Benefits and Costs of Dual and Informal Apprenticeship in Bénin*

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Abstract

This paper evaluates the impact of and provides a detailed account of the costs and benefits associated with (dual) apprenticeship training in the informal sector in Bénin using unique matched apprentice-firm survey data. To study the effectiveness of dual training in an informal economy, successful applicants to the *Certificat de Qualification Professionelle*, program, a national training program that combines in-firm training with classroom teaching, are compared to unsuccessful applicants and non-applicants three years after program start. Human capital gains among all apprentices, as measured by trainers' subjective appraisal of apprentice experience and competence, are significant, with improvements of .73 and .66 standard deviation between survey waves, respectively. Gains were 3concentrated in the masonry and carpentry sector, in larger firms, and among apprentices who did not apply for the CQP program. To study net benefits of training for firms, two cost and benefit models are used. When only fees, allowances, and reported training costs are considered, firms suffer a net loss of 130 $US per apprentice per year: an average of 630 $US total per firm. When projected apprentice contributions and foregone trainer productivity are included, net estimated losses are reduced to 33 $US per apprentice per year, and an overall estimated benefit of 218 $US per firm. 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. 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. Apprentices hired at larger firms are associated with higher net benefits. In sum, we find that participation in the CQP program is not associated in any benefits for either trainees or firms relative to non-participating apprentices, though effectiveness of dual training may have been negatively impacted by the Covid-19 crisis.

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1 Introduction

In sub-Saharan Africa (SSA), interest in apprenticeship is on the rise. In economies with large informal sectors, traditional apprenticeships (also referred to as apprenticeships in the informal economy or informal apprenticeships) are the most important source of skills for early school leavers, accounting for as much as 80% percent of technical and vocational training (TVET) in SSA (Filmer and Fox, 2014), and 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 increasing numbers of youth in SSA suffer from a lack of labor attachment, underemployment, and poverty, informal sector training is seen by many policy experts as an important tool to tackle the youth employment challenge (Filmer and Fox, 2014).

Traditional apprenticeships take place predominantly in the informal sector and generally last between three and four years. They involve a private contractual arrangement between an apprentice - usually a school-leaver between the ages of 14 and 18 - or his or her parents and a master craftsman (MC) who trains the apprentice in the workplace for a fee (Bas, 1989). In contrast to formal TVET, which takes place almost exclusively in the classroom in the SSA context, traditional apprentices train on-the-job. Upon completion of the apprenticeship, the MC issues a certificate acknowledging the training; 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 (Frazer, 2006). While unregulated at the national level, informal apprenticeships are nevertheless structured according to the dictates of tradition and the customs of local professional associations, and are considered more effective at generating relevant skills than formal TVET (Ahadzie, 2009).

While abundant and flexible, training in the informal economy is subject to little

oversight. The unregulated nature of traditional apprenticeships give rise to a number of potential market failures that negatively affect their provision and quality, and have led to calls for their reform (Walther, 2011). For instance, in the absence of complete, enforceable contracts, firms may be unable to commit to providing general skills training (Acemoglu and Pischke, 1998, 1999; Dustmann and Schönberg, 2012). Others have argued that traditional apprentices are exposed to inexperienced trainers who keep them in their apprenticeship for too long (Bas, 1989). 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 are critical for guiding any reforms to adjust such market failures. Finally, since informal apprenticeships are often outside formal accreditation systems, they offer limited labor market mobility into formal sector wage jobs relative to formal education and training schemes (Acemoglu and Pischke, 2000; Alfonsi et al., 2020; World Bank, 2017). Policies introducing competency-based, nationally-accredited certification of informal apprenticeship are thus a popular solution to this issue, and have been recently introduced in SSA in countries including Malawi and Tanzania.

Another proposed reform is the introduction of a classroom component to traditional apprenticeship, producing a hybrid "dual system" comparable to the Swiss and German variety (Walther, 2011). Dual systems promise to increase training quality by introducing a state-regulated classroom component, while also improving the signalling ability of apprentices upon graduation by offering official certification. 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 training firms in the informal sector and the

growing demand among parents and youth for formal education, dual system apprenticeship certification schemes seem to remain an underutilized approach in the field of TVET reform.

In this paper, we employ apprentice-firm survey data collected in Bénin in two waves (2019 and 2021) for 427 apprentices training in 197 firms to analyze the impact of a national dual system training program 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 while continuing with their traditional in-firm apprenticeship training with an MC. Youth and firms were interviewed before the onset of training and after three years (somewhat shorter than the typical duration of an apprenticeship). We use a sector-specific skills test to compare the learning outcomes of dual system apprentices to unsuccessful program applicants and non-applicants (with both comparison groups pursuing traditional apprenticeships at the same firms as dual-system participants). We also estimate the marginal effect of apprentice participation in dual system training on firm size and profits.

Vocational training interventions combining on-the-job and classroom teaching 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). Unlike the dual system program studied in this paper, however, these programs are generally short in duration (under a year in total) and exist outside the national education framework. To our knowledge, Crépon and Premand (2019) is the only study of a dual system apprenticeship program in SSA. The authors study a program in Côte d'Ivoire that offered a stipend to youth to participate in a 12-24 month long dual apprenticeship — also eliminating all training fees. They find that, about two years after graduation, dual apprentices partake in more complex, non-routine tasks than traditional apprentices and have 15% higher earnings. We study a similarly structured program, but one that is about twice as long and does not involve any direct subsidies or eliminate any

fees.

In a second contribution, we provide a detailed account of the costs and benefits associated with (dual) apprenticeship training for firms in the informal sector in SSA. Apprenticeship fees paid by apprentices to their MCs and allowances disbursed to apprentices by firms are reported in papers relating the specificity of training in Ghana to contract type (Velenchik, 1995) and propensity of apprenticeship graduates to enter self-employment (Frazer, 2006), but firm training costs are not. Due to data limitations, neither study is conclusive about whether firms benefit from dual system training. Meanwhile, the intervention in Crépon and Premand (2019) precludes the study of net costs and benefits of traditional apprenticeship, as it removes training fees and apprentice allowances — the two largest transfers between training firm and apprentice — by design. Using detailed firm survey data that includes information on training costs, this paper attempts to fill this gap.

Our paper contributes to several strands of research. First, empirical research from high-income countries suggests that completing an apprenticeship improves overall labor market outcomes for participating youth, both in terms of employment and earnings (OECD & International Labour Organization, 2017). Though traditional apprenticeships are very common in West Africa (Adams et al., 2013; Filmer and Fox, 2014; Walther, 2011), there is limited direct empirical evidence on their impact on labor market outcomes. Existing studies suggest that long-term returns to training are heterogeneous, but tend to favor apprentices with lower starting levels of education. In the context of Ghana, Monk et al. (2008) show that while former apprentices earn significantly less than the rest of the working population, there are positive returns to apprenticeship training for individuals with little or no formal education. Similarly, Frazer (2006) points to positive returns to informal training in Ghana, but, like Alfonsi et al. (2020) in Uganda, highlights that skills acquired in informal training tend to be firm-specific and thus less conducive to career progression than those acquired through for-

mal schooling. Indeed, the sector-specific or even firm-specific nature of skills acquired in informal apprenticeship may be a reason why self-employment is the dominant path after graduation for many apprentices: for example, Hardy et al. (2019) find that youth who participate in an apprenticeship are more likely to shift out of wage work and into self-employment (and thereby suffer a 3% wage penalty), though training under more experienced firm owners increases the likelihood of an increase in earnings.

