Benefits and Costs of Dual and Informal Apprenticeship in Bénin*

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Abstract

This paper evaluates the costs and benefits of apprenticeship training in the informal sector in Benin using unique matched apprentice-firm survey data. Costs and benefits for the training firm and the trainee are investigated separately. Special attention is paid to the net benefits of the *Certificat de Qualification Professionelle*, program, a national dual training program. Two cost and benefit models of differing complexity are used: in the simplest, fees comprise all benefits for the firm, while apprentice wages and benefits represent total costs. In a second, more complex model, estimates of current and future productivity, apprentice retainment by the firm, and training costs are also considered. We find that apprentices benefit from training in terms of improved competence and experience. Fees paid to the training firms account are not enough to defray the expenses associated with training, which are dominated by allowances paid to apprentices. Most firms report net costs from training, though large firms appear to benefit when apprentice productivity is considered. Participation in the CQP program is not associated in any benefits for either trainees or firms relative to non-participating apprentices.

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1 Introduction

Interest in apprenticeship is on the rise. Many youth participate (as much as 4x more in Africa than in formal TVET - Filmer and Fox (2014)).

"Traditional apprenticeship in the informal sector consists of private contractual arrangements between an apprentice or his/her parents and a master craftsman who agrees to provide practical training in the workplace, and subsequently certifies the training in return for a fee"

However, market failures have led to calls for reform. One potential reform is introducing a classroom component, creating a dual system similar to the Swiss and German variety (Walther (2011)). Dual systems promise to increase training quality by introducing a state-regulated classroom component, while also increasing the signalling ability of apprentices upon graduation. In SSA, dual apprenticeship schemes were first introduced in Bénin and Togo in the 1980s by the Hans Seidel Foundation, a German NGO, and apprenticeship reforms based on the dual system have since been introduced in Mali, Ivory Coast, Senegal, Tanzania, Togo, and Niger ILO (2020). Many of these schemes have struggled with funding issues and integration into the existing national TVET and regulatory frameworks. With their potential to simultaneously harness the abundance of informal apprenticeships and African youths' thirst for formal education, dual system apprenticeship certification schemes remain an underutilized approach in the field of TVET reform.

Training interventions combining on-the-job and classroom training in LICs have suffered from low take-up, high dropout, and low efficacy (see Blattman and Ralston (2015); Tripney and Hombrados (2013); Ghisletta et al. (2021) for an overview), but, unlike the CQP, these are generally not embedded in the existing institution of traditional apprenticeship training. The single study of dual apprenticeship in Africa has reported comparatively positive effects, showing that subsidies encourage enrollment and offset earnings reductions during training, and increase earnings by as much as 15 percent after four years. However, aside from Crépon and Premand (2019), evidence on the effectiveness of dual training in Africa is very limited.

1.1 First contribution

In this paper, we analyze the impact of informal sector dual system training on participating apprentices and firms. The program offered youth in select trades the opportunity to attend classroom training at a local training center once a week for the duration of their otherwise traditional apprenticeship. Outcomes for youth and firms were recorded by means of surveys before the onset of training and after three years (somewhat shorter than the typical duration of an apprenticeship). Youth received a nationally recognized certificate upon graduation.

1.2 Second contribution

Since the firms providing dual system training are recruited from the existing pool of informal training firms, we also use the treatment and control groups to provide insights on the finances and net benefits of training for both dual system and traditional (non-participating) apprentices. Traditional apprenticeships are very widespread, but may suffer from market failures that negatively affect their provision and quality. For instance, in the absence of complete, enforceable contracts, firms may be unable to commit to providing general skills training (Acemoglu and Pischke, 1998, 1999a; Dustmann and Schönberg, 2012). Lack of certification may inhibit the ability of apprentices to signal their skills on the labor market, limiting their mobility up the wage ladder [Acemoglu and Pischke (2000); alfonsi2020]. Recruitment costs may keep apprenticeships below their optimal level (M. L. Hardy et al., 2019). Finally, apprentice productivity may be so low that subsistence levels (paid in the form of "chop money" by the firm owner) outstrip returns from training, causing an underprovision of training. A deeper understanding of the costs and benefits of are critical for guiding any reforms to adjust such market failures.

Our paper contributes to several strands of research.

1.3 Apprentice Benefits from informal sector training

Returns to informal apprenticeship: M. L. Hardy et al. (2019); crepon2019. Using national household surveys: Monk et al. (2008), Frazer (2006). Skills: Crépon and Premand (2019).

1.4 Firm Benefits from informal sector training

Rosholm et al. (2007); M. Hardy and McCasland (2022); Alfonsi et al. (2020); Crépon and Premand (2019)

1.5 Cost/benefit analyses of dual training

summary for HICs: Muehlemann and Wolter (2014); Mühlemann (2016); Mühlemann and Wolter (2019). case studies in LMICs and LICs: Bolli et al. (2020)

1.6 Studies of the CQP

Davodoun (2011); David-Gnahoui and Ahouangnivo (2017); Bankolé and Nouatin (2020)

In sub-Saharan Africa (SSA), interest in apprenticeship is on the rise. According to survey data, informal apprenticeships (also referred to as apprenticeships in the informal economy or traditional apprenticeships) are estimated to provide as much as 95 percent of technical and vocational education and training (TVET) in SSA, and in

some countries account for as much as 90 percent of total employment in the crafts sector (Walther and Filipiak, 2007; World Bank, 2017). For youth who drop out of school early, informal on-the-job training is often the only alternative for acquiring the skills necessary to start a business or find employment. As a result, informal sector training is seen by many policy experts as an important tool to tackle the youth employment challenge in Africa (Filmer and Fox, 2014).

Apprenticeships generally last between three and four years and involve learning from a master of a traditional craft or trade, such as metalworking or car repair. Upon completing an apprenticeship, some apprentices continue to work for the same or for another workshop as a wage employee, though most seek to start their own firm given access to sufficient capital. Most training firms are small, and most are owned by the trainer, or "master craftsman."

The literature on informal apprenticeship in SSA has focused on two aspects of training: the long-term impacts of training on employment and wages for participating apprentices and the impact of training on the size and profitability of training firms. Studies of apprentice benefits indicate that the long-term returns to training are heterogeneous, but tend to favor apprentices with lower starting levels of education. Monk et al. (2008) show positive returns to apprenticeship for youth with little or no education (though former apprentices are also shown to have significantly lower earnings than the rest of the working population). Frazer (2006) likewise points to positive returns to informal training in Ghana, but, like Alfonsi et al. (2020) in Uganda, highlights the fact that skills acquired in informal training tend to be firm-specific and thus less conducive to career progression than those acquired through formal schooling. Indeed, the sector-specific or even firm-specific nature of skills acquired in informal apprenticeship may be reason why self-employment is the dominant path after graduation for many apprentices: for example, M. L. Hardy et al. (2019) find that youth who participate in a apprenticeship are more likely to shift out of wage work and into self-employment (and suffer a wage penalty).

Other studies suggests that firms may be the greater beneficiaries of informal training. In Uganda, both formal TVET and on-the-job training were shown to increase firm profitability (Alfonsi et al., 2020). M. Hardy and McCasland (2022) find that assigning an apprentice to informal firms in Ghana increase firm size by about half a worker, while firm revenues increase by 5-15% per apprentice. Firms not assigned an apprentice do not hire new workers, suggesting screening costs are high.

Few studies, however, have attempted to quantify the immediate human capital gains accruing to apprentices for participating in an informal apprenticeship in SSA. One exception is Crépon and Premand (2019), who find higher earnings and higher involvement in non-routine tasks after two years, albeit following not a traditional apprenticeship but rather a specialized, 12- to 24-month subsidized apprenticeship with a theoretical training component. Similarly, while several studies document increased profitability among training firms (Alfonsi et al., 2020; M. Hardy and McCasland, 2022),

few focus on the details of the financial arrangements between apprentices and firms, despite some authors suggesting that training fees may be a substantial source of financing for some firms Frazer (2006).

The first task of this paper is thus fill this training gap by identifying the short-term impacts of training on the human capital of apprentices and on the financial accounts of training firms. To do this, we employ matched apprentice-firm survey data collected in Bénin in two waves (2019 and 2021) for 427 apprentices training in 197 firms.

We find that the majority of firms suffer net losses over the duration of the apprenticeship. The proportion of firms with negative net benefits from training, and the magnitude these losses, vary considerably depending on assumptions around allowances disbursed by the firms. Larger firms benefit the most, while smaller firms suffer the largest losses, suggesting that economies of scale contribute to the incentive structures surrounding firm training.

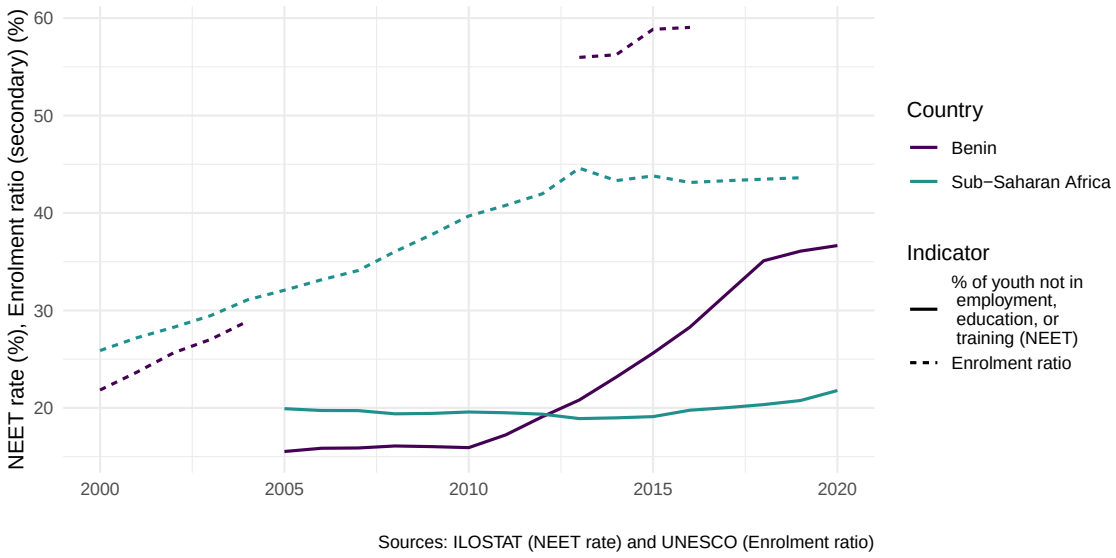
The paper proceeds as follows. Informal apprenticeship in Bénin and the CQP program are described in detail in Section **??**. The survey data used for the analysis is presented in Section **??**. Results are presented in Section 3. Section 4 concludes.

2 Data

2.1 Country Context

Despite the relative stability of its democratic government and strategic importance as a transportation hub, Bénin (population approx. 12.1 million) performs poorly on many development indicators, ranking 158th out of 189 countries on the 2020 Human Development Index. Youth employment is a particularly pressing issue, with an alarming decrease in youth labor force participation in the past decade. As in other parts of SSA, secondary and tertiary school enrollment has seen a steady increase in the past two decades, with the predominant effect of displacing employment: according to the most recent labor force surveys, the youth employment-to-population ratio decreased by 22%, from 40% to 31%, between 2011 and 2018, compared to an 8% decrease for adults over the age of 25 over the same time period. Meanwhile, the share of youth neither in employment, education or training (NEET) increased from 17.2% in 2011 to 35.1% in 2018 (see Figure 1) - one the highest rates in West Africa, and the world (ILO, 2022).

Figure 1: Rates of youth enrolment and inactivity: Bénin and SSA



As enrollment in formal education has not translated to increasing rates of youth employment, interest in promoting alternative pathways to the labor force has grown. In economies with large informal sectors, apprenticeships with small workshops are the most important source of skills for early school leavers, accounting for as much as 95 percent of TVET in SSA (Walther and Filipiak, 2007).

In 2005, the government of Benin announced a restructuring of traditional apprenticeship in the informal sector. Two national apprenticeship schemes were introduced: a formalization of the existing, firm-based apprenticeship program in the form of the *Certificat de Qualification aux Métiers* (CQM) certification system, and the **dual system** *Certificat de Qualification Professionnelle* (CQP) program, which combined in-firm training and classroom teaching. The three stated objectes were to (i) offer practical and theoretical training to youth under apprenticeship contracts in the craft sector (ii) train a high-performance labor force; and (iii) improve the productivity and profitability of workshops in the craft sector (Davodoun, 2011). The main government organs responsible for the administration of the CQP are the national TVET directorate (DETFP), the Direction of Test and Exam Services (DEC), in charge of the entrance and exit examinations for the CQP, and FODEFCA, the body responsible for procuring and distributing funding for the CQP (Nouatin et al., 2019). The CQP began curriculum planning in 2005 with technical assistance from the French Development Agency (AFD) and the Swiss Agency for Development and Cooperation (SDC), among others, and became operational in 2008. In 2012, management of the program passed from Swisscontact, a Swiss NGO, entirely into the hands of FODEFCA (Nouatin et al., 2019).

