation becomes more expensive. Those who leave accumulate skills faster	Pro (males, large firms)
19	Descriptive model	***	Germany/1984-1990 (Winkelman, 1996)	Evaluates the German Apprenticeship Training (GAT).	se	(+) (23-24 pp) vs university graduates and unskilled workers	(+) 1 st employment at 5 years (3.5 - 11.4 pp) vs university graduates and unskilled workers	se	se	se	Skills transferability (+)	Pro
20	Descriptive model	***	US, Great Britain, Australia/1966-1980, 1981, 1985-1988 (Booth, et al., 1991)	Study funded by the US Department of Education to analyze the status of young people in each country that receive on-the-job and off-site training.	se	(+)	se	se	(+) 18% US, 7% GB, 7%-9% Australia	se	A > education, > probability of receiving training. Skills are depreciated and	na

											transferable	
21	Descriptive model	***	US, UK/1981-1989 (Blanchflower & Lynch, 1994)	Compares the Apprenticeship Act wage gains between the US and UK system.	se	se	se	se	(+) 20% males, (0) females	se	na	Pro (males)
22	Descriptive model	***	UK, Norway/1981; 1975 & 1981 (Baker et al. 1994)	Compares the vocational systems in the UK (employer-based apprentices) and Norway (school-based vocational education).	se	se	se	se	(+) males UK, (-) females	se	na	Pro (males UK)
23	Descriptive model	***	East Germany/1975-1995 (Winkelmann & Euwals, 2004)	Analyzes how the intensity of training and labor mobility after apprenticeship affects their wage profiles, retention rates, and first job lengths.	se	se	(+) 1 st job 11%	se	stayers > movers (+) 14.9 to large firm; (-) 10.7 to small firm	se	Δ 10% apprentice wage = (+) 2pp-16pp retention rate	Pro
24	Descriptive model	***	Denmark/1980-1991 (Westergaard-Nielsen & Rue Rasmussen, 1997)	Estimates the effect of the apprenticeships subsidies on the supply of places by the firm using the changes in the amounts of the subsidies.	se	(+) 33%	se	se	(+) 10% workers in positions with low levels of sophistication	se	Impact of the subsidy on places in the manufacturing and trade sectors (only) (+ 7%)	Pro
25	Descriptive model	***	Germany/1979, 1985-1986, 1991-1992 (Acemoglu & Pischke, 1998)	Tests the adverse selection among firms that finance training - the theory that workers do not pay for the general training they receive.	se	se	se	se	(+)	se	na	Pro

26	Descriptive model	***	Switzerland/2000, 2001 (Schweri et al., 2006)	Analyzes why some Swiss firms do not provide training since most apprentices counteract the cost of their training during this period given the productive contribution of the work they perform.	se	se	se	se	se	se	Average net costs of training firms = - 6,174, for those that do not= 42,395.	na
27	Descriptive model	***	Austria/1993-1998 (Hofer & Lietz, 2004)	Examines the gains and stability of the graduate apprentices' occupational career with respect to individuals from the same birth cohort (1970) who took different educational paths.	se	(+) high school > apprentices > non skilled	se	se	se	se	(-) employment after 3 yrs females	Pro (vs no education)
28	Descriptive model	***	East Germany/1975-1990 (Bellman et al., 2000)	Analyzes the effect of apprentices on the duration of work in East Germany, using information from two cohorts of new entrants to the labor market.	se	se	(+) 1s job 1.9 times	se	se	se	na	Pro
29	Descriptive model	**	Germany/1975-1995 (Clark & Fahr, 2002)	Evaluates the German Apprenticeship Training (GAT).	se	se	se	se	(+)	se	Apprentices tend to leave more the occupation (vs. Not trained)	Pro
30	Descriptive model	**	Germany/1984-1993 (Franz et al., 2000)	Analyzes young people who were left out of the program, who did not complete it, or who did not find work after one.	se	se	(+)	se	se	se	System failures: 4% who register do not enter the system; 16% canceled contract; 10% did not pass the test.	na