Two experimental studies on the benefits of traditional apprenticeship have shown that, on the balance, apprentices increase their human capital through training. Crépon and Premand (2019) shows that treated youth who enroll in the subsidized dual training program are more likely to be involved in complex, non-routine tasks after two years than traditional apprentices, with the likelyhood to undertake non-routine analytical tasks increasing by .24 standard deviations (SDs) and non-routine interpersonal tasks increasing by 0.08 SDs. A task intesity index was found to be .21 SDs lower for dual apprentices, i.e. dual apprentices were found to be involved in a wider range of tasks. Alfonsi et al. (2020) find that six months of in-firm training improved skills in Uganda, and these skills persisted two to three years after training. However, they observe no difference between formal TVET and informal, in-firm training. Hardy et al. (2019) report that training with more experienced trainers leads to higher skills transmission, though the authors do not estimate the progress made by apprentices or compare them to the skills of youth following other educational paths.

We also contribute to the literature on the impact of training on informal firms, which suggests that firms may be the more unambiguous beneficiaries of traditional apprenticeship training. 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 instead, suggesting that screening costs are high. Using data on manufacturing firms from Kenya, Zimbabwe and Ghana in 1992, Rosholm et al. (2007) observe a signif-

icant wage increase (of about 20%) among firms that trained in the previous 12 months. Large firms are shown to benefit more than small firms. However, the study focuses primarily on formal firms in the manufacturing sector. While Crépon and Premand (2019) looks at the impact of fee subsidies on firm's apprentice and employee stocks, and both Crépon and Premand (2019) and Alfonsi et al. (2020) investigate substitution effects within firms resulting from apprenticeship subsidies, they do not estimate the change in size or revenues that a firm can expect from hiring additional (dual) apprentices. This study is the first, to our knowledge, to report the impact of training on firm size and profits in this context.

While these studies suggest that informal apprenticeship training can have positive impacts on firm productivity, they differ from a formal cost-benefit analysis in focusing only on a subset of outcomes and cost components. The net benefits of dual apprenticeship training has been formally studied in the European context using a variety of detailed cost-benefit surveys and simulations (see Muehlemann and Wolter, 2014; Mühlemann, 2016; and Mühlemann and Wolter, 2019 for a review), but cost-benefit studies in lower-middle and low-income countries have not been undertaken until recently (Bolli et al., 2020 in Nepal; Bolli et al., 2021 in Serbia; de Amesti et al., 2021 in Chile), and are non-existent for SSA. Firm lose money training apprentices in Serbia (though the costs vary a great deal by size, with larger firms suffering relatively small losses), while Nepali firms profit from training, with little variation across firm size.

Few studies have focused on the details of the financial arrangements between traditional apprentices and firms, despite some authors suggesting that training fees may be a substantial source of financing for some firms Frazer (2006). Velenchik (1995) studies the structure of apprenticeship contracts in small informal firms in Ghana, and identifies three dominant transactions between apprentice and firm — apprentice wages, fees and allowances — and distinguishes between two broad types of contracts, with and without training fees. She finds that firms that do not charge fees are smaller and tend

to offer more specific training.

Finally, we contribute to the literature on the CQP program in Benin: the history of dual apprenticeship in Benin by Davodoun (2011), an audit and critical appraisal of the CQP by David-Gnahoui and Ahouangnivo (2017), and a sociological study of the relationship of CQP stakeholders by Bankolé and Nouatin (2020).

We find that, in general, all apprentices gain trade-specific human capital over the three observed years of training. However, we are unable to show that participation in dual system training contributes to additional learning. We find large variation in learning across trades, and the largest gains in human capital to be for youth with low learning scores at baseline. On the firm side, we find that the majority of MCs suffer net losses for each apprentice they train. 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. Mean net benefits per apprentice range from a total -130.49 $US to $-\infty$ $US depending on the costs and benefits taken into consideration. Only 33%-45% of apprentices are estimated to generate a profit for their MC; a similar range captures the proportion of firms that are estimated to profit (generate a positive net benefit) from their training activities. Finally, we find that 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.

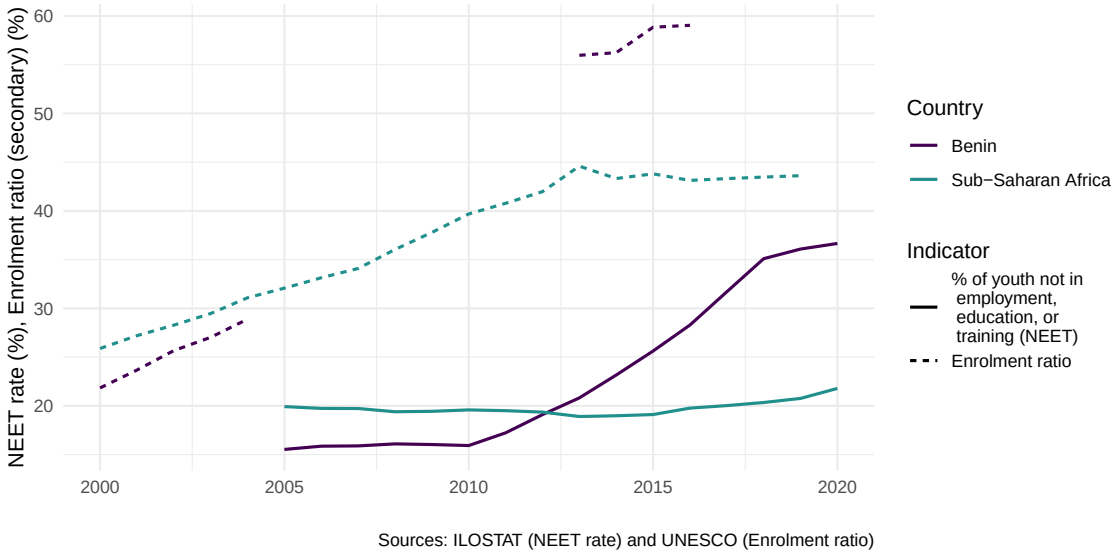
The paper proceeds as follows. Informal apprenticeship in Bénin, the CQP program, and the survey data used for the analysis are presented in Section 2. Results are presented in Section 3. Section 4 concludes.

2 Data and Methods

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



Sources: ILOSTAT (NEET rate) and UNESCO (Enrolment ratio)

As enrollment in formal education has not translated to increasing rates of youth employment, interest in promoting alternative pathways to the labor force in Bénin has grown. Recent examples of investment in Bénin's apprenticeship system include $6.3 million from the World Bank's for the Benin Youth Employment Project (PEJ), completed in 2019, and a planned $16.4 million dollar investment in strengthening the TVET system starting in 2020 (World Bank, 2020).

In 2005, the government of Bénin 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 government organs tasked with the administration of the CQP were 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, 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). Thus, rather than formal TVET, it is informal apprenticeship that is the primary conduit into the labor market for early school leavers in Bénin, with as many as 300,000 young men and women estimated to be in training (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 (i) be at least 14 years old, unless otherwise authorized by the labor inspector; (ii) have a written apprenticeship contract that complies with labor laws; (iii) have completed at least 6 years of formal schooling; and (iv) 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]. 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

[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.

various sources (national budget, donors, NGOs, etc.).

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. The final examination has a practical and a written component and is carried out by state representatives and local craftsmen. Upon successful completion, apprentices receive a nationally-recognized certificate. 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).

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 their respective training firms. To reduce travel distances and allow for subsample analyses across trades, apprentices were randomly selected from a subsample of apprentices: 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 Bénin.

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 non-applicants. 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 below.

Table 1: Apprentice Sampling

CQP Status	Explanation	Apprentice Survey Sampling	Firm Survey Sampling
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 Bénin)	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 Bénin)	If more than one CQP applicant training in firm, at most two apprentices were randomly selected at baseline.
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 in the firm, wages, costs and revenues. In addition, we surveyed all MCs about the firm's training practices and expenditures for training, as well as their perception of individual apprentices' skills, experience, diligence, efficiency, learning ability, and so on. Data on 427 apprentices working for 197 unique firms was collected at baseline. Descriptive statistics for apprentices and firms is shown in Table 2 below.