Entry into formal technical and vocational education and training (TVET) begins after the completion of the second year of secondary school, or nine years of education.

Yet across the country, the median number of years spent in the education system is four; only five percent of youth of secondary school age are enrolled in TVET (ILO, 2021), in line with the six percent of young workers estimated to participate in formal TVET across SSA (Hofmann et al., 2022). Informal apprenticeship is the conduit into the labor market for early school leavers in Bénin, estimated to be training as many as 300,000 young men and woman in the small country of 12 million (ILO, 2021).

Officially, the CQP recognizes "professional, technological and general skills acquired by the apprentice for the exercise of a professional activity" (*Decret N 2010-641*, 2010). It also allows the pursuit of further technical and professional studies upon its completion. To participate in the CQP, applicants must 1. be at least 14 years old, unless otherwise authorized by the labor inspector; 2. have a written apprenticeship contract that complies with labor laws; 3. have completed at least 6 years of formal schooling; 4. pass a national entry examination (*KOF*, 2017). Firm owners apply on behalf of the apprentices in their charge, generally through local craftsmen associations.

The CQP is currently available for 13 out of the more than 300 trades listed in the craft sector: auto mechanics, motorcycle mechanics, air conditioning mechanics, tailors, masons, carpenters, metalworkers, electricians, and plumbers (*Swisscontact*, 2019)[1]. With the goal of expanding the number of trades eligible for the CQP and CQM, the Beninese government, through the Youth Employment Project (PEJ) co-financed by the World Bank, has focused on expanding the programs to the crafts, tourism and food processing sectors in recent years. Cost sharing for the CQP program is shared by the state and the apprentice, with the state financing body for dual apprenticeship, FODEFCA, officially taking on 90 percent of the training costs (*KOF*, 2017). However, FODEFCA is largely reliant on external donor funding, and regular financing has been an issue for the program in recent years (David-Gnahoui and Ahouangnivo, 2017).

The financing of dual training comprises three main budget items: the firm/workshop, the training center and certification. While on-the-job training in the firm is paid for by the parents, training in the training center is largely financed through FODEFCA from various sources (national budget, donors, NGOs, etc.). Certification upon successful completion of the CQP exam is allocated to the national budget via the Directorate of Examinations, DEC (David-Gnahoui and Ahouangnivo, 2017).

CQP qualification is attained upon the completion of a three to four year apprenticeship with a training firm in one of the designated trades or crafts and the passing of the annual national CQP examination. Competency charts ("*matrices des compétences*") published separately for each participating trade specify the knowledge and know-how that must be acquired to obtain the diploma, and a detailed testing procedure for the skills that the holder of the diploma must possess are published in a evaluation guide (*grille evaluation*) for each trade. The final examination has a practical and a written com-

[1]This selection of trades was based at least in part on existing trades from early experimental dual training programs to take advantage of existing training center infrastructure. The CQM is available for about 50 trades.

ponent and is carried out by state representatives and local craftsmen. Upon successful completion, apprentices receive a nationally-recognized certificate.

Criticisms of the CQP include the lack of certified and accredited trainers at the training centers and unstable financing, which leads to high fluctuation in the number of applicants admitted to the program (David-Gnahoui and Ahouangnivo, 2017; ILO, 2020).

2.2 Sampling

The data for this study was collected in two separate surveys. The first consisted of interviews with apprentices who had applied to the 2019 cohort of the CQP program; the second was conducted with the owners of the respective training firms. To reduce travel distances and allow for subsample analyses across trades, apprentices were randomly selected from a subsample of applicants: those who had applied to train in electrical installation, carpentry, masonry, metalwork (primarily welding of gates for living compounds), or plumbing (out of a total of 13 participating trades) and who were training in the south of Benin.

In addition to questions regarding training practices and firm performance, master craftsmen were interviewed on the subject of specific apprentices training at their firm. These apprentices were either participants in the CQP program, unsuccessful applicants to the program, or had not applied to the program at all. As the apprentice survey consisted only of applicants to the program, the only data on non-applicants comes from master craftsmen. To limit the duration of the firm interviews, apprentice-specific questions were only posed for a randomly chosen subset of apprentices for firm owners with high numbers of trainees. This sampling procedure is summarized in Table 1.

Table 1: Apprentice Sampling

CQP Status	Explanation	Apprentice Survey Sampling	Firm Survey Sapmling
Selected	Already in apprenticeship, applied via master craftsmen. Passed exam and selected.	Random sampling from list of all CQP applicants in five chosen trades and geographic region (Southern Benin)	If more than one CQP applicant training in firm, at most two apprentices were randomly selected at baseline.
Not selected	Already in apprenticeship, applied via master craftsmen. Not selected due to exam score or lack of training center.	Random sampling from list of all CQP applicants in five chosen trades and geographic region (Southern Benin)	If more than one CQP applicant training in firm, at most two apprentices were randomly selected at baseline.

CQP Status	Explanation	Apprentice Survey Sampling	Firm Survey Sapmling
Did not apply	Did not apply to CQP. Trained as traditional apprentice.	N/A	Firm owner listed *up to* 5 apprentices who did not apply to CQP. One randomly selected at baseline.

The baseline wave for the two surveys was collected in July-August 2019. The apprentice survey included questions on training characteristics, employment outcomes, skill and competency assessments and apprentice assessments of training quality, while the firm survey included questions on workforce composition, wages, costs and revenues, training practices, and individual apprentice assessments. Data on 427 apprentices working for 197 unique firms was collected at baseline (see Table 2). Summary statistics from the baseline survey show the sample to be predominantly male youth who, though of average age for an apprenticeship at 21.28 years (ILO, 2022), are significantly more educated than is typical for traditional apprentices, with over half having completed at least some secondary schooling. Apprentices selected for participation in the CQP are more educated than those not selected. Non-applicants have the lowest educational attainment and are the least experienced at baseline, suggesting that master craftsmen send most able apprentices to stand for the entrance exam. Finally, it is notable that CQP applicants have over three years of apprenticeship experience on average, though the CQP entrance requirement only stipulates six months. This again suggests a selection mechanism for more experienced/able applicants that may indicate that the CQP is considered more of a continuing education program among craftsmen than an entry-level apprenticeship program.

Table 2: Descriptive Statistics

	Overall		By baseline status		
Characteristic	**Baseline**	**Endline**	**Selected**	**Not Selected**	**Did Not Apply**
Apprentices					
N	427	240	149	107	171
Age	21.3 (3.4)	23.2 (3.5)	21.7 (2.8)	22.3 (4.1)	20.1 (3.2)
Gender					
Female	8 (2.0%)	4 (1.7%)	2 (1.3%)	2 (1.9%)	4 (2.7%)
Male	398 (98%)	235 (98%)	147 (99%)	105 (98%)	146 (97%)
Trade					
Masonry	91 (21%)	43 (18%)	29 (19%)	25 (23%)	37 (22%)
Carpentry	48 (11%)	27 (11%)	20 (13%)	7 (6.5%)	21 (12%)
Plumbing	54 (13%)	36 (15%)	26 (17%)	12 (11%)	16 (9.4%)
Metalworking	86 (20%)	47 (20%)	41 (28%)	13 (12%)	32 (19%)
Electrical Inst.	148 (35%)	87 (36%)	33 (22%)	50 (47%)	65 (38%)
Years in training	2.33 (1.38)	4.39 (1.38)	2.52 (1.24)	2.64 (1.30)	1.92 (1.48)
Education					
None	10 (2.5%)	8 (3.3%)	0 (0%)	1 (0.9%)	9 (6.0%)
<Primary	61 (15%)	35 (15%)	9 (6.0%)	7 (6.5%)	45 (30%)
Primary	91 (22%)	51 (21%)	32 (21%)	34 (32%)	25 (17%)
Secondary	230 (57%)	136 (57%)	99 (66%)	63 (59%)	68 (45%)
Technical	8 (2.0%)	6 (2.5%)	4 (2.7%)	1 (0.9%)	3 (2.0%)
Tertiary	6 (1.5%)	3 (1.3%)	5 (3.4%)	1 (0.9%)	0 (0%)
Firms					
N	197	150			
Apprentices trained					
Total	6.1 (7.3)	6.1 (8.0)			
Selected	1.78 (3.49)	1.65 (3.32)			
Not Selected	3.10 (10.50)	3.05 (11.16)			
Did Not Apply	1.2 (11.6)	1.1 (10.1)			
Firm size					
Total (calculated)	9.6 (13.9)	8.9 (10.9)			
Total (reported)	6.7 (7.5)	6.6 (7.1)			
Permanent wage	0.36 (1.8)	0.80 (2.8)			
Paid family	0.06 (0.4)	0.14 (0.6)			
Unpaid family	0.05 (0.4)	0.03 (0.2)			
Occasional	0.83 (2.6)	0.83 (2.3)			
Trade					
Masonry	45 (23%)	30 (20%)			
Carpentry	24 (12%)	18 (12%)			
Plumbing	26 (13%)	21 (14%)			
Metalworking	39 (20%)	32 (21%)			
Electrical Inst.	63 (32%)	49 (33%)			

[1] N; Mean (SD); n (%)

The majority of training firms are small workshops comprising the firm owner — the master trainer — and several apprentices. Two firm sizes are shown in Table 2: those stated directly by the firm owner in response to the question, "How many people (in-

cluding you and your apprentices) are currently working in your business?" and those calculated by the author by summing the number of apprentices, partners, paid and unpaid family workers, and occasional workers engaged by the firm owner. Using self-reported size, 50.62% of firms employed a total of five or less (including the owner) at baseline and 79.51% of firms employed no more than ten. Using the calculated firm size, 33.57% of firms employed a total of five or less (including the owner) at baseline and 72.34% of firms employed no more than ten. Thus, training firms in the sample are small, in line with observations from the informal sector in Ghana Velenchik (1995). Moreover, the workforce of the average firm in the sample is dominated by apprentices: at baseline, the average firm employs about four apprentices for every other type of employee (81.47% of calculated firm size at baseline and 85.1% at endline).

The endline survey was conducted in August-September 2021.

Attrition between baseline and endline for CQP applicants (selected and non-selected) is driven by both youth non-response and firm non-response[2]. Overall apprentice attrition is 43.8%. However, Table A1 in the Appendix gives no indication of attrition bias, as there is no systematic difference in the sample composition by CQP participation status, trade, or relevant socioeconomic variables.

Similarly, of 197 firms interviewed at baseline, only 150 could be contacted at endline, for an overall firm attrition rate of 23.9%. Table A2 in the Appendix likewise suggests that firm attrition was not correlated with key firm characteristics such as trade or the number of CQP applicants (selected or non-selected).

2.3 Methods

2.3.1 Apprentice Benefits

We first examine the benefits accruing to apprentices over the observed time period of two years. Though all applicants applied to the same cohort of the CQP program, they came in having more experience than the required six months previous to application: the average apprentice had 1.93 years of experience at the time of application 2. About one third of the sample graduated before the endline survey.

The benefit to accruing to apprentices is measured using three sets of trade-specific human capital indicators for each apprentice at baseline and endline, a simplified version of the "task approach" utilized in the technological change literature (Crépon and Premand, 2019; see Dicarlo et al., 2016). Firms were asked to assess apprentices on a series of trade-relevant tasks, and apprentices were given a short test of trade-specific knowledge. Similar to the task approach, this method allows for worker-level measurement of ability and experience based on tasks performed, as each apprentice receives a score in each of the three dimensions. Unlike the task approach, however, tasks are trade-specific and not strictly comparable across trades.

[2]Data on apprentices who had not applied to the CQP was only obtained from firm owners, and thus only subject to firm attrition.

The **competency and experience scores** are the percentage of tasks in which apprentices are deemed competent or experienced. They are based on a set of 10 to 15 tasks for each trade in question that apprentices should master in the course of an apprenticeship in their selected trade that were selected with the help of active local craftsmen (shown in Appendix B.1). Apprentices are evaluated on each task by their master trainer[3] on a binary scale: they are either competent at realizing a given task (competency metric) or have already realized a given task in the past (experience metric), or not.