											40% of those who did not complete were unemployed. Of those that yes, the 4% in unemployment. Failure in apprenticeships impacts subsequent income.	
31	Descriptive model	**	The Netherlands/ 1987-1989 (van der Velden & Lodder, 1995)	Analyzes the effect of the two forms of vocational education in the Netherlands (full-time with periods of non-employment practice versus dual education with continuous on-the-job / in-service training and apprentice status).	se	se	se	se	se	se	(-) Growth at work once they reach the average level or from the age of 26. In unemployment, mobility down and horizontal. (-) Transfer of skills to other sectors	Against

32	Descriptive model	**	Germany/1984-1990 (Kalleberg & Witte, 1995)	Evaluates the German vocational system.	se	se	se	se	se	se	(-) 50% of apprentices do not have adequate jobs. Males have returns on apprentices, but <opportunity of adequate jobs. More effective apprentices in medium firms with a favorable opportunity structure.	Against
33	Descriptive model	**	US, Germany/1988 (Couch, 1994)	Compares the increase in earnings associated with vocational education in both countries (apprentices for Germany, vocational education for the United States).	se	se	se	se	(+) males Germ>US	se	na	Pro (males)
34	Descriptive model	**	East Germany/1984-1990 (Winkelman, 1994)	Analyzes the differences in wage and mobility of German workers depending on the different levels of education and skills (including apprentices).	se	se	se	se	(+)	(-) 32%	na	Pro

35	Descriptive model	**	Germany/1996-2005 (Backes-Gellner & Mohrenweiser, 2010)	Analyzes the motivations of the firms: substitution (cheap labor force) versus investment.	se	se	se	se	se	se	Substitution strategy (18.5% of firms), retention rate <20%. Investment strategy (43.75%) (retention rate > 80%).	na
36	Descriptive model	**	United Kingdom/1997-2015 (McIntosh y Morris 2016)	Estimates the returns related to different levels and types of qualifications.	se	se	se	se	(+) (9%) apprentices; (13%) HNC/HND, (7%) BTEC Level 3, (2%) BTEC, (0) Level 2; (+) RSA females	se	na	Pro (high certifications)
37	Descriptive model	**	United Kingdom/2004-2005 (McIntosh, 2007)	Analyzes the wage benefits for individuals completing courses as apprentices.	se	se	se	se	(+) (16%) Level 2 - (18%) Level 3 (14%) females Level 3	se	(+) NPV and IRR	Pro
38	Descriptive model	**	US, Germany/1979-1981 (Buechtemann et al., 2001)	Compares the educational system of both countries.	(+) (4%) Germ > (10%) US	se	se	se	(+) (2X) Germ > US	se	In Germany there is a better match between skills obtained and those required for work	Pro

39	Descriptive model	**	England (Greenwood et al., 2007)	Analyzes in detail the current economic value of the entire range of vocational qualifications at level 2 and level 3 of the English labor force.	(+) (2pp) apprentices, (1.5pp) BTEC Level 3, (2.5pp) City & Guilds L3, (1.5pp) ONC/OND, (0) RSA L2, (-) Level 2	se	se	se	(+) (10-16%) male apprentices, (29%) NVQ3 professionals. Females NVQ3: (20%) energy and water, (19%) services, (18%) machines, (12%) sales, (5%) admin. Males NVQ3: (14%) prof, (15%) machines. Construction: (34%) ONC/OND, (23%) BTEC L3, (24%) City & Guilds.	se	na	Pro (high levels)
40	Cost-Benefit Analysis	**	US/2000-2010 (Reed et al., 2012)	Study commissioned by the DoL in 10 US states (Florida, Georgia, Iowa, Kentucky, Maryland, Missouri, New Jersey, Ohio, Pennsylvania, Texas).	se	se	se	se	(+) \$240,037 whole working life	se	Social benefits exceed costs	Pro
Note:	Positive	effects	(+),	negative	effects	(-),	non-significant	results	(ns),	not	applicable	(na).