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)
Male	98%	98%	99%	98%	97%
Trade					
Masonry	21%	18%	19%	23%	22%
Carpentry	11%	11%	13%	6.5%	12%
Plumbing	13%	15%	17%	11%	9.4%
Metalworking	20%	20%	28%	12%	19%
Electrical Inst.	35%	36%	22%	47%	38%
Years in training	2.33 (1.38)	4.39 (1.38)	2.52 (1.24)	2.64 (1.30)	1.92 (1.48)
Status at endline					
Still training	NA%	73%	92%	69%	55%
Graduated	NA%	17%	6.7%	29%	21%
Dropped out	NA%	2.5%	1.1%	1.7%	3.6%
Unknown	NA%	7.1%	0%	0%	20%
Education					
None	2.5%	3.3%	0%	0.9%	6.0%
<Primary	15%	15%	6.0%	6.5%	30%
Primary	22%	21%	21%	32%	17%
Secondary	57%	57%	66%	59%	45%
Technical	2.0%	2.5%	2.7%	0.9%	2.0%
Tertiary	1.5%	1.3%	3.4%	0.9%	0%
Firms					
N	197	150			
Apprentices trained					
Total	6.1 (7.3)	6.1 (8.0)			
Selected	1.58 (3.02)	1.49 (3.19)			
Not Selected	1.67 (3.08)	1.45 (2.87)			
Did Not Apply	3.0 (3.9)	3.0 (4.1)			
Firm size					
Total (calculated)	9.6 (13.9)	8.9 (10.9)			
Total (reported)	6.7 (7.5)	6.6 (7.1)			
Apprentices	6.1 (7.3)	6.1 (8.0)			
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	23%	20%			
Carpentry	12%	12%			
Plumbing	13%	14%			
Metalworking	20%	21%			
Electrical Inst.	32%	33%			

[1] N; Mean (SD); %

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. Though all applicants applied to the same cohort of the CQP program, they came in having more experience than the required six months: the average apprentice had 1.93 years of experience at the time of application. 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.

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 (including 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, 94.81% of firms employed a total of five or less (including the owner) at baseline and 96.79% of firms employed no more than ten. Using the calculated firm size, 97.16% of firms employed a total of five or less (including the owner) at baseline and 97.64% 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. It is quite common for studies of training programs to be affected by high rates of attrition (McKenzie, 2017). Overall apprentice attrition in our sample, at 43.8%, is clearly very high, even when compared to studies in similar contexts: for instance, Crépon and Premand (2019) and Hardy et al. (2019) both report youth attrition of around 10%. It is driven both by youth non-response and firm non-response[2]. However, dropout rates suggest that survey attrition is not caused predominantly by apprenticeship leavers: even when considering as dropouts apprentices whose reason for discontinuing training is unknown, just 9.58% of all apprentices for whom data was collected at endline left their program before graduation. 17.08% had graduated after three years, and the majority, 73.33%, were still training. Graduation rates are highest for electrician apprentices, at NaN%, but comparable across trades. However, graduation rates were much lower for participants in the CQP than non-participants, potentially caused by Covid-19 related training delays. As we were observing the cohort that began training in 2019, it is consistent with an apprenticeship duration of 4 years that the majority of the sample was still training after three years. Program dropout is quite low compared to similar studies, e.g. Crépon and Premand (2019) who report 31.2% dropout for dual apprenticeships and 32.5% for traditional apprenticeships. 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]Data on apprentices who had not applied to the CQP was only obtained from firm owners, and thus only subject to firm attrition.

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 endline, NaN% of apprentices reported participating in such training in the preceding three months. However, only NaN% of CQP participants reported doing so, despite external training being a constituent and necessary component of the CQP program's dual training structure.

The majority (NA%) 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 (0%) followed by seeking employment with a different workshop (0%).

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.

Apprentices report working 41.53 hours in the previous week, compared to 43.65 hours reported by the patron.

2.3 Estimating Apprentice Benefits

We first examine the benefits accruing to apprentices over the observed time period of two years. These benefits can be separated into material benefits and human capital gains.

Material benefits accruing to apprentices amount to **total fees paid** less **allowances received**. Fees are typically paid by the parents directly to the MC at the beginning and end of an apprenticeship.

Human capital gains, the second category of benefits accruing to apprentices, are measured using a set of trade-specific scores measured separately for each apprentice at baseline and endline. These amount to a simplified version of the "task approach" utilized in the technological change literature (Crépon and Premand, 2019; see Dicarlo et al., 2016). Unlike the general tasks used to measure skill in the task approach, however, we measure craft knowledge using a short test designed using CQP curricula, and experience using a short roster of tasks drafted in collaboration with local craft experts and practitioners, similar to Hardy et al. (2019). Firms were asked to assess apprentices on this series of trade-relevant tasks, while apprentices were given the short knowledge test as a small part of their interview at baseline and endline. 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.

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

[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

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.

We also use regression analysis to examine the impact of dual training on our various measures of apprentice learning outcomes. We use the specification

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

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. $CQP_i{*}wave_t$ 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.

2.4 Estimating Firm Benefits

Firm benefits were calculated using the accounting approach (Gambin et al., 2013; Muehlemann and Wolter, 2014), which relies on survey data from training firms to identify and quantify the costs and benefits arising from training provision, 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. Additionally, we use regression analysis to directly assess the impact of hiring an additional apprentice, for both traditional and CQP apprentices, on firm profits and firm size.

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 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.

The simplest model of net benefits reduces the value of training accruing to 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. This model estimates the

benefit per apprentice per year 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** for the firm. In the competitive model of labor markets (with heterogeneous wages), workers are paid the marginal product of their labor. We assume this model 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 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

[4]A popular alternative to this 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.

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:

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

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

To estimate the effect dual training on firm size and profits, 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).

3 Results

3.1 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	expenses	427	153,934 (235,112)	240	204,135 (294,421)	<0.001
	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. 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. Evidence of apprenticeship effectiveness is clearer when regarding the apprentice competency and experience met-

rics. Table 3 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.

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.

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).

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.

Table 4: 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 4 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 A11 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.