The **knowledge score** is based on a short battery of questions drawn from the official competency charts for each trade and posed directly to the apprentices. Each question was a multiple choice question, and between 4 and 5 knowledge questions were posed to each apprentice. The knowledge questions are reproduced in Appendix B.2. Because apprentices who did not apply to the CQP were not interviewed directly, the knowledge score was only measured for CQP applicants.

2.3.2 Firm Benefits

Firm benefits were calculated using the accounting approach, which relies on survey data from training firms to identify and quantify the costs and benefits arising from training provision (see Gambin et al., 2013; Muehlemann and Wolter, 2014), and which has recently started to be applied in lower-middle income countries (Bolli et al., 2020; Bolli et al., 2021; Renold et al., 2018). This approach involves subtracting the costs of training from its benefits and is a simple way of estimating the value that training apprentices generates for the training firm.

To identify **costs** accruing to the firm, owners were asked to identify any costs directly or indirectly related to their training activities. These costs can be divided into two categories: **Equipment costs** comprise all costs for physical infrastructure necessary for training: **raw materials** such as cement, lumber, or scrap metal used in the course of training; **training equipment** such as workbenches, toolkits, or other machines purchased or rented specifically for training purposes, **rent** for training facilities if training was not conducted exclusively in the firm owner's workshop, and **books and any other training materials**. Firms report training costs for each category the past month; to estimate annual training costs per apprentice per year, the reported costs are thus divided by the number of apprentices training in the firm and multiplied by the number of months the firm was open in the previous year. Annual sums for training costs are reported at the firm level and thus normalized by the number of apprentices training in the firm, yielding approximate costs per apprentice per year.

Allowances are disbursed irregularly by the firm owner for small expenses such as travel and meals. These are reported by firms at the apprentice level (separate reported allowances for each apprentice). To estimate total annual allowance expenditures per

[3]Apprentices were asked to self-evaluate their competence at endline using the same metric. Self-evaluation was not initially planned and thus unavailable at baseline

apprentice, we thus sum over all allowance categories and assume that apprentices work 20 days per month; the extrapolated monthly sum is then multiplied by the number of months the training firm was operating in the past year to arrive at an annual estimate for each apprentice.

Finally, **foregone trainer productivity** is calculated as the wage of a trained employee times the number of hours trained in the firm per year, extrapolated from the reported hours trained in the past month (as reported by the firm owner). Annual training hours are then multiplied by the number of training staff and divided by the number of apprentices benefiting from training to arrive at foregone trainer productivity per apprentice.

The simplest model of net benefits reduces the value of training for the firm to the direct material incomes and expenditures related to training; namely, apprenticeship fees from the apprentices and their parents, an approximation of training costs, and the total reported allowances disbursed to the apprentice. These are detailed in Sections 3.3.2 and 3.3.1.

The first model used to estimate net benefits accruing the firm per apprentice per year is thus:

Model I:

$$annual\ net\ benefits_i = \frac{fees\ paid_i}{4} - apprentice\ allowances_i - \frac{total\ training\ costs_j}{N_j}$$

for each apprentice i in firm j, where N_j is the total number of apprentices in firm j.

In a second approach, we keep all components of Model I and add two additional factors. First, we estimate an additional benefit of training to the firm: apprentices' net productive value to the firm. In the competitive model of labor markets (with heterogeneous wages), workers are paid their marginal productivity. We assume competitive labor markets and use detailed wage information elicited from each firm to estimate the total productive output of apprentices. Namely, we assume apprentice productivity is equal to that of an untrained employee with no more than a primary education for the first two years of training, and increases to that of trained employee (who had trained at the training firm) for the final two years. Under these assumptions, the annual productive value generated by apprentice work amounts to the average of these two wages[4].

Second, we add to Model I an additional estimated cost of training: foregone trainer productivity. Firms estimated the hours trained on the last day the firm stopped all productive activities to train apprentices, as well as the number of days per week that such training occurred. We use this information as the basis for our estimation. We extrapolate weekly hours of training (hours trained on previous day of training x days trained per week) to annual hours by assuming four work weeks per month and multiplying

[4]A popular alternative to this admittedly unpolished approach involves eliciting specific tasks performed by apprentices and estimating costs savings based on the wages paid to workers who would otherwise be responsible for said tasks [@hauschildt2018]. Our firm-apprentice data did not cover specific tasks and is thus not equipped to carry out such an analysis.

by the number of months the firm owner reported being open in the previous year. As when estimating apprentice productivity, we set reported monthly wages for skilled workers (wage employees who had trained with the current firm) equal to trainer productivity and divide by the approximate hours worked in the past month to arrive at approximate hourly wage per trainer (assuming four work weeks per month and using firm-reported days open last week and hours worked on the last day). Finally, we multiply by the number of trainers and divide by the number apprentices per firm to arrive at an estimated cost, per apprentice, in terms of total foregone employee productivity resulting from training activities.

In this formulation, the net annual benefits accruing to the firm take the form:

Model II:

$$\begin{aligned} \textit{annual net benefits}_i = & \frac{\textit{fees paid}_i}{4} - \textit{apprentice allowances}_i - \frac{\textit{total training costs}_j}{N_j} + \\ & \textit{estimated apprentice productivity}_i - \\ & \frac{\textit{estimated foregone productivity per trainer}_j}{N_j} \end{aligned}$$

for each apprentice i in firm j, where N_j is the total number of apprentices in firm j.

3 Results

In this section, we analyze the benefits of apprenticeship training for apprentices and training firms.

3.1 Training Firms and Dual Apprenticeship in Low Income Settings

Before proceeding with the cost and benefit analysis, we provide some background on apprenticeship training and the CQP program using apprentice and firm owner survey responses.

Though dual training is predicated on classroom teaching about once a week, we found that external training (classes or training that took place outside of their master's workshop) was not limited to CQP participants. At baseline, 32.42% of apprentices reported participating in such training in the preceding three months. However, only 43.62% of CQP participants reported doing so, despite external training being a constituent and necessary component of the CQP program's dual training structure. Interruptions due to the Covid-19 pandemic may have played an important role in extending

the duration of training in the period of observation: 26.4% of apprentices reported reduced hours of training, while 14.04% reported complete work stoppages at their training firm, due to the pandemic. Covid-19 is also likely to have had an outsized impact on participants in the CQP program, 58.43% of whom reported that their training center had suspended classes. Among apprentices who participated in any external training, 89.16% reported working spending at least 10 days in this training in the preceding three months (approximately equal for the CQP subsample), while the average reported training duration was 6.67 hours. Thus, CQP apprentices reported training externally at only a marginally higher rate than apprentices who applied but were not accepted into the program.

The majority (82.81%) of apprentices reported that the training center they attended was within one hour of traveling distance. Among apprentices who attended classes or training outside their master's workshop, nearly three quarters reported that the training took place in a training center (the rest said it took place in another workshop).

Apprentices also explained their motivation for starting an apprenticeship. The most frequently cited motive was interest in the trade, followed by the promise of good earning opportunities and the insistence of the parents. They were also asked why they had chosen the craftsmen they were training with; the majority replied that they were attracted by the patron's reputation, or that their parents had made the choice in their stead. As found in previous studies of informal apprenticeship in SSA, most apprentices express a wish to start their own business after graduation (67.97%) followed by seeking employment with a different workshop (17.19%).

By combining time trained at the time of the survey with the expected graduation date, we find that apprentices expect their training to last 3.94 years, with a standard deviation of 1.21 years, in line with our assumption of four-year apprenticeships. Metalworking apprenticeships reportedly last almost a year longer than the other trades in the sample.

3.2 Impact of Informal and Dual Training on Individuals

Table 3: Change in apprentice human capital

Group	Trade	N	Baseline	N	Endline	p-value
Competencies	Electrical Installation	125	0.80 (0.24)	69	0.96 (0.09)	<0.001
	Masonry	90	0.75 (0.22)	39	0.90 (0.18)	0.008
	Carpentry	48	0.76 (0.28)	21	0.93 (0.15)	0.14
	Plumbing	54	0.73 (0.29)	26	0.92 (0.15)	0.008
	Metalwork	86	0.75 (0.22)	38	0.86 (0.21)	0.006
	Overall	403	0.76 (0.24)	193	0.92 (0.16)	<0.001
Experience	Electrical Installation	125	0.77 (0.26)	69	0.96 (0.08)	<0.001
	Masonry	90	0.72 (0.23)	39	0.91 (0.13)	<0.001
	Carpentry	48	0.73 (0.31)	21	0.98 (0.06)	0.013
	Plumbing	54	0.66 (0.30)	26	0.89 (0.17)	0.001
	Metalwork	86	0.72 (0.24)	38	0.85 (0.15)	0.004
	Overall	403	0.73 (0.26)	193	0.92 (0.13)	<0.001
Knowledge	Electrical Installation	77	0.90 (0.16)	49	0.93 (0.10)	0.4
	Masonry	56	0.76 (0.19)	30	0.83 (0.20)	0.8
	Carpentry	25	0.91 (0.18)	15	0.97 (0.09)	0.3
	Plumbing	38	0.52 (0.12)	26	0.64 (0.16)	0.013
	Metalwork	209	0.85 (0.18)	117	0.88 (0.15)	0.8
	Overall	247	0.77 (0.21)	143	0.81 (0.19)	0.078

[1] Mean (SD)
[2] Paired t-test

Changes in the three human capital measures are presented in Table 3. Changes in scores averaged across wave and trade are shown in Figure A3 in the Appendix. We find that apprentice knowledge indeed increased between 2019 and 2021, from an average knowledge score of 77% to 81% across all trades (paired t-test significant at the 10% level.) Mean knowledge scores increase in each individual trade, though the increase is only statistically significant for plumbing; thus, the marginally significant increase in knowledge scores is driven by improvements in a single trade.

In Table 3 above, scores are pooled at the trade level in each wave. Alternatively, we can observe the change in scores for individuals before taking means. Individual changes in score averaged across trades are shown in Figure A2 in the Appendix. Viewed thus, improvements in competence and experience scores are much more pronounced, with apprentices in masonry doubling their experience and nearly doubling their competence (on the other hand, improvements for electrical installation appear lower compared to the case where data is pooled). However, due to attrition between the two waves, this subgroup analysis suffers from small group size, with $N = 34$ for masonry and $N = 20$ for carpentry.

Evidence of apprenticeship effectiveness is clearer when regarding the apprentice

competency and experience metrics. Table **??** in the Appendix shows that mean *competency* score among all apprentices improved from 76% of tasks at baseline to 92% at endline, an improvement of .66 standard deviations. Improvements were observed across all trades, and all differences were statistically significant at standard levels (with the exception of carpentry). Similarly, apprentice *experience* improved from having performed 73% of tasks at baseline to 92% at endline, an improvement of .73 standard deviations.

Apprentices who participated in the CQP program exhibit greater improvement across all three human capital metrics than apprentices who applied but were not accepted or chose not to participate, though these differences are not statistically significant. On average, CQP apprentices improved by 14.8%, 11%, and 3.4% on their experience score, competency score, and knowledge score, respectively, while those who applied but did not participate in the program improved by 10.4%, 6% and 1.7%, respectively (see Table A4 in the Appendix). However, it should be noted that apprentices that did not apply to the CQP program at all made the largest strides of all: 20.6% and 15.8% on the experience and competence metrics, respectively (knowledge was not measured for non-applicants). These results are examined in greater detail using a linear regression approach in Section 3.4.

Finally, the three metrics used to measure apprentice progress are not comprehensive, in that they do not measure outcomes such as the physical and psychological well-being of apprentices, "soft skills," etc. Thus, we also examine subjective measures of apprenticeship quality captured by a 5-point Likert scale rating of the following characteristics of the firm, as perceived by the apprentice: physical safety of the workshop, the master trainer's knowledge, the master trainer's treatment of apprentices, the treatment of the apprentice by other employees and apprentices, apprenticeship benefits, apprenticeship working hours, the quality of training, and the quality of the equipment and machinery in the workshop. We observe generally positive levels of satisfaction with training quality, ranging from an average of 4 (somewhat good) to 5 (very good) on all categories except physical safety at baseline (average = 3.96) and working hours at endline (3.66). Subjective ratings are also generally constant over time. One exception is satisfaction with working hours, which decreases from an average rating of 4.07 to 3.66 - indeed, we observe an increase in reported working hours from 42 to 45 average hours worked in the past week for apprentices who applied but did not participate in the program (while CQP participants work hours remained stable). Generally, we observe no significant differences in satisfaction between CQP participants and apprentices who applied to the program but did not participate.

To summarize, satisfaction is generally high and stable among all apprentice throughout their training period, though apprentices not participating in the CQP report a sharp increase in working hours towards the tail end of their training.

3.3 Impact of Informal and Dual Training on Firms

3.3.1 Benefits

In the German and Swiss context, the primary benefit of training for firms is the productive value of apprentices during and after their apprenticeship. This value is generated when the apprentices is working in the firm, performing skilled or unskilled tasks that would otherwise be carried out by the firm owner, paid employees, or unpaid labor. These benefits accumulate after graduation if the apprentice is hired for less than the labor market wage for workers of equal productivity, as well as any savings on recruitment and hiring costs (Acemoglu and Pischke, 1998, 1999a, 1999b).

In comparison to Swiss or German apprentices, youth in SSA are less likely to continue working for their training firm upon graduation. For example, in Ghana, three out of every four apprentices plan to start their own business within five years (Ahadzie, 2009; Breyer et al., 2007). Many who don't set off on their own are unable to, citing "high start-up costs, the unavailability of land and hostile planning policies tend to obstruct the ability of newly qualified craftsmen to set up on their own" (Ahadzie, 2009). Informal firms must thus recoup their costs during the training period (or within a few years) if hiring apprentices is to remain a profitable enterprise. Moreover, workshops rarely hire skilled wage employees, and thus any benefits from "screening" apprentices for their productive capabilities (i.e. wage compression) or savings in hiring costs play a relatively minor role in the training decision (Table 2).

If this is the case, why do craftsmen in Bénin train at all? First, apprentices are the cheapest and most abundant source of labor, and can be hired to complete unskilled tasks at little overhead. Second, if trades can be mastered relatively quickly, apprentices will provide skilled labor in the later years of their graduation (and after graduation as well, for as long as they need to work to pay off outstanding training fees or save up for their own workshop). Finally, the apprentices (or, more often, their families) traditionally pay fees to the master craftsmen in return for the provision of training (Bankolé and Nouatin, 2020; Frazer, 2006; Velenchik, 1995).

Table 4: Total apprenticeship fees reported by apprentices and firm owners

	Baseline		Endline	
Fee Type	**Apprentice**	**Firm**	**Apprentice**	**Firm**
Initiation	16.89 (55.09)	10.95 (16.44)	15.92 (35.55)	15.58 (36.59)
Training	167.18 (149.59)	144.17 (152.18)	191.69 (155.07)	145.05 (154.44)
Graduation	39.43 (79.49)	37.82 (75.39)	42.32 (78.12)	38.14 (100.51)
Materials	27.89 (33.93)	26.23 (37.24)	31.33 (33.80)	20.60 (19.38)
Contract	25.28 (60.95)	34.21 (67.95)	28.38 (64.38)	19.60 (49.84)
Application	11.41 (15.74)	12.55 (17.02)	12.77 (16.02)	17.61 (15.73)
Total	288.08 (191.06)	244.84 (184.84)	322.42 (184.87)	239.98 (167.79)

[1] Mean (SD). Fees in USD.

Fees are the simplest set of benefits to quantify, and are summarized in Table 4. General training fees account are the largest sum paid to the firms and account for over half of total fees paid. Other minor fees cover the provision of equipment and materials, application fees (pertinent for the CQP, as the master trainer must submit paperwork in their apprentices' stead), and initiation and graduation fees. In total, apprentices report paying about 175,000 FCFA (280 $US) in fees for training, while firm owner report around 160,000 FCFA (255 $US) in fees per apprentice. This indicates an minor increase in the costs of training in Benin over the past two decades: Walther and Filipiak (2007) reports total fees ranging from 50,000 to 150,000 FCFA (96-290 $US, inflation adjusted). Though generally unregulated, in some cases professional associations and public authorities step in to regulate fees, particularly those levied for initiation and graduation ceremonies.

Apprentices report significantly higher fees than firms, for this specific fee in particular. Firms may underreport fees to avoid accusations of gauging, but are at the same time likely to have more direct knowledge of all fees than apprentices, whose parents and relatives usually pay the craftsmen directly. Finally, firms report collecting higher initiation and application fees at the time of the endline survey. This may indicate a shift to fee payments to the beginning of the apprenticeship as graduation ceremonies (and the concomitant graduation fees) are phased out as legislation prohibiting graduation ceremonies is put into practice over time.

3.3.2 Costs

Figure A4 shows the breakdown of various costs per apprentice, averaged over both interview waves. All costs total to approximately 240,000 FCFA, or 400 $US, per apprentice per year. The largest expenses are associated with allowances and raw materials (which are particularly high in the carpentry trade). They also in line with the upper range of costs from David-Gnahoui and Ahouangnivo (2017), who, citing Zinsou, 2012, reported total costs of 100,000 to 250,000 FCFA ($165-$413) for a complete CQP training program in 2012.

Figure A5 in the Appendix accounts for the number of apprentices training in firms and reports mean total training expenditures per firm. These total, on average, 1.4 million FCFA, or 2,325 $US, per firm, corresponding to over half of the reported annual firm revenues (4517 $US) and about 135% of reported total annual costs (1718 $US), as averaged over the two survey waves.

3.3.3 Impact (Net Benefits)

Table 5: Net Benefits

Characteristic	**Baseline**, N = 427	**Endline**, N = 240
Benefits		
Fees	60.49 (46.41)	49.75 (44.38)
Entry	2.51 (4.01)	3.05 (8.25)
Formation	32.92 (37.75)	28.40 (37.29)
Liberation	8.48 (18.08)	7.07 (22.03)
Materials	6.01 (9.09)	3.97 (4.77)
Contract	7.75 (16.36)	3.82 (11.18)
Application	2.83 (4.15)	3.43 (3.92)
Apprentice productivity	110.67 (402.21)	84.19 (338.05)
Costs		
Allowances	173.22 (334.54)	132.47 (455.66)
Food	43.96 (120.94)	39.97 (76.27)
Transport	37.93 (156.76)	12.97 (50.29)
Pocket money	90.93 (161.30)	79.52 (439.55)
Other	0.41 (8.40)	0.00 (0.00)
Training costs	28.43 (65.55)	28.79 (53.81)
Rent	23.43 (57.75)	30.76 (70.17)
Equipment	32.63 (87.57)	31.44 (67.22)
Books and teaching materials	7.37 (45.66)	8.41 (38.76)
Raw materials	46.58 (150.15)	36.85 (127.97)
Foregone trainer productivity	3.76 (19.20)	3.28 (20.99)
Net Benefits (Model I)	-141.16 (340.42)	-111.51 (455.59)
Net Benefits (Model II)	-34.24 (485.26)	-30.59 (549.88)

[1] Mean (SD)

Table 6: Annual estimated net benefits of training

	Overall, N = 667	**Selected**	**Not Selected**	**Did Not Apply**
Model I	-130.49 (385.76)	-116.61 (409.34)	-140.22 (332.98)	-137.00 (396.75)
Model II	-32.93 (509.05)	-26.57 (512.67)	-16.01 (536.47)	-50.19 (487.91)

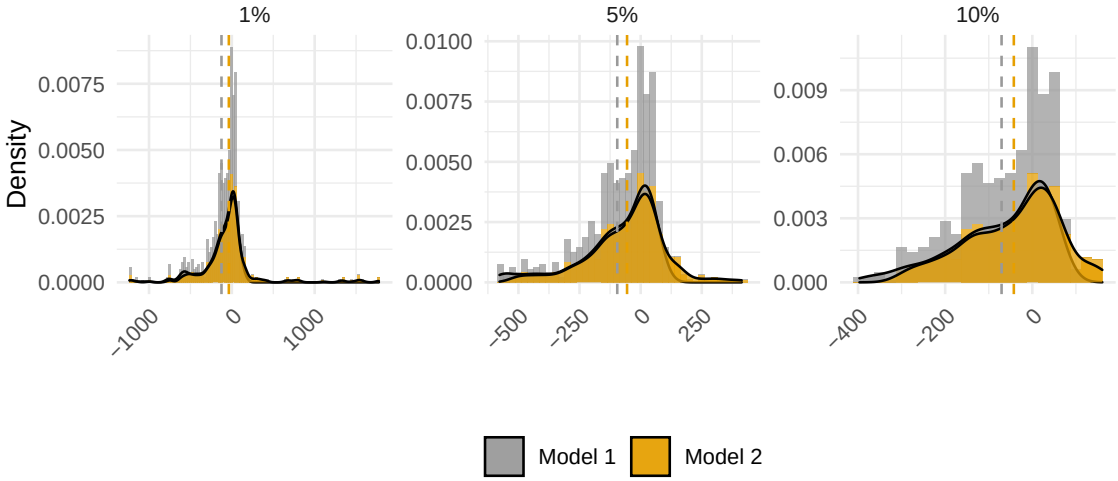
[1] Mean (SD)

Table 6 shows the estimated annual net benefits of training apprentices, calculated separately for apprentices who successfully applied to the CQP program, applied to the CQP program but were not accepted, and did not apply at all. Depending on which model is used, training is, on average, associated with a net loss ranging from about 30 $US to about 125 $US per apprentice per year for the training firm.

The net costs of apprenticeship according to Model I are lower for CQP apprentices, despite CQP apprentices paying the lowest fees (see Table A7 in the Appendix) and

receiving higher allowances than non-applicants (and on par with unsuccessful applicants, see Table A6 in the Appendix). **This suggests that firms bletraining CQP participants have lower training costs per apprentice, on average, than firms without successful CQP applicants**. Estimated net benefits do not change drastically over the course of the program (Table A9 in the Appendix).

Figure 2: Annual net benefits per apprentice (in USD), truncated at varying percentiles



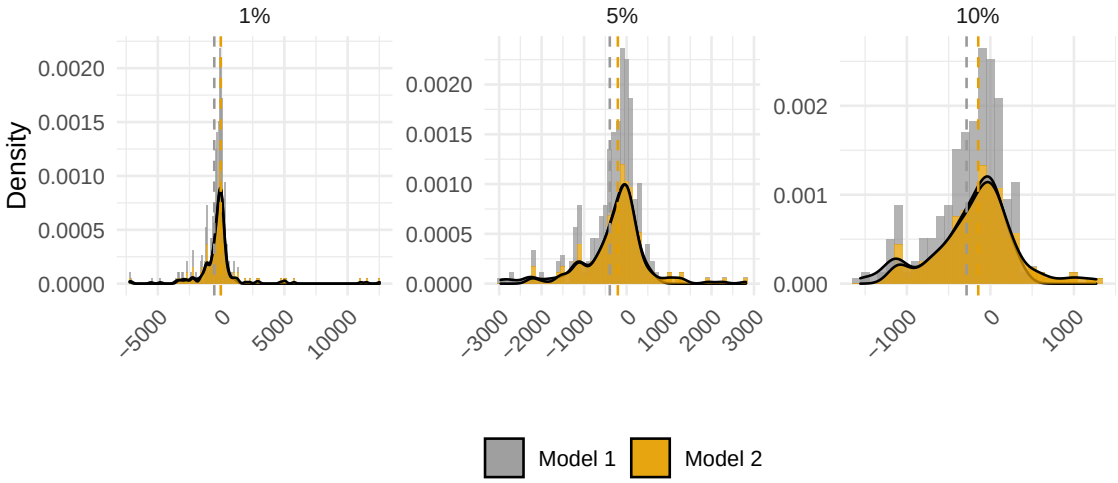
Mean benefits per apprentice total -130.49 $US when using Model I and-32.93 $US using Model II. The distributions of net benefits by individual apprentice have long left and right tails, particularly for Model II. With higher wages (reported especially by larger firms) skewing the projected apprentice productivity estimates, and the high number of apprentices in certain firms generating unrealistic annual allowance totals, Model II generates especially exaggerated numbers, extending from -4604.75 $US in losses for a single apprentice to as much 3679.34 $US in annual benefits. Such estimates should be taken with caution as they suggest apprentices generate costs and/or benefits out of proportion with reported firm accounts.

To account for such outliers, we truncate estimated net benefits per apprentice at the 1st, 5th and 10th percentiles and present the truncated distributions in a histogram and kernel density plot, shown in Figure 2. Using Model I, mean net benefits amount to -102.81 $US per apprentice when dropping the top and bottom percentile, -83.09 $US per apprentice when the top and bottom 5% are dropped, and -67.02 $US per apprentice when the top and bottom deciles are dropped. Using Model II, mean net benefits per apprentice are -22.01 $US when dropping the top and bottom percentile, -38.09 $US when the top and bottom 5% are dropped, and -36.48 $US when the top and bottom deciles are dropped.