3.2 Impact of Informal and Dual Training on Firms

Table 5: Net Benefits

Characteristic	Overall	CQP Selected	CQP Not Selected	Did Not Apply
Benefits				
Fees[1]	60.49 (46.41)	47.60 (38.10)	50.89 (40.65)	77.74 (51.00)
Entry	2.51 (4.01)	2.11 (3.22)	2.53 (5.08)	2.84 (3.85)
Formation	32.92 (37.75)	18.21 (26.89)	26.06 (32.65)	50.03 (41.98)
Liberation	8.48 (18.08)	8.56 (17.92)	6.52 (17.05)	9.64 (18.82)
Materials	6.01 (9.09)	5.75 (9.20)	5.56 (8.57)	6.50 (9.34)
Contract	7.75 (16.36)	9.97 (18.09)	7.80 (16.80)	5.78 (14.20)
Application	2.83 (4.15)	2.99 (4.16)	2.42 (3.87)	2.94 (4.30)
Apprentice productivity	110.67 (402.21)	102.00 (398.14)	114.47 (408.13)	115.85 (404.24)
Total	**347.65 (771.59)**	**245.94 (618.06)**	**377.10 (853.35)**	**417.86 (831.09)**
Costs				
Allowances	173.22 (334.54)	137.05 (331.55)	182.09 (374.50)	199.19 (308.92)
Food	43.96 (120.94)	34.71 (122.41)	47.58 (145.61)	49.76 (101.35)
Transport	37.93 (156.76)	26.06 (143.04)	42.41 (170.09)	45.45 (159.80)
Pocket money	90.93 (161.30)	76.28 (143.47)	92.10 (167.79)	102.96 (171.42)
Other	0.41 (8.40)	0.00 (0.00)	0.00 (0.00)	1.01 (13.27)
Training costs	28.43 (65.55)	26.74 (72.20)	32.31 (66.12)	27.47 (59.09)
Rent	23.43 (57.75)	20.20 (48.05)	28.82 (71.53)	22.88 (55.95)
Equipment	32.63 (87.57)	21.49 (44.86)	41.92 (114.53)	36.52 (95.42)
Books and teaching materials	7.37 (45.66)	10.02 (61.71)	6.50 (37.89)	5.62 (31.68)
Raw materials	46.58 (150.15)	54.78 (200.86)	38.59 (111.34)	44.43 (116.33)
Foregone trainer productivity	Inf (NA)	21.06 (39.75)	Inf (NA)	Inf (NA)
Total	**Inf (NA)**	**184.85 (339.86)**	**Inf (NA)**	**Inf (NA)**
Net Benefits				
Model I	**-112.73 (334.81)**	**-89.45 (330.05)**	**-131.20 (376.73)**	**-121.46 (311.14)**
Model II	**-141.16 (340.42)**	**-116.20 (334.33)**	**-163.51 (383.92)**	**-148.92 (316.64)**
Model III	**174.43 (816.07)**	**108.89 (693.56)**	**195.01 (892.07)**	**218.67 (864.79)**
Model IV	**146.00 (819.01)**	**82.14 (695.44)**	**162.70 (896.90)**	**191.20 (867.43)**
Model V	**-Inf (NA)**	**61.08 (679.82)**	**-Inf (NA)**	**-Inf (NA)**

Mean (SD). Net benefits per apprentice per year, calculated using responses from baseline survey. Amounts in $US.

[1] Fees reported by firm owner. Annual fees assume apprenticeship duration of four years.

In contrast to the dual training program studies by Crépon and Premand (2019), the CQP program did not eliminate fees or directly subsidize apprentices. Training fees for both CQP participants and other, traditional apprentices are summarized in Table 5. General training fees represent the largest single fee 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 a minor increase in the costs of training in Bénin 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 the training fee in particular (Table A6 in the Appendix). 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.

Figure A3 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 A4 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.

Table 5 shows the estimated annual net benefits of training per apprentice by wave. Estimated benefits by CQP status are also shown for baseline numbers. Depending on which model is used, training is, on average, associated with a net loss ranging from about 30 $US to about 120 $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 A8 in the Appendix) and receiving higher allowances than non-applicants (and on par with unsuccessful applicants, see Table A7 in the Appendix). This suggests that CQP participants train predominantly in firms with lower reported training costs. Estimated net benefits do not change drastically between the baseline and the endline (Table A10 in the Appendix).

Mean benefits per apprentice total -101.93 $US when using Model I, -130.49 $US using Model II, 172.69 $US using Model III, 144.13 $US using Model IV, and $-\infty$ $US using Model V.

The distributions of net benefits by individual apprentice have long left and right tails. 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 V generates especially exaggerated numbers, extending from $-\infty$ $US in losses for a single apprentice to as much 3774.07 $US in annual benefits. Such estimates should be taken with caution as they suggest apprentices generate costs and/or benefits out of proportion with firm revenues.

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 **??** in the Appendix. Using Model I, mean net benefits amount to -73.95 $US per apprentice when dropping the top and bottom percentile, -53.04 $US per apprentice when the top and bottom 5% are dropped, and -37.83 $US per apprentice when the top and bottom deciles are dropped.

Using Model II, mean net benefits per apprentice are -102.81 $US when dropping

the top and bottom percentile, -83.09 $US when the top and bottom 5% are dropped, and -67.02 $US when the top and bottom deciles are dropped.

Using Model III, mean net benefits per apprentice are 167.61 $US when dropping the top and bottom percentile, 107.45 $US when the top and bottom 5% are dropped, and 67.26 $US when the top and bottom deciles are dropped.

Using Model IV, mean net benefits per apprentice are 139.05 $US when dropping the top and bottom percentile, 79.03 $US when the top and bottom 5% are dropped, and 40.16 $US when the top and bottom deciles are dropped.

Using Model V, mean net benefits per apprentice are 117.03 $US when dropping the top and bottom percentile, 63.96 $US when the top and bottom 5% are dropped, and 24.29 $US when the top and bottom deciles are dropped.

According to Model I, 43.33% and 43.33% of apprentices are estimated to generate a positive net benefit during training at baseline and endline, respectively; using Model II, 37.24% and 34.17% of apprentices are estimated to do so; using Model III, 54.1% and 68.75% of apprentices are estimated to do so; using Model IV, 48.95% and 62.92% of apprentices are estimated to do so; using Model V, 43.79% and 59.58% of apprentices are estimated to do so.

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, thus assuming that the 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, -

502.16 $US using Model I, -626.13 $US using Model II, 1898.22 $US using Model III, 1774.25 $US using Model IV, and $-\infty$ $US using Model V.

Truncating again at the 1st, 5th and 10th percentiles and present the truncated distributions in a histogram and kernel density plot, shown in Figure **??** in the Appendix. Using Model I, mean net benefits amount to -340.17 $US per apprentice when dropping the top and bottom percentile, -206.17 $US per apprentice when the top and bottom 5% are dropped, and -148.46 $US per apprentice when the top and bottom deciles are dropped.

Using Model II, mean net benefits per apprentice are -463.74 $US when dropping the top and bottom percentile, -332.55 $US when the top and bottom 5% are dropped, and -263.62 $US when the top and bottom deciles are dropped.

Using Model III, mean net benefits per apprentice are 1175.07 $US when dropping the top and bottom percentile, 563.05 $US when the top and bottom 5% are dropped, and 333.85 $US when the top and bottom deciles are dropped.

Using Model IV, mean net benefits per apprentice are 1053.96 $US when dropping the top and bottom percentile, 448.12 $US when the top and bottom 5% are dropped, and 231.97 $US when the top and bottom deciles are dropped.

Using Model V, mean net benefits per apprentice are 921.49 $US when dropping the top and bottom percentile, 367.75 $US when the top and bottom 5% are dropped, and 169.83 $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, 40.1% and 44% of firms are estimated to earn a positive net benefit from training (positive net benefits) at baseline and endline, respectively; using Model II, 32.49% are estimated to do so at baseline and 34% at endline, using Model III, 50.25% are estimated to do so at baseline and 68% at endline; using Model IV, 44.67% are estimated to do so at baseline and 64% at endline; using Model V, 40.1% are estimated

to do so at baseline and 60.67% at endline.

Table 6: Net Benefits by Firm

Characteristic	**Overall**, N = 195	(**1,2**], N = 8	(**2,5**], N = 71	(**5,10**], N = 70	(
Revenues	3,989 (4,820)	1,127 (842)	2,408 (2,064)	3,484 (4,365)	
Expenses	2,575 (4,452)	1,083 (1,247)	1,362 (1,550)	1,883 (2,233)	
Profits (reported)	1,672 (2,634)	612 (420)	978 (946)	1,624 (1,770)	
Profits (calculated)	677 (4,554)	-378 (1,681)	605 (2,102)	1,203 (3,839)	
Extrapolated total fees	340 (361)	54 (43)	146 (151)	335 (224)	
Extrapolated total apprentice productivity	8,320 (12,883)	NA (NA)	895 (1,305)	2,608 (2,895)	1
Extrapolated total benefits	2,383 (7,345)	54 (43)	295 (644)	855 (1,683)	
Extrapolated allowances	1,787 (5,063)	302 (273)	528 (521)	1,683 (3,880)	
Total reported training costs	145 (287)	155 (271)	104 (194)	161 (358)	
Total foregone trainer productivity	Inf (NA)	75 (57)	69 (78)	Inf (NA)	
Extrapolated total costs	Inf (NA)	361 (316)	442 (493)	Inf (NA)	
Model I	-685 (2,626)	-172 (269)	-172 (385)	-969 (3,570)	
Model II	-805 (2,654)	-269 (285)	-259 (435)	-1,107 (3,600)	
Model III	1,363 (7,552)	-172 (269)	-21 (760)	-447 (3,951)	
Model IV	1,243 (7,552)	-269 (285)	-108 (787)	-585 (3,978)	
Model V	-Inf (NA)	-306 (309)	-148 (786)	-Inf (NA)	

[1] Mean (SD)

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 0.63 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 Inf. 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.

This implies that for firms that benefits from apprenticeship, apprenticeship fees and apprentice 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.

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; Hardy and McCasland, 2022).

Table 7: 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	−0.16	0.04***	0.03
	(0.01)	(0.04)	(0.02)	(0.21)	(0.01)	(0.02)
CQPs	−0.02		−0.02		0.001	
	(0.03)		(0.05)		(0.01)	
Endline	0.49***	0.40**	−0.06	−1.40**	−0.02	−0.18
	(0.13)	(0.18)	(0.22)	(0.61)	(0.10)	(0.15)
log Firm size†	0.42***	0.31	0.41*	0.23		
	(0.12)	(0.23)	(0.21)	(0.83)		
Constant	7.60***		7.10***		1.10***	
	(0.17)		(0.29)		(0.07)	
Firm FE	NO	YES	NO	YES	NO	YES
Observations	126	134	96	103	146	155
R^2	0.26	0.24	0.08	0.41	0.34	0.10
F Statistic	11.00***	2.60*	2.00	2.10	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 7, 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.

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. 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.

First, we find that there is visible selection into the CQP program. CQP applicants are better educated, older, and have spent more time as apprentices than other apprentices in the firm. Firms sending apprentices to the CQP have fewer than 10 total workers on average, of whom the majority are apprentices.

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.

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 ∞ $US per apprentice per year, and even a net benefit of $-\infty$ $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.

Interruptions due to the Covid-19 pandemic may have disrupted 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, NA% 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 NA hours. Thus, CQP apprentices reported training externally at only a marginally higher rate than apprentices who applied but were not accepted into 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 observable 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.

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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

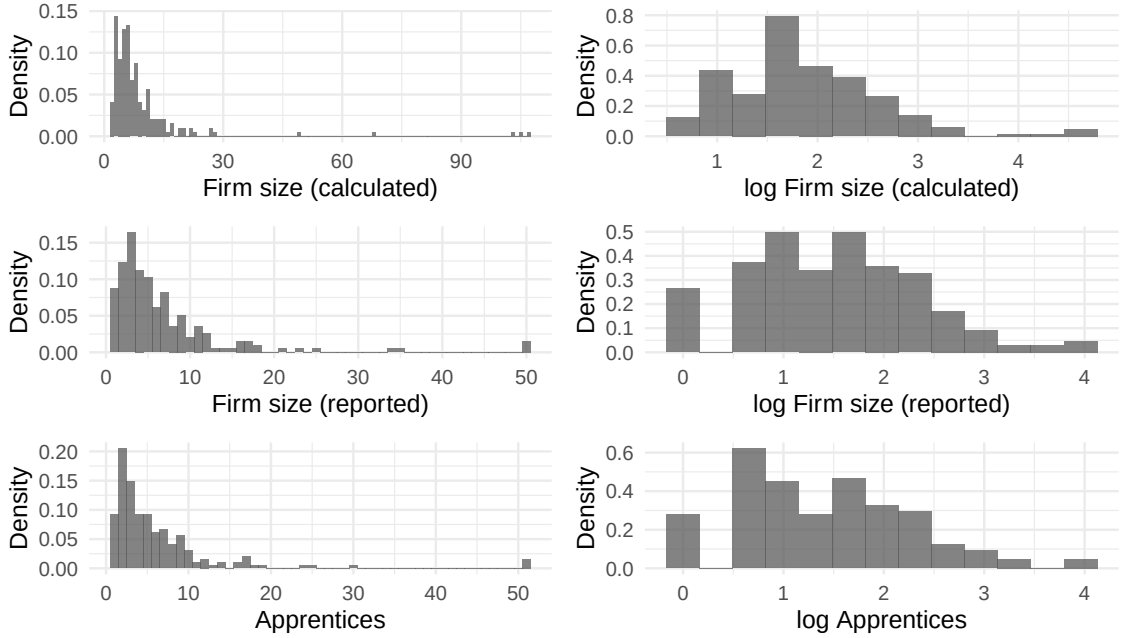


Figure A2: Change in apprentice human capital scores

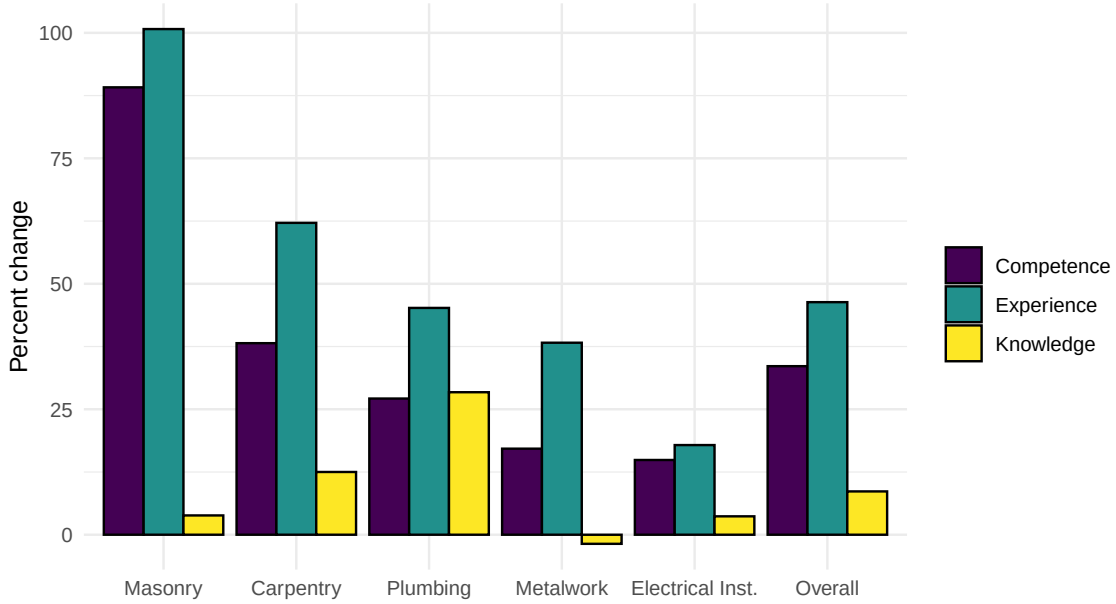


Table A4: Change in apprentice human capital scores

Characteristic	**CQP Selected**, N = 150	**CQP 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)

Table A6: Apprenticeship Fees

	Baseline			Endline		
Fee Type	Apprentice	Firm	p-value	Apprentice	Firm	p-value
Initiation	16.89 (55.09)	10.95 (16.44)	0.11	15.92 (35.55)	15.58 (36.59)	0.4
Training	167.18 (149.59)	144.17 (152.18)	0.3	191.69 (155.07)	145.05 (154.44)	0.12
Graduation	39.43 (79.49)	37.82 (75.39)	0.4	42.32 (78.12)	38.14 (100.51)	0.13
Materials	27.89 (33.93)	26.23 (37.24)	0.13	31.33 (33.80)	20.60 (19.38)	0.019
Contract	25.28 (60.95)	34.21 (67.95)	0.048	28.38 (64.38)	19.60 (49.84)	0.2
Application	11.41 (15.74)	12.55 (17.02)	0.4	12.77 (16.02)	17.61 (15.73)	0.008
Total	288.08 (191.06)	244.84 (184.84)	0.003	322.42 (184.87)	239.98 (167.79)	<0.001

Mean (SD). All fees are total amounts to be paid over the course of the apprenticeship. Amounts in $US.