The distribution of net benefits per apprentice is bimodal in both models, with a concentration of firms breaking even for each apprentice trained and a second clustering

of firms with annual net losses of about 100 $US per apprentice. **According to Model I, 37.24% and 34.17% of apprentices are estimated to generate a positive net benefit during training at baseline and endline, respectively; using Model II, 43.56% and 44.58% of apprentices are estimated to do so.**

Figure 3: Annual net benefits per firm (in USD), truncated at varying percentiles



We are also interested in total firm benefits from training, i.e. the net benefit from all apprentices being trained in a firm at a particular point in time. Although apprentices taken individually generate a net loss on average, it is possible that larger firms hire productive and unproductive apprentices in equal measure, leading to higher net benefits at the firm than at the apprentice level.

To generate a firm-level distribution of net benefits, apprentice benefits are averaged at the firm level. This firm-specific mean benefit is then multiplied by the number of apprentices training in the firm. This projection thus assumes that mean net benefits associated with apprentices for whom data was collected are, on average, equal to the net benefits for all unobserved apprentices in the same firm. Net firm benefits total, on average, -626.13 $US using Model I and218.92 $US using Model II. The distribution is unimodal, with the majority of firms' net benefits clustered to the right of the mean for both models.

Truncating again at the 1st, 5th and 10th percentiles and present the truncated distributions in a histogram and kernel density plot, shown in Figure 2. Using Model I, mean net benefits amount to -463.74 $US per apprentice when dropping the top and bottom percentile, -332.55 $US per apprentice when the top and bottom 5% are dropped, and -263.62 $US per apprentice when the top and bottom deciles are dropped. Using Model II, mean net benefits per apprentice are 84.44 $US when dropping the top and bottom percentile, -60.88 $US when the top and bottom 5% are dropped, and -94.07 $US when the top and bottom deciles are dropped. Mean net benefits are thus even more sensitive

to large outliers, especially positive ones, at the firm level than at the apprentice level.

According to Model I, 32.49% and 34% of firms are estimated to earn a positive net benefit from training (positive net benefits) at baseline and endline, respectively; using Model II, 39.09% are estimated to do so at baseline and 46% at endline.

Table 7: Annual firm accounts

	Overall, N = 347	**Baseline**	**Endline**
Firm size (reported)	6.65 (7.34)	6.73 (7.54)	6.56 (7.10)
Firm size (calculated)	9.27 (12.70)	9.57 (13.94)	8.87 (10.90)
Apprentices in training	6.10 (7.58)	6.12 (7.28)	6.07 (7.98)
Revenues	4,405.17 (4,917.24)	3,988.90 (4,820.09)	4,874.57 (5,000.09)
Non-wage expenses	1,640.22 (3,178.66)	1,592.98 (3,152.24)	1,703.64 (3,223.59)
Total wages	1,365.22 (2,998.90)	971.69 (2,351.66)	1,886.39 (3,628.85)
Profits (reported)	1,429.15 (2,158.81)	1,671.55 (2,633.84)	1,131.50 (1,316.66)
Profits (calculated)	1,548.60 (3,249.10)	1,701.25 (3,055.72)	1,375.08 (3,458.80)

[1] Mean (SD)

[2] Mean (SD). Revenues, expenses, and profits in USD.

In contrast to dual apprenticeship in the European context, in which apprentice wages represent the bulk of training costs, most apprentices in Bénin receive no regular wages whatsoever (see Table A5). Allowances or "pocket money" for minor expenditures such as food and transportation disbursed by training firms amount to a small percentage of total training costs. On the other hand, apprenticeship fees, paid by apprentices directly to the master trainer, contribute significantly more to total firm revenues than in Swiss or German firms.

Apprentice training thus represents a relatively large fraction of firm costs, or revenues, depending on the preferred model. At the upper extreme (Model II, untruncated), the average ratio of total net training benefits to total firm revenues is 0.32 for firms that benefit from or break even on training, and the ratio of total (negative) net benefits from training to total firm expenses is 1.24. At the low-benefit extreme (the simpler Model I, untruncated), the average ratio of total net training benefits to total firm revenues is 0.14 for firms that benefit from or break even on training, and the ratio of total (negative) net benefits from training to total firm expenses is 1.22.

In other words, this implies that for firms that benefits from apprenticeship, apprenticeship fees and productivity are estimated to only contribute slightly to their total revenues. For firms that do not turn a profit on their apprentices, on the other hand, estimated training costs are actually higher on average than the total costs reported by firm owners. As more firms report making net losses on apprenticeship training than not, this implies that training is major financial burden for a high proportion of informal firms.

Finally, how do these numbers compare to evidence from high-income countries?

Due to the disparities in firm size and productivity of informal firms in Bénin and training firms in Germany and Switzerland, where the majority of studies have been conducted, an informative comparison is difficult to make. Though cost-benefit studies from these countries do not report earnings data of training firms, they do suggest that whether firms recoup the costs of training depends on the firm, trade, and region. For instance, Hauschildt (2018) reports that in Germany, productive contributions of apprentices covered about 70 percent of a company's training costs, while in Switzerland, net benefits per apprentice per year amounted to about €2,500 (Strupler and Wolter, 2012). Without a clearer understanding of future benefits and better instruments to measure apprentice productivity, the true benefit of apprenticeship training in informal firms will remain ambiguous.

3.4 Regression Analysis

In this section, we employ a linear regression approach to explore the drivers of training benefits at both the firm and apprentice level.

3.4.1 Firm-level outcomes

In addition to direct financial benefits associated with training, which are reflected by a positive balance in the net benefit calculations presented above, apprenticeship training may affect firm productivity through a variety of additional channels. For the CQP program in particular, participating apprentices may acquire skills at a faster pace than their traditional counterparts as a direct result of their theoretical training. Moreover, theoretical training may "spill over" to the master trainer and other employees in the workshop, for instance by introducing new technologies or improving knowledge about the operation of existing workshop machinery. Additional apprentices in general may improve firm productivity by encouraging the owner to hire more employees (e.g. as trainers) or through investments in additional machinery. Indeed, evidence from previous studies indicates that small firms in Uganda and Ghana, when randomly assigned apprentices to train, increased profits by up to 15% per apprentice (Alfonsi et al., 2020; M. Hardy and McCasland, 2022).

To estimate the effect of participating in the CQP program, and training apprentices in general, on firm size and profits (Table 7), we run a simple pooled OLS regression taking the form

$$y_{it} = a + CQP_i + apprentices_{it} + \mathbf{X}_{it} + u_{it},$$

where y_{it} is the outcome of interest, $\mathbf{X}_{it}$ is a matrix of additional covariates for firm i in wave t, and u_{it} is an error term. CQP_i is the number of CQP applicants who were accepted into the 2019 cohort of the program, while $apprentices_{it}$ controls for the total number of apprentices training with the firm (and in contrast to CQP_i is a time-varying

measure).

Table 8: Firm-level regressions

	log revenues (USD)		log profits (USD)		log Firm size†	
	(1)	(2)	(3)	(4)	(5)	(6)
Apprentices	0.02*	−0.02	0.01	−0.17	0.04***	0.03
	(0.01)	(0.04)	(0.02)	(0.20)	(0.01)	(0.02)
CQPs	−0.02		−0.02		0.001	
	(0.03)		(0.05)		(0.01)	
Endline	0.49***	0.40**	−0.08	−1.60**	−0.02	−0.18
	(0.13)	(0.18)	(0.23)	(0.62)	(0.10)	(0.15)
log Firm size†	0.42***	0.31	0.41*	0.15		
	(0.12)	(0.23)	(0.21)	(0.81)		
Constant	7.60***		7.10***		1.10***	
	(0.17)		(0.29)		(0.07)	
Firm FE	NO	YES	NO	YES	NO	YES
Observations	126	134	94	101	146	155
R^2	0.26	0.24	0.08	0.50	0.34	0.10
F Statistic	11.00***	2.60*	2.00	2.70	24.00***	2.00

Note: *p<0.1; **p<0.05; ***p<0.01
†Excluding apprentices.

Pooled OLS estimation results are shown in Columns 1, 3 and 5 of Table 8, while firm fixed effects are included in the specification shown in Columns 2, 4, and 6. Reported firm revenues increase by close to 50% between the two waves, but are offset by rising costs and wages, to the point of eliminating any observed growth in profitability. According to the pooled specifications, additional apprentices are associated with smaller gains in revenue than the hiring of other types of workers, but higher profits (about 92 $US annual profit per additional apprentice). Specifications including firm fixed effects to control for heterogeneity between firms, on the other hand, suggest that the hiring of non-apprentice employees is associated with both higher revenues and profits, while the number of apprentices is not a significant predictor of either. Regressions (5) and (6) reinforce the notion that firms hire more apprentices than non-apprentice employees: taking into account firm fixed effects, a single additional employee is associated with over three additional apprentice hires, on average. Finally, we note that the number apprentices from the 2019 cohort of the CQP program have no discernible association with firm revenues or profits.

3.4.2 Apprentice-level outcomes

Next, we examine apprentice-level effects of training on our various measures of apprentice learning outcomes, outlined in section 3.2. Similarly to the firm-level regressions,

the basic specification used is

$$y_{it} = a + \sum_{j} \text{status}_{ij} + CQP_i{*}wave + \mathbf{X}_{it} + \mathbf{Z}_{jt} + u_{it}$$

where y_{it} is the outcome for apprentice i at time t, status_{ij} corresponds to apprentice status j of apprentice i in the context of the CQP program for: either successful applicant, unsuccessful applicant, or non-applicant. $\mathbf{X}_{it}$ is a column vector of apprentice characteristics, $\mathbf{Z}_{jt}$ is a column vector of training-related training characteristics, a is a constant, and u_{it} is an error term. $CQP_i{*}wave$ is a dummy for CQP apprentices interacted with survey wave, which identifies any gains in learning outcomes that can be linked with participation in the CQP.

Table 9: Apprentice regressions

	Experience				Competence			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CQP participant	−0.01	−0.005	0.16	0.16	−0.01	−0.01	−0.09	−0.09
	(0.02)	(0.03)	(0.22)	(0.19)	(0.02)	(0.03)	(0.21)	(0.16)
CQP non-applicant	−0.12***	−0.12***	0.30		−0.14***	−0.14***	0.11	
	(0.02)	(0.02)	(0.25)		(0.02)	(0.02)	(0.24)	
Endline	0.18***	0.19***	0.15***	0.11***	0.14***	0.14***	0.11***	0.06**
	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)
Firm size†	0.003**	0.003**	−0.001	−0.004	0.002**	0.002**	−0.002	−0.0001
	(0.001)	(0.001)	(0.003)	(0.004)	(0.001)	(0.001)	(0.003)	(0.003)
CQP x Endline		−0.02	−0.01	0.04		0.001	−0.0004	0.05
		(0.04)	(0.04)	(0.04)		(0.04)	(0.04)	(0.04)
Constant	0.77***	0.77***	0.70***	0.71***	0.82***	0.82***	0.90***	0.90***
	(0.02)	(0.02)	(0.18)	(0.15)	(0.02)	(0.02)	(0.17)	(0.13)
Individual FE	NO	NO	YES	YES	NO	NO	YES	YES
Observations	594	594	594	376	594	594	594	376
R^2	0.19	0.19	0.84	0.81	0.17	0.17	0.84	0.82
F Statistic	34.00***	27.00***	2.30***	2.20***	31.00***	25.00***	2.20***	2.30***

Note: *p<0.1; **p<0.05; ***p<0.01
Omitted CQP category: applied but did not participate.

Table 9 reports knowledge and competence score regressions. For each of the two measures, the first two columns report coefficient estimates without firm fixed effects; in the third column, fixed effects are added, and in the fourth column apprentices who did not apply to the CQP program are dropped from the analysis.

The results indicate that while apprentices show gains in experience and competence scores, participation in the CQP program is not associated with greater gains along these two metrics. All CQP applicants (including those not accepted into the program) receive higher scores than non-applicants. This suggests that trainers choose

the more experience of their existing apprentices to apply to the dual apprenticeship program. An analogous analysis of apprentice performance on knowledge questions (which were posed directly to apprentices, rather than their trainers) shows a similar pattern (see Table A10 in the Appendix): participation in the CQP has no measurable effect on apprentice knowledge, while apprentices in the program score slightly lower on the metric than those who apply but do not get in.