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	expenses	0	NA (NA)	155	215,629 (332,070)
	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.

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 A7: Monthly allowances

Group	Characteristic	**Overall**, N = 427	**CQP Selected**	**CQP Not Selected**	**Did**
Baseline	Food	6.66 (12.76)	5.85 (13.54)	8.45 (16.40)	6.3
	Transportation	5.89 (18.74)	4.67 (17.84)	7.63 (21.45)	5.9
	Pocket Money	14.68 (18.60)	14.45 (18.62)	16.47 (17.52)	14.
	Other	0.07 (1.06)	0.00 (0.00)	0.00 (0.00)	0.
	Total	27.30 (35.11)	24.98 (37.33)	32.55 (39.68)	26.
	Total	168,231.20 (234,824.34)	147,077.38 (249,388.31)	206,798.25 (277,181.23)	164,860.
Endline	Food	9.68 (8.04)	7.81 (7.17)	13.08 (7.87)	9.
	Transportation	2.91 (6.58)	1.91 (4.24)	3.31 (5.65)	3.
	Pocket Money	16.62 (55.33)	18.46 (61.51)	8.29 (16.49)	21.
	Other	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.
	Total	29.21 (54.68)	28.18 (59.64)	24.68 (18.43)	34.
	Total	188,568.63 (398,984.10)	181,392.86 (437,190.29)	152,035.71 (130,829.26)	229,953.
Overall	Food	7.50 (11.72)	6.51 (11.81)	9.98 (14.28)	6.
	Transportation	5.06 (16.35)	3.75 (14.79)	6.20 (17.92)	5.5
	Pocket Money	15.22 (33.06)	15.79 (38.40)	13.78 (17.52)	15.
	Other	0.05 (0.90)	0.00 (0.00)	0.00 (0.00)	0.
	Total	27.83 (41.40)	26.05 (45.76)	29.96 (34.25)	28.
	Total	173,868.21 (289,325.39)	158,515.87 (322,882.85)	188,758.82 (239,565.52)	178,127.

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

Table A8: Fees reported by firm

Group	Characteristic	**CQP Selected**, N = 149	**CQP 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 A3: Breakdown of mean annual training costs per apprentice

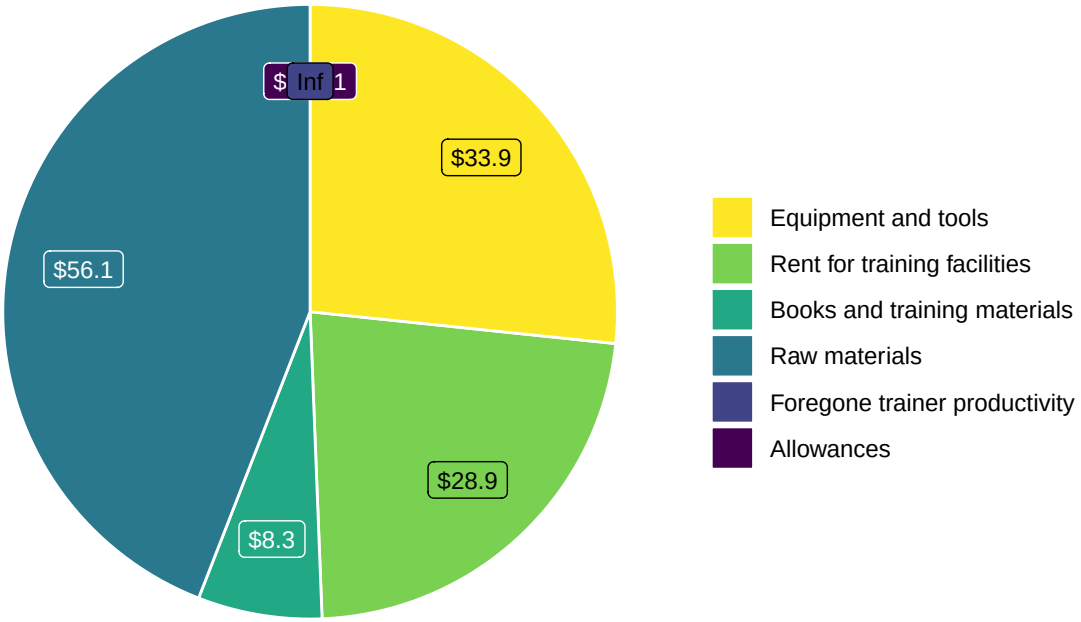


Figure A4: Breakdown of mean annual training costs per firm

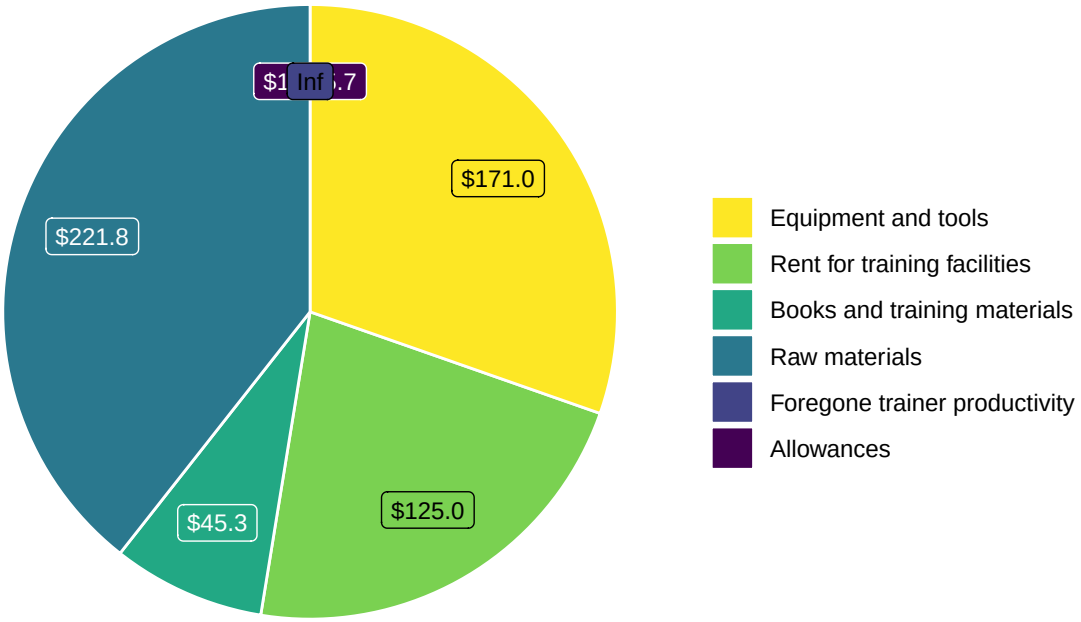


Table A9: Summary of firm costs

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.

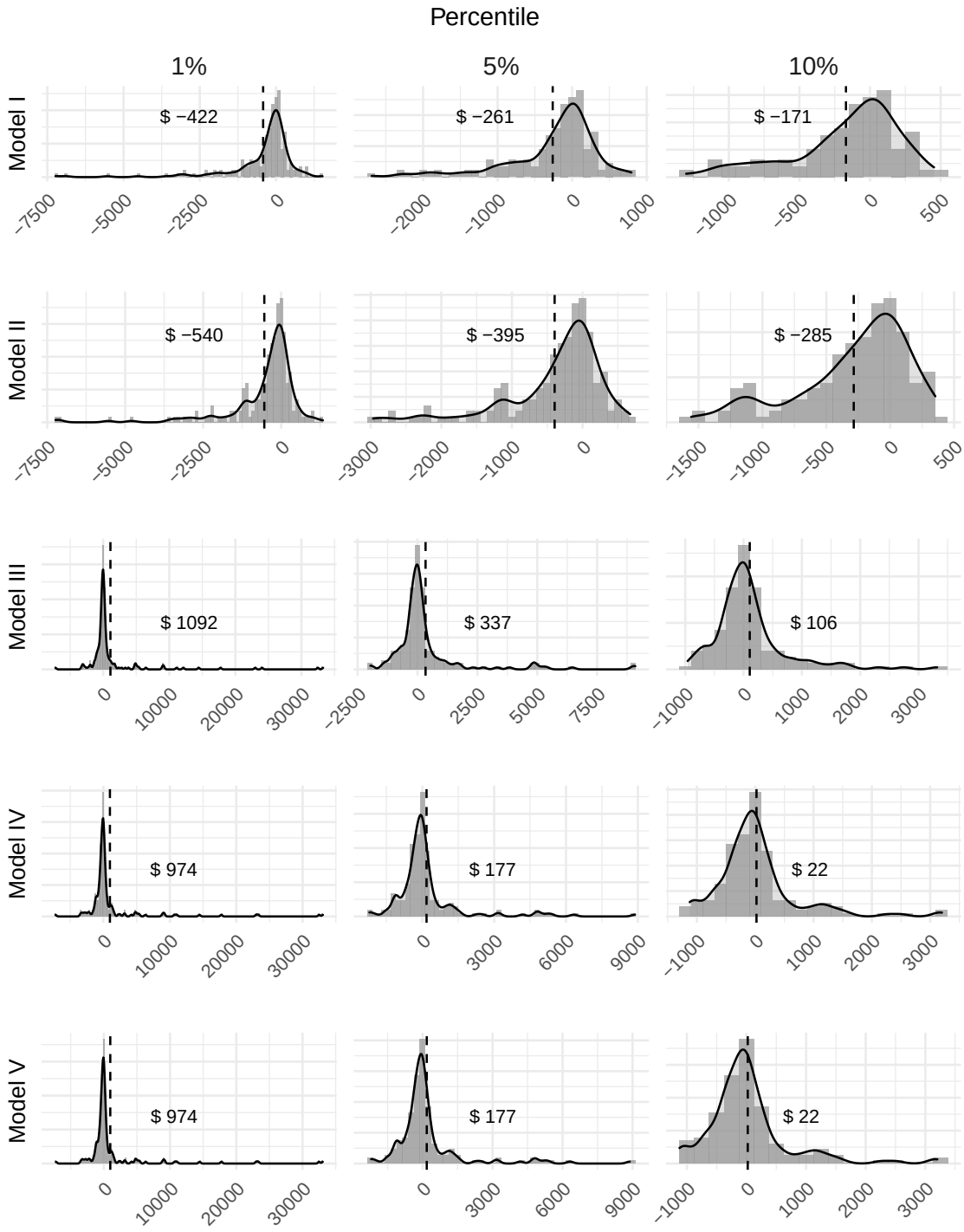
Table A10: Net benefits

Group		**Overall**, N = 427	**CQP Selected**	**CQP Not Selected**	**Did Not Apply**
Baseline	Model I	-141.16 (340.42)	-116.20 (334.33)	-163.51 (383.92)	-148.92 (316.64)
	Model II	-Inf (NA)	61.08 (679.82)	-Inf (NA)	-Inf (NA)
Endline	Model I	-111.51 (455.59)	-117.29 (511.04)	-101.29 (220.77)	-113.01 (523.52)
	Model II	131.24 (685.91)	74.49 (629.89)	264.55 (690.13)	91.63 (733.25)
Overall	Model I	-130.49 (385.76)	-116.61 (409.34)	-140.22 (332.98)	-137.00 (396.75)
	Model II	-Inf (NA)	66.17 (660.03)	-Inf (NA)	-Inf (NA)

[1] Mean (SD)

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

Figure A5: Truncated distributions of net benefits per firm



Firm benefits calculated as mean net benefits of all observed apprentices in firm times reported number of apprentices trained. Estimated using baseline data. Density shown on y−axis. Labelled dotted line indicates mean of truncated distribution.

Table A11: 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 A12: 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 A13: 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.

Characteristic	**Overall**, N = 195	**(1,2]**, N = 8	**(2,5]**, N = 71
Revenues	3,989 (4,820)	1,127 (842)	2,408 (2,064)
Expenses	2,575 (4,452)	1,083 (1,247)	1,362 (1,550)
Profits (reported)	1,672 (2,634)	612 (420)	978 (946)
Profits (calculated)	677 (4,554)	-378 (1,681)	605 (2,102)
Extrapolated total fees	340 (361)	54 (43)	146 (151)
Extrapolated total apprentice productivity	8,320 (12,883)	NA (NA)	895 (1,305)
Extrapolated total benefits	2,383 (7,345)	54 (43)	295 (644)
Extrapolated allowances	1,787 (5,063)	302 (273)	528 (521)
Total reported training costs	145 (287)	155 (271)	104 (194)
Total foregone trainer productivity	Inf (NA)	75 (57)	69 (78)
Extrapolated total costs	Inf (NA)	361 (316)	442 (493)
Model I	-685 (2,626)	-172 (269)	-172 (385)
Model II	-805 (2,654)	-269 (285)	-259 (435)
Model III	1,363 (7,552)	-172 (269)	-21 (760)
Model IV	1,243 (7,552)	-269 (285)	-108 (787)
Model V	-Inf (NA)	-306 (309)	-148 (786)

B Appendix B

B.1 Human Capital Questions

Table A14: 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	
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

French	English
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

French	English
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
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

Masonry

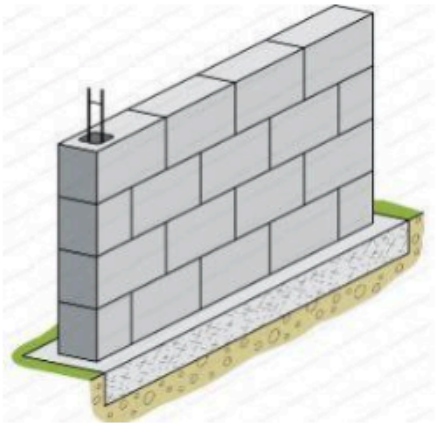
What is this tool used for?

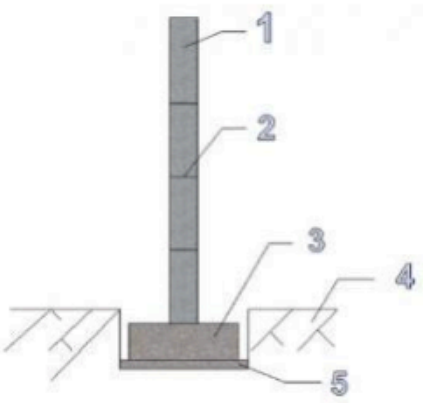
- ○ Pour prendre la verticalité
- ○ Pour creuser des trous
- ○ Pour tracer ou mesurer des angles
- ○ Pour fermer les joints entre les agglomérés, à prendre du mortier, à lisser
- ○ Je ne sais pas

A right angle has how many degrees?

- ○ 45°
- ○ 90°
- ○ 100°
- ○ 360°
- ○ Je ne sais pas

A partir des figures ci-dessus, indiquez le numéro correspondant à chaque partie de l'ouvrage.