Table 10: Apprentice-level cost benefit regressions

	Annual Net Benefits in USD							
	Model I				Model II			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CQP participant	25.0	44.0	−62.0	−62.0	−7.1	6.5	−62.0	−62.0
	(39.0)	(46.0)	(581.0)	(578.0)	(51.0)	(60.0)	(676.0)	(686.0)
CQP non-applicant	4.9	5.6	37.0		−27.0	−26.0	37.0	
	(38.0)	(38.0)	(581.0)		(50.0)	(50.0)	(676.0)	
Endline	31.0	50.0	72.0	119.0	13.0	26.0	83.0	125.0
	(31.0)	(40.0)	(49.0)	(76.0)	(41.0)	(52.0)	(57.0)	(90.0)
Firm size†	0.8	0.8	−4.4	−0.3	8.9***	8.9***	1.0	14.0
	(2.2)	(2.2)	(6.2)	(9.1)	(2.9)	(2.9)	(7.3)	(11.0)
CQP x Endline		−50.0	−66.0	−110.0		−36.0	−52.0	−86.0
		(65.0)	(78.0)	(98.0)		(85.0)	(91.0)	(116.0)
Constant	−156.0***	−163.0***	37.0	33.0	−54.0	−59.0	32.0	18.0
	(33.0)	(34.0)	(411.0)	(409.0)	(44.0)	(45.0)	(478.0)	(486.0)
Indiv. FE	NO	NO	YES	YES	NO	NO	YES	YES
Observations	664	664	664	410	664	664	664	410
R^2	0.002	0.003	0.6	0.6	0.01	0.02	0.7	0.7
F Statistic	0.4	0.4	0.8	0.8	2.5**	2.0*	1.2*	1.2*

Note: *p<0.1; **p<0.05; ***p<0.01
Omitted wave: Baseline
†Excluding apprentices.

Finally, we investigate characteristics potentially associated with "valuable" apprentices: those who generate positive net benefits for their training firms. We run the same specifications as before, but use the two models of net benefits as the outcome of interest. Table 10 suggests that

Instead, apprentices at larger firms (in terms of non-apprentice employees) are shown to be associated with higher profitability, attributable to the higher wages (hence higher estimated apprentice productivity) reported by these firms.

4 Conclusion

This paper analyses the costs and benefits of apprenticeship training with informal firms in Bénin, with a particular focus on the 2019 cohort of apprentices participating in the CQP dual training program. Matched apprentice-firm data is used to (1) estimate the human capital gains accumulated by apprentices over the three-year observation period, (2) calculate the total benefits (primarily in the form of apprenticeship fees received) and (3) costs of training reported by firms, (4) calculate the net benefits accruing to firms using two models, one estimating apprentice contribution and foregone trainer productivity and one not, and (5) identify the association between apprenticeship training, and participation in the CQP program in particular, on firm profitability, apprentice human capital gains, and the net benefits accruing to firms per apprentice.

Human capital gains as measured by trainers' subjective appraisal of apprentice experience and competence were significant, with improvements of .73 and .66 standard deviation between survey waves, respectively. Gains were concentrated in the masonry and carpentry sector, in larger firms, and among apprentices who did not apply for the CQP program.

Firms in the sample were training an average of six apprentices at both baseline and endline - significantly more than wage, family, or occasional employees they hired - despite reporting net losses from training apprentices in the majority (approximately 60%) of cases. Total fees for a single apprentice amount to about 250 $US (for three to four years of training), while annual revenues per firm average about 1500 $US. Reported costs of training are significantly higher than the fees collected, however: we estimate that trainers pay around 400 $US per apprentice per year, especially when daily apprentice allowances are taken into account. When multiplied by the number of apprentices trained per firm, total training costs are indeed higher than total firm expenditures reported by the firm, suggesting that owners either underestimate their training costs or that the method used to estimate and sum training costs used in this paper is suffering from some shortcoming.

Two cost benefit models help us understand how net benefits are distributed across firms and apprentice types. When only fees, allowances, and reported training costs are considered, firms suffer a net loss of 130.49 $US per apprentice per year, and a total of 626.13 $US when accounting for the number of apprentices trained. Using reported wages for skilled and unskilled workers to estimate apprentice productive contributions and foregone trainer productivity reduces the net estimated losses, to 32.93 $US per apprentice per year, and even a net benefit of 218.92 $US per firm when projecting total benefits at the firm level. Apprentices who do *not* apply to the CQP program are associated with somewhat lower net losses to their training firms when estimated using the first model.

Regression analysis reveals a stronger relationship between firm size (sans apprentices) and firm profits than exists for apprentice hires (CQP and otherwise). Similarly,

apprentices hired at larger firms are associated with higher net benefits. There are no significant differences in effects observed for CQP applicants or CQP participants, though firms appear to select less experienced apprentices to apply for the program.

In sum, we find that training with informal firms fulfills its promise to apprentices, granting them the experience and competence to transition to self-employment upon graduation. Not all firms benefit from training on the balance, with about 60% of firms suffering net losses from training and training costs generally outpacing the apprenticeship fees paid. Dual training in the form of the CQP program generates few visible benefits, either in terms of apprentice progression or benefits to the training firm. However, the timing of the current CQP cohort, being interrupted in the middle of the training schedule due to the Covid-19 pandemic, may have contributed to lower-than-usual outcomes at both the apprentice and firm level. Nevertheless, this paper finds little support for or against the continuation of the program. Given its difficulties with sustainable financing, and in light of criticisms centered on the administration of training centers and qualifications of classroom teachers, helping individual firms defray the high costs of traditional training, and focusing on material and equipment provision for traditional on-the-job apprenticeships, may be a better use of public financing in the short term. For the time being, in any case, dual training only represents a minuscule fraction of all apprenticeship training in the country of Bénin and across West Africa; with the slow growth of formal TVET programs, traditional apprenticeships are likely to remain a promising route for young Africans who lack the financial means or interest to pursue formal education.

- *The number of trades in which the CQP and CQM are awarded must be increased. Indeed, while the Benin craft trades register lists 310 trades, the CQP only covers 13 and the CQM fewer than 100. It is essential to develop the design tools needed to organize the CQP and CQM. This requires the training of a sufficient number of methodology experts across all departments nationwide. In addition to these methodology experts, trainers in all crafts and trades need to be trained in sufficient numbers.*
- *There are no qualifications that recognize the learning done by employers. As a result, some employers still refuse to enter their apprentices for the CQP or the CQM, as they think that their apprentices will become better skilled than them. In order to maintain the system, it is essential to introduce a mechanism for validating and recognizing the skills of employers.*
- *Both the apprentices and their employers show more interest in the CQM than the CQP, as the conditions for the CQP – namely required educational level (completed primary education), attendance at a (dual) training centre, preparation for and successful completion of an admission test, and the irregular financing of the FODEFCA – constitute obstacles that they cannot overcome. If these conditions are not reviewed or improved, there is a risk that the CQP will lose its candidates.*
- *Internal and external financial resources must be mobilized to manage the increased number of trades and apprentices involved in the CQP and CQM.*
- *The DEC needs to allocate or obtain timely budgetary resources to organize the CQM examinations.*
- *UCIM-B demands responsibility for organizing the CQP and CQM examinations in accordance with the West African Economic and Monetary Union (WAEMU) community code on crafts. Dialogue between this body and the ministry responsible for training should facilitate resolving the matter of the transfer of powers* (ILO, 2021)

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A Appendix A

Table A1: Apprentice Attrition

Characteristic	**Baseline**, N = 427	**Endline**, N = 240	**p-value**
Age	21.3 (3.4)	21.2 (3.4)	0.7
Male	98%	98%	>0.9
Education			>0.9
None	10 (2.5%)	8 (3.3%)	
<Primary	61 (15%)	35 (15%)	
Primary	91 (22%)	51 (21%)	
Secondary	230 (57%)	136 (57%)	
Technical	8 (2.0%)	6 (2.5%)	
Tertiary	6 (1.5%)	3 (1.3%)	
CQP status			0.5
Selected	149 (35%)	90 (39%)	
Not Selected	107 (25%)	59 (25%)	
Did Not Apply	171 (40%)	84 (36%)	
Training experience, years	2.33 (1.38)	2.39 (1.38)	0.5
Trade			
Masonry	0 (NA%)	0 (NA%)	
Carpentry	0 (NA%)	0 (NA%)	
Plumbing	0 (NA%)	0 (NA%)	
Metalworking	0 (NA%)	0 (NA%)	
Electrical Inst.	0 (NA%)	0 (NA%)	

[1] Mean (SD); %; n (%)

[2] Wilcoxon rank sum test; Fisher's exact test; Pearson's Chi-squared test

Table A2: Firm Attrition

Characteristic	**Baseline**, N = 197	**Endline**, N = 150	**p-value**
Apprentices trained			
Total	6.1 (7.3)	6.4 (7.8)	0.7
Selected	1.78 (3.49)	1.65 (3.32)	>0.9
Not Selected	3.10 (10.50)	3.05 (11.16)	0.6
Did Not Apply	1.2 (11.6)	1.6 (11.4)	0.5
Firm size			
Total (calculated)	9.6 (13.9)	9.9 (15.6)	>0.9
Total (reported)	6.7 (7.5)	6.9 (7.9)	0.9
Permanent employees	0.36 (1.75)	0.31 (1.90)	0.4
Paid family workers	0.0561 (0.3536)	0.0336 (0.2149)	0.6
Unpaid family workers	0.0510 (0.3615)	0.0470 (0.3737)	0.7
Occasional workers	0.83 (2.62)	0.74 (2.67)	0.5
Trade			>0.9
Masonry	45 (23%)	30 (20%)	
Carpentry	24 (12%)	18 (12%)	
Plumbing	26 (13%)	21 (14%)	
Metalworking	39 (20%)	32 (21%)	
Electrical Inst.	63 (32%)	49 (33%)	

[1] Mean (SD); n (%)

[2] Wilcoxon rank sum test; Pearson's Chi-squared test

Figure A1: Firm size dsitributions

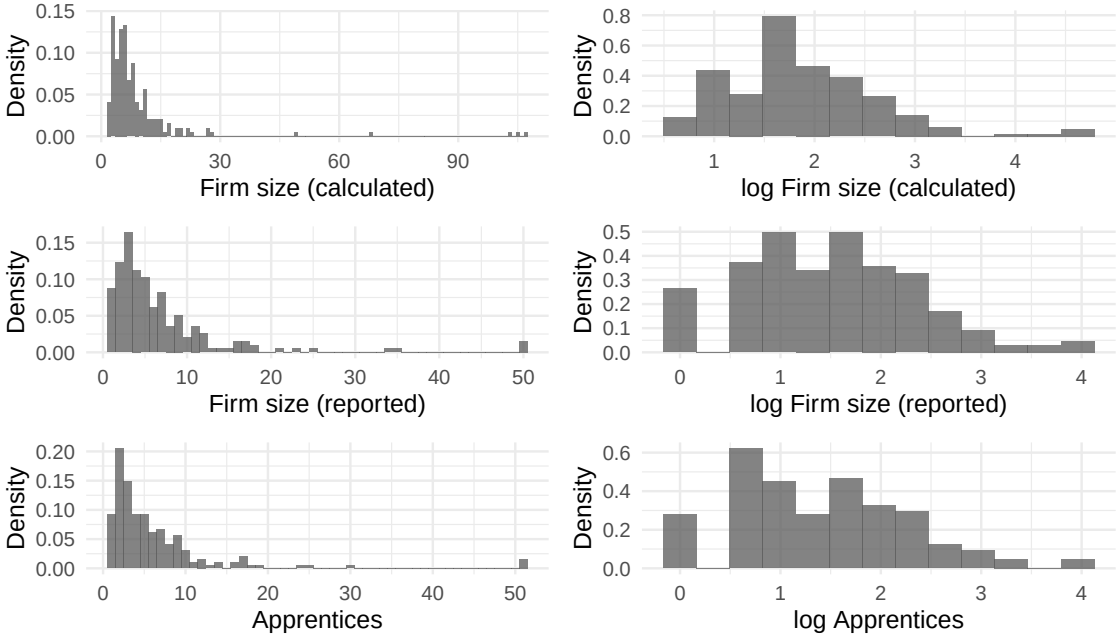

Figure A2: Change in apprentice human capital scores

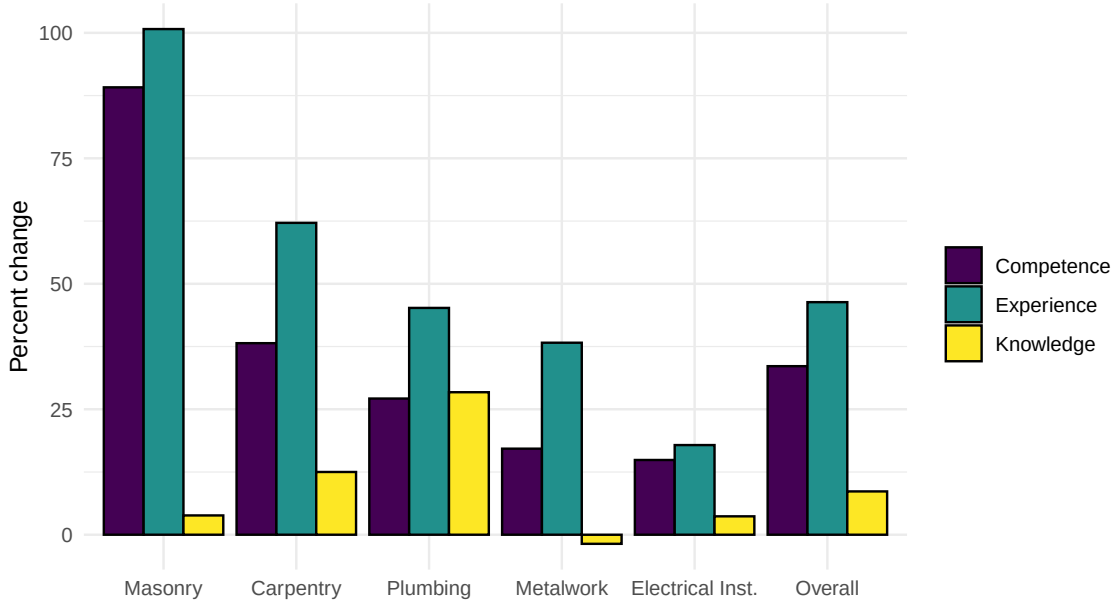

Table A4: Change in apprentice human capital scores

Characteristic	**Selected**, N = 150	**Not Selected**, N = 112	**Did Not Apply**, N = 172
Competence	0.110 (0.201)	0.060 (0.165)	0.158 (0.325)
Experience	0.148 (0.222)	0.104 (0.207)	0.206 (0.314)
Knowledge	0.034 (0.185)	0.017 (0.166)	NA (NA)

[1] Mean (SD)

```
## ANOVA Table (type III tests)
##
##          Effect DFn DFd    F       p p<.05   ges
## 1      SELECTED   2 178 15.1 9.0e-07     * 0.095
## 2          wave   1 178 36.5 8.6e-09     * 0.072
## 3 SELECTED:wave   2 178  2.2 1.2e-01       0.009

## ANOVA Table (type III tests)
##
##          Effect DFn DFd    F       p p<.05   ges
## 1      SELECTED   2 178  7.2 1.0e-03     * 0.047
## 2          wave   1 178 64.3 1.4e-13     * 0.122
## 3 SELECTED:wave   2 178  2.1 1.2e-01       0.009

## ANOVA Table (type III tests)
```

Table A3: Competency and experience, firm rating vs. apprentice self-appraisal

Group	Trade	N	Apprentice	N	Firm
Competencies	Electrical Installation	49	0.97 (0.06)	46	0.98 (0.05)
	Masonry	28	0.95 (0.08)	28	0.94 (0.10)
	Carpentry	14	0.92 (0.13)	16	0.95 (0.08)
	Plumbing	25	0.95 (0.13)	22	0.92 (0.15)
	Metalwork	21	0.90 (0.17)	26	0.92 (0.15)
	Overall	137	0.95 (0.11)	138	0.95 (0.11)
Experience	Electrical Installation	49	0.97 (0.06)	46	0.97 (0.06)
	Masonry	28	0.95 (0.09)	28	0.93 (0.11)
	Carpentry	14	0.95 (0.12)	16	0.99 (0.03)
	Plumbing	25	0.98 (0.06)	22	0.89 (0.17)
	Metalwork	21	0.89 (0.16)	26	0.89 (0.11)
	Overall	137	0.95 (0.10)	138	0.94 (0.11)

[1] Mean (SD). Proportion of tasks elicited at endline.

```
##
##          Effect DFn DFd    F     p p<.05     ges
## 1      SELECTED   1 133 4.74 0.031     * 0.02800
## 2          wave   1 133 2.60 0.109       0.00400
## 3 SELECTED:wave   1 133 0.28 0.598       0.00043
```

Figure A3: Change in apprentice human capital scores

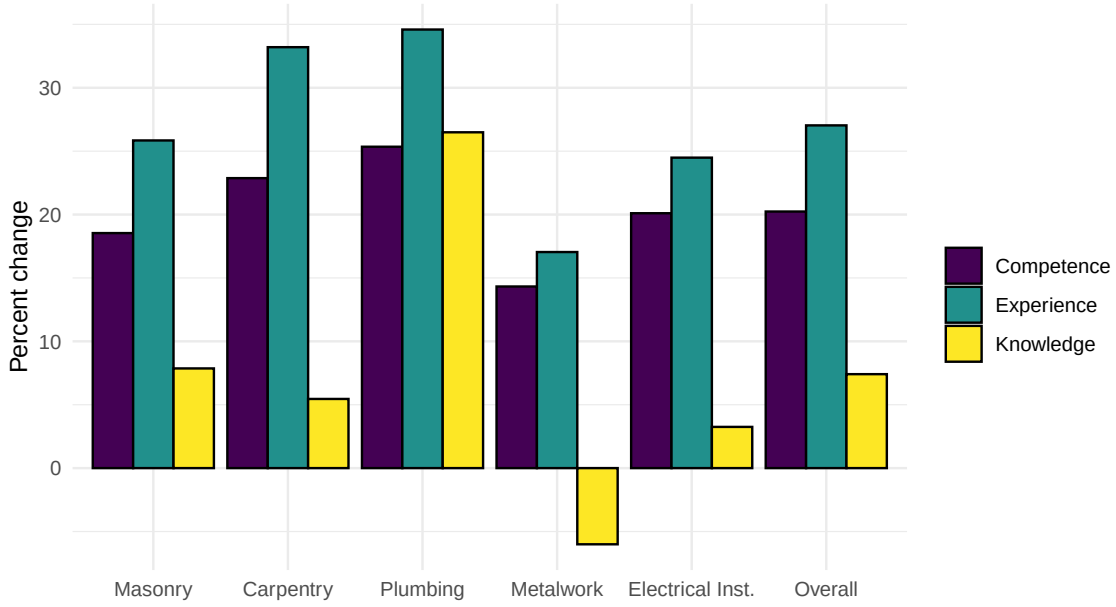

Table A5: Monthly wages

	N	Baseline	N	Endline
Former apprentice (diff. workshop)	139	17 (56)	140	17 (43)
Former apprentice (same workshop)	139	19 (68)	140	15 (43)
Worker with secondary educ. or more	128	7 (35)	140	9 (52)
Worker with primary educ. or less	132	5 (30)	140	4 (34)
Paid family worker	124	4 (19)	140	4 (18)
Occassional worker	155	39 (77)	145	27 (59)
Firm owner	173	82 (88)	144	124 (95)
Traditional apprentice (first year)	172	0 (4)	140	6 (10)
Traditional apprentice (third year)	172	1 (6)	140	11 (16)
CQP apprentice (first year)	170	1 (6)	140	3 (8)
CQP apprentice (third year)	166	2 (9)	140	13 (35)

[1] Mean (SD). Monthly wages in USD.

Table A6: Monthly allowances

Group	Characteristic	Overall, N = 427	Selected	Not Selected	Did Not Apply
Baseline	Food	6.66 (12.76)	5.85 (13.54)	8.45 (16.40)	6.38 (10.10)
	Transportation	5.89 (18.74)	4.67 (17.84)	7.63 (21.45)	5.92 (18.10)
	Pocket Money	14.68 (18.60)	14.45 (18.62)	16.47 (17.52)	14.02 (19.15)
	Other	0.07 (1.06)	0.00 (0.00)	0.00 (0.00)	0.14 (1.55)
	Total	27.30 (35.11)	24.98 (37.33)	32.55 (39.68)	26.46 (31.20)
Endline	Food	9.68 (8.04)	7.81 (7.17)	13.08 (7.87)	9.17 (8.56)
	Transportation	2.91 (6.58)	1.91 (4.24)	3.31 (5.65)	3.87 (9.33)
	Pocket Money	16.62 (55.33)	18.46 (61.51)	8.29 (16.49)	21.49 (68.13)
	Other	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
	Total	29.21 (54.68)	28.18 (59.64)	24.68 (18.43)	34.53 (68.50)
Overall	Food	7.50 (11.72)	6.51 (11.81)	9.98 (14.28)	6.95 (9.84)
	Transportation	5.06 (16.35)	3.75 (14.79)	6.20 (17.92)	5.50 (16.68)
	Pocket Money	15.22 (33.06)	15.79 (38.40)	13.78 (17.52)	15.54 (34.97)
	Other	0.05 (0.90)	0.00 (0.00)	0.00 (0.00)	0.11 (1.39)
	Total	27.83 (41.40)	26.05 (45.76)	29.96 (34.25)	28.10 (41.44)

[1] Mean (SD). Allowances reported in USD by firm.

Table A7: Fees reported by firm

Group	Characteristic	**Selected**, N = 149	**Not Selected**, N = 107	**Did Not Apply**, N = 171
Baseline	Initiation	9.31 (13.21)	11.28 (21.16)	12.14 (15.64)
	Training	80.41 (110.32)	117.40 (132.92)	213.87 (164.88)
	Graduation	37.77 (74.45)	30.32 (72.71)	42.28 (77.83)
	Materials	25.40 (37.86)	24.78 (35.33)	27.80 (37.98)
	Contract	44.03 (74.81)	35.53 (70.66)	25.03 (58.71)
	Application	13.31 (17.03)	11.15 (16.13)	12.74 (17.57)
	Total	190.39 (152.39)	209.43 (161.14)	314.63 (202.33)
Endline	Initiation	19.34 (47.58)	16.45 (34.10)	9.52 (14.31)
	Training	85.51 (128.53)	134.83 (152.04)	237.82 (147.63)
	Graduation	59.44 (125.34)	29.94 (90.98)	17.56 (60.24)
	Materials	18.83 (16.53)	25.10 (19.18)	18.98 (22.67)
	Contract	21.34 (52.90)	17.90 (45.73)	18.77 (49.97)
	Application	17.83 (14.25)	19.94 (17.24)	15.08 (16.10)
	Total	207.81 (159.47)	226.71 (173.61)	296.56 (161.55)
Overall	Initiation	12.98 (30.92)	13.14 (26.56)	11.46 (15.32)
	Training	82.28 (117.04)	123.72 (139.89)	220.08 (160.60)
	Graduation	45.38 (95.71)	30.19 (79.21)	35.75 (74.26)
	Materials	22.99 (31.86)	24.89 (30.63)	25.52 (34.83)
	Contract	35.72 (68.37)	29.17 (63.22)	23.39 (56.51)
	Application	14.97 (16.18)	14.34 (17.02)	13.35 (17.19)
	Total	196.57 (154.82)	215.55 (165.33)	309.89 (192.31)

[1] Mean (SD). Fees reported in USD by firm.

Figure A4: Breakdown of costs of training per apprentice

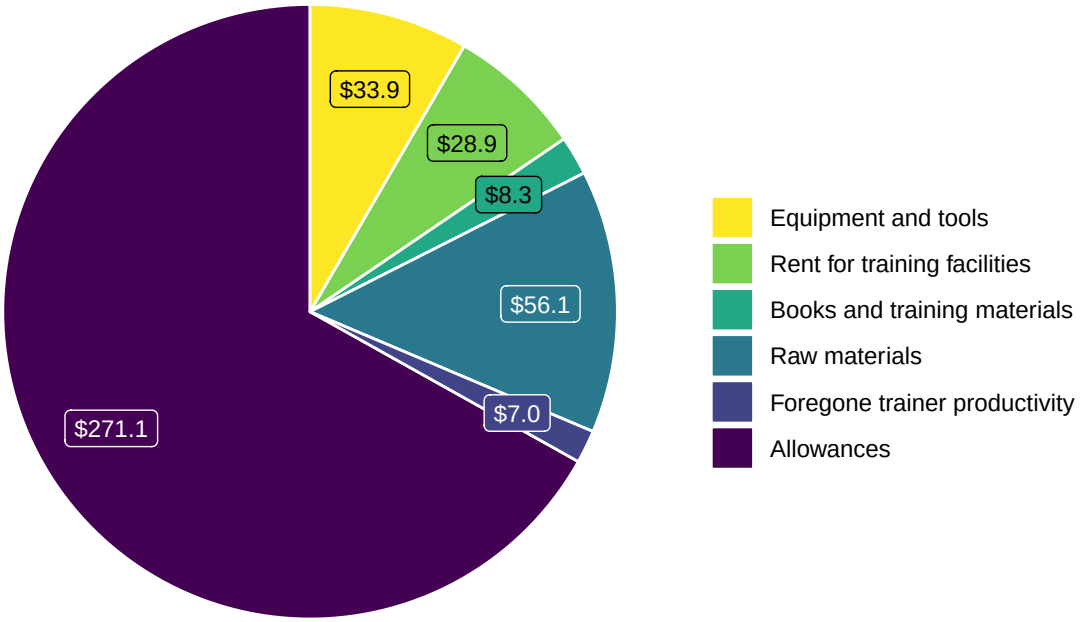

Figure A5: Breakdown of total costs of training per firm

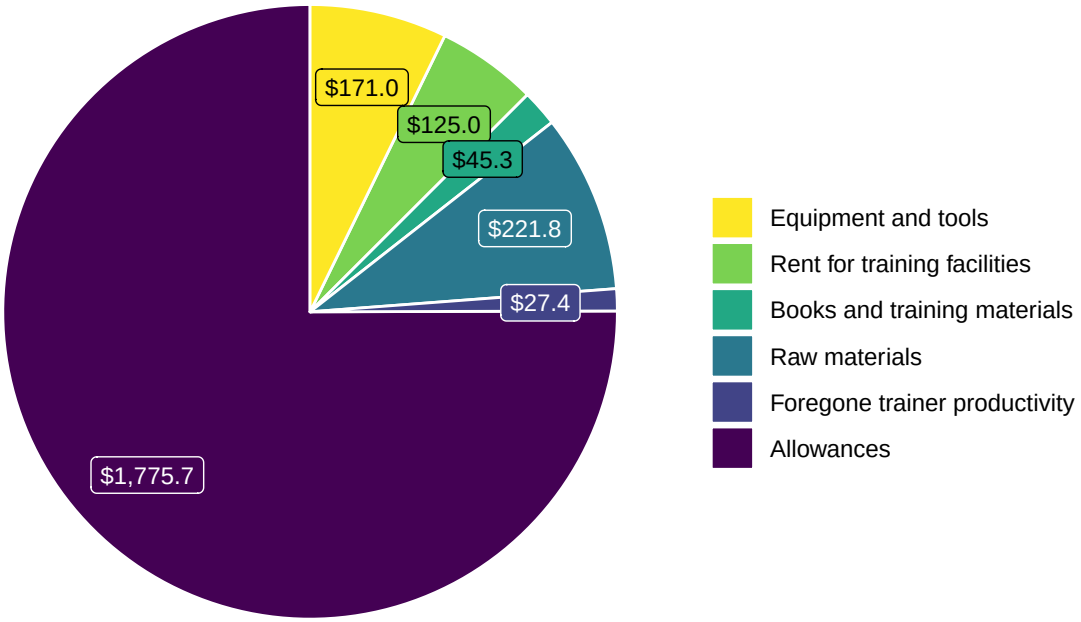

Table A8: Summary of firm costs

Characteristic	**Overall**, N = 347	**Baseline**, N = 197	**Endline**, N = 150
Rent	28.89 (67.44)	28.32 (64.41)	29.51 (70.79)
Equipment	33.89 (76.23)	35.82 (85.63)	31.80 (64.71)
Books	8.31 (48.51)	10.00 (60.00)	6.46 (31.71)
Raw materials	56.06 (182.99)	66.32 (207.33)	44.89 (152.07)
Foregone trainer prod.	4.56 (16.12)	4.28 (17.86)	5.10 (12.09)
Allowances	271.07 (422.17)	256.64 (327.84)	298.65 (561.55)

[1] Mean (SD). Fees reported by firm, in USD.

Table A9: Net benefits

Group		**Overall**, N = 427	**Selected**	**Not Selected**	**Did Not Apply**
Baseline	Model II	-141.16 (340.42)	-116.20 (334.33)	-163.51 (383.92)	-148.92 (316.64)
	Model III	-34.24 (485.26)	-18.93 (488.84)	-51.17 (523.80)	-37.00 (458.87)
Endline	Model II	-111.51 (455.59)	-117.29 (511.04)	-101.29 (220.77)	-113.01 (523.52)
	Model III	-30.59 (549.88)	-39.10 (552.05)	42.77 (556.19)	-76.72 (543.56)
Overall	Model II	-130.49 (385.76)	-116.61 (409.34)	-140.22 (332.98)	-137.00 (396.75)
	Model III	-32.93 (509.05)	-26.57 (512.67)	-16.01 (536.47)	-50.19 (487.91)

[1] Mean (SD)

[2] Mean (SD). Annual net benefits per apprentice in $US.

Table A10: Knowledge regressions

	Knowledge							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CQP participant	−0.04**	−0.05*	0.10	0.10	−0.05*	−0.04*	−0.01	−0.01
	(0.02)	(0.03)	(0.18)	(0.18)	(0.03)	(0.03)	(0.03)	(0.03)
Endline	0.05**	0.04	0.02	0.02	0.04	0.04	−0.004	−0.004
	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)	(0.08)	(0.08)
CQP x Endline		0.01	0.02	0.02	0.01	0.01	0.03	0.03
		(0.04)	(0.03)	(0.03)	(0.04)	(0.04)	(0.09)	(0.09)
Experience					0.0004	0.01	0.01	0.01
					(0.01)	(0.01)	(0.01)	(0.01)
Firm size						−0.003	−0.003	−0.003
						(0.002)	(0.002)	(0.002)
Total apprentices						0.01***	0.01***	0.01***
						(0.002)	(0.002)	(0.002)
Total instructors							−0.02	−0.02
							(0.01)	(0.01)
Days trained per week							−0.01	−0.01
							(0.01)	(0.01)
Duration, last training							0.003	0.003
							(0.01)	(0.01)
External training							−0.04	−0.04
							(0.03)	(0.03)
Constant	0.79***	0.79***	0.50***	0.50***	0.79***	0.74***	0.74***	0.74***
	(0.02)	(0.02)	(0.13)	(0.13)	(0.03)	(0.03)	(0.05)	(0.05)
Individual FE	NO	NO	YES	YES	NO	NO	NO	NO
Observations	390	390	390	390	390	389	253	253
R^2	0.02	0.02	0.87	0.87	0.02	0.08	0.11	0.11
F Statistic	4.60**	3.10**	3.40***	3.40***	2.30*	5.70***	3.10***	3.10***

Note: *p<0.1; **p<0.05; ***p<0.01
Omitted CQP category: applied but did not participate.

Table A11: Allowances per apprentice per year, reported by firm

Assumption	Bound	**Overall**, N = 347	**Baseline**, N = 197	**Endline**, N = 150
12 months/year | 20 days/month	lower	176,000 (96,000)	172,384 (96,000)	182,647 (96,000)
	mid	191,291 (126,000)	184,154 (126,000)	204,923 (126,000)
	upper	240,273 (156,000)	232,523 (156,000)	255,077 (156,000)
(F) months/year | 20 days/month	lower	150,955 (96,000)	144,515 (88,000)	162,794 (96,000)
	mid	163,999 (102,000)	155,266 (99,000)	180,683 (119,250)
	upper	205,858 (143,000)	196,498 (120,000)	223,737 (156,000)
12 months/year | 4 x (F) weeks/month	lower	207,917 (115,200)	202,714 (115,200)	217,482 (115,200)
	mid	225,880 (151,200)	216,399 (151,200)	243,992 (151,200)
	upper	283,559 (187,200)	273,109 (187,200)	303,523 (187,200)
(F) months/year | 4 x (F) weeks/month	lower	179,743 (112,000)	170,931 (105,600)	195,941 (115,200)
	mid	195,064 (118,800)	183,383 (109,200)	217,378 (145,800)
	upper	244,636 (156,000)	231,850 (136,800)	269,060 (187,200)
12 months/year | 4 x (A) weeks/month	lower	220,471 (134,400)	204,383 (124,800)	273,081 (134,400)
	mid	238,771 (149,800)	218,059 (142,800)	312,022 (176,400)
	upper	300,617 (187,200)	275,869 (168,000)	388,141 (218,400)
firm months | 4 x (A) weeks/month	lower	192,323 (100,800)	174,176 (100,800)	251,670 (100,800)
	mid	208,273 (111,000)	186,961 (109,200)	283,645 (132,300)
	upper	261,635 (144,800)	236,540 (124,800)	350,388 (187,200)

[1] Mean (Median). (F): reported by firm; (A): reported by apprentices.

Table A12: Allowances per apprentice per year, reported by apprentice

Assumption	Bound	**Overall**, N = 347	**Baseline**, N = 197	**Endline**, N = 150
12 months/year | 4 weeks/month	lower	120,396 (120,000)	113,623 (96,000)	152,432 (144,000)
	mid	160,189 (144,000)	152,846 (120,000)	194,919 (192,000)
	upper	199,944 (167,952)	192,033 (143,952)	237,360 (239,952)
(F) months/year | 4 weeks/month	lower	99,802 (72,000)	92,720 (70,000)	133,297 (132,000)
	mid	133,925 (96,000)	126,194 (88,000)	170,486 (176,000)
	upper	168,017 (119,952)	159,640 (109,956)	207,637 (219,956)

[1] Mean (Median). (F): reported by firm; (A): reported by apprentices.

B Appendix B

B.1 Human Capital Questions

Tasks used for assessment of competence and experience

French	English
Masonry	
Lecture d'un plan de construction	Reading a building plan
Identification des différents types de briques	Identifying different types of bricks
Composition du béton de fondation	Composition of foundation concrete
Composition du béton de la dalle	Composition of slab concrete
Élévation	Drafting an elevation
Chaînage bas	Low trussing
Chaînage haut	High trussing
Réalisation des pentes	Pouring out inclined surface
Pose des hourdis	Laying down slabs
Réalisation des poutres	Installing beams
Réalisation des feuillures	Installing rabbets
Cimentage du plafond	Cementing a ceiling
Cimentage du sol	Cementing a floor
Pose des chapes	Laying the floorboards
Réalisation d'un devis pour une construction	Drawing up an estimate
Carpentry	

French	English
Prise de mesure des portes et fenêtres	Measurement of doors and windows
Prise de mesure des tables et chaises	Measurement of tables and chairs
Pointage du bois	Scoring of wood
Rabotage	Planing
Ponçage	Sanding
Savoir faire le mastic	Knowing ho to make sealant
Assemblage pour la construction d'une chaise	Chair assembly
Assemblage pour la construction d'une table	Table assembly
Identification des différents bois utilisés	Identification of different woods used
Identification des différentes coupures de bois	Identification of different wood cuts
Réalisation de devis pour un produit	Drawing up an estimate for a product
Plumbing	
Lecture d'un plan de plomberie	Reading a plumbing plan
Grattage de tuyau	Pipe scraping
Collage des raccords	Attachment of fittings
Pose des tuyaux	Laying of pipes
Réservation des attentes aux poteaux	Securing pipes at the posts
Canalisation des tuyaux dans les fausses septiques et puisards	Piping in septic tanks and sumps
Canalisation d'un bâtiment	Piping a building
Canalisation pour l'alimentation en eau froide	Piping for cold water supply
Réalisation d'un devis	Drawing up an estimate
Pose apparente des appareils sanitaires	Installation of exposed sanitary appliances
Metalworking	
Lecture du plan de construction de l'ouvrage	Reading a construction plan
Identification des types de feuilles de tôles	Identifying different types of sheet metal
Identification des types de barres de fer	Identifying the different types of iron bars
Prise de mesure des feuilles de tôles	Measuring the sheet metal
Découpage des feuilles de tôles pour la formation de la charpente	Cutting of sheet metal for the frame
Prise de mesure pour la formation des fenêtres	Window measurements
Prise de mesure pour la formation des portails	Gate measurements
Prise de mesure pour la formation des charpentes	Frame measurement
Réalisation des cadres pour les fenêtres	Making the frames for the windows
Réalisation des cadres pour les portails	Making the frames for the gates
Pose des serrures	Fitting the locks
Assemblage des feuilles de tôles pour la formation des fenêtres	Assembly of sheet metal for windows
Assemblage des feuilles de tôles pour la formation des portails	Assembly of sheet metal for gates

French	English
Assemblage des feuilles de tôles pour la réalisation des charpentes	Assembly of sheet metal for joining of frames
Réalisation d'un devis pour un ouvrage	Drawing up an estimate
Electrical Inst.	
Lecture d'un plan d'électricité	Reading an electrical plan
Conception d'un plan d'électricité	Designing an electrical plan
Installation du barrage de terre	Installing an earth barrier
Tubage du sol	Soil casing
Tubage de la dalle	Tubing the floor slab
Serrage des boîtiers et coffrets	Clamping of boxes and cabinets
Pose des lampes	Installation of lamps
Pose des prises	Installation of sockets
Installation des disjoncteurs dans les coffrets	Installation of circuit breakers
Réalisation d'un devis	Drawing up an estimate

B.2 Knowledge Questions