- [ ] Joint
- [ ] Béton de propreté
- [ ] Béton de fondation
- [ ] Terrain naturel (TN)
- [ ] Agglomére

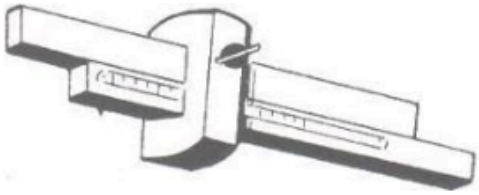
What are the correct proportions for mixing plaster?

- ○ **1** paquet de ciment, **2** brouettes de sable et **1** brouette de gravier
- ○ **1** paquet de ciment, **2** brouette de sable et de l'eau
- ○ **3** paquets de ciment, **2** brouettes de sable et de l'eau
- ○ **1** paquet de ciment, **3** brouettes de sable et de l'eau
- ○ Je ne sais pas

Carpentry

Which of the following is called a rabot de finition?

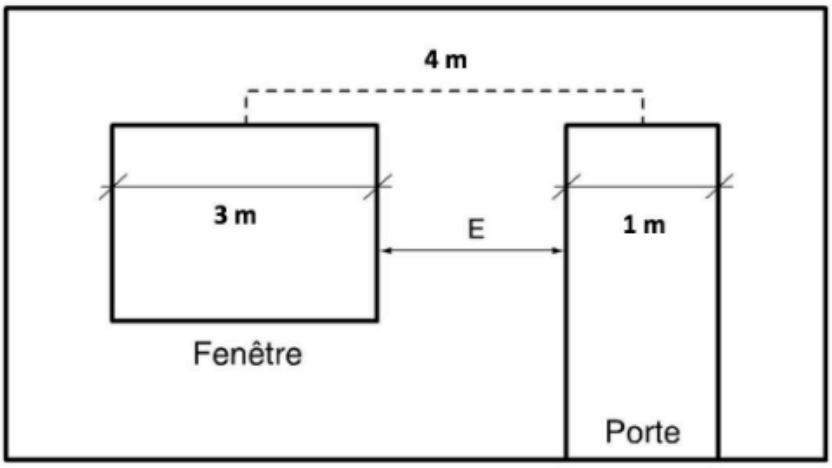
○ 

○ 

○ 

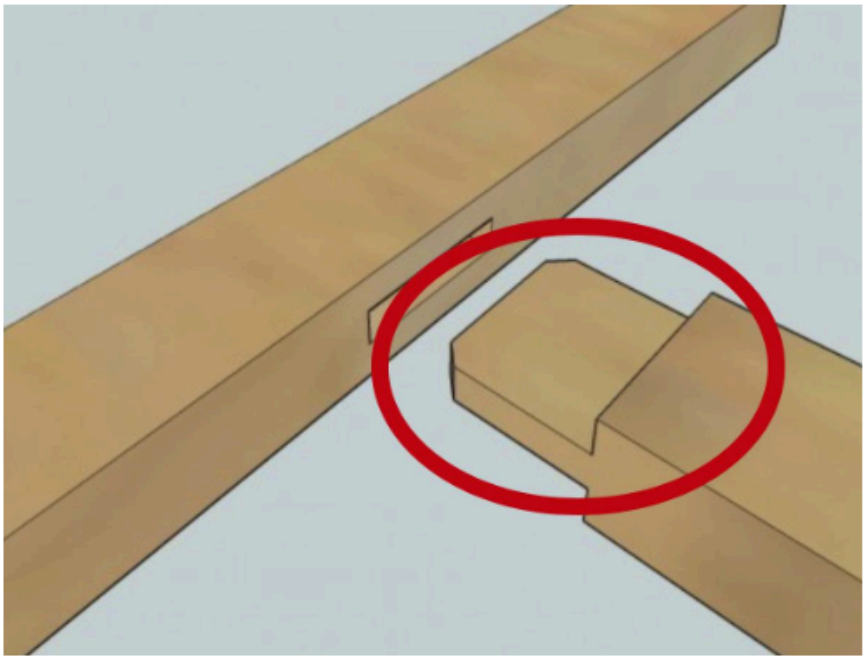
○ 

En vous référant au schéma suivant, quelle est la distance E entre la fenêtre et la porte?



- ○ 0,5 m
- ○ 1 m
- ○ 1,5 m
- ○ 2 m
- ○ Je ne sais pas

What is the name of the circled object?

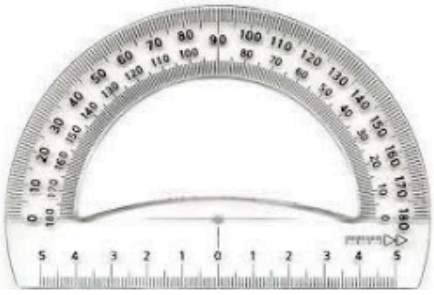


- ○ Tenon
- ○ Gabarit
- ○ Mortaise
- ○ Pied divan
- ○ Je ne sais pas

Which of these tools is called a compass?

○ 

○ 

○ 

○ 

○ Je ne sais pas

Plumbing

Which of the following is called a compass?

○ 

○ 

○ 

○ 

○ Je ne sais pas

What is the following tool used for?

- ◯ Pour contrôler la quantité du fluide dans la fosse à partir de la hauteur d'eau
- ◯ Pour saisir ou serrer certains objets
- ◯ Pour vérifier les angles droits
- ◯ À creuser des trous
- ◯ Je ne sais pas

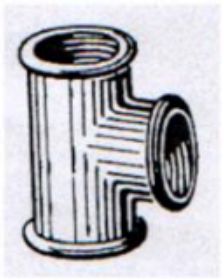
Un angle droit a combien de degrés ? / Il y a combien de degrés dans un angle droit ?

- ◯ 45°
- ◯ 90°
- ◯ 100°
- ◯ 360°
- ◯ Je ne sais pas

Lequel des pièces suivantes est un manchon ?

○ 

○ 

○ 

○ 

○ Je ne sais pas

What is this object used for?

- ○ Pour replanir des pièces de bois
- ○ Pour taper des éléments
- ○ Pour contrôler les angles droits
- ○ Pour saisir ou serrer certains objets
- ○ Je ne sais pas

Metalworking

Which of the following is called a baguette?

○ 

○ 

○ 

○ 

What is the name of this tool?

- ○ Plieuse
- ○ Poste à souder
- ○ Jeux de pinces
- ○ Perceuse à table
- ○ Je ne sais pas

Which of the following is the "fer cornière"?

○ 

○ 

○ 

○ 

A right angle has how many degrees?

- ○ 45°
- ○ 90°
- ○ 100°
- ○ 360°
- ○ Je ne sais pas

What measurements do you need to use for a gate that is 1 meter wide and 2 meter high? (1m x 2m)

- ○ 0,985m x 1,985m
- ○ 1m x 2m
- ○ 1,015m x 2,015m
- ○ 1,5m x 2,5m
- ○ Je ne sais pas

Electrical Inst.

What is the name of this tool?

- ○ Telluromètre
- ○ Multimètre
- ○ Niveaux à bulle d'air
- ○ Circuit imprimé
- ○ Je ne sais pas

What is this tool used for?

- ○ Pour mesurer la valeur ohmique de la prise de terre
- ○ Pour signaler la présence de la phase et le neutre
- ○ Pour contrôler la présence de la tension et la continuité
- ○ Pour serrer le bout d'un câble conducteur dans une corse
- ○ Je ne sais pas

Electric resistance is typically measured in what units?

- ○ Ampere
- ○ Ohm
- ○ Volt
- ○ Joule
- ○ Je ne sais pas

Which of the following is called a disjoncteur?

- ○ 
- ○ 
- ○ 
- ○ 
- ○ Je ne sais pas

What is the name of this object?

- ○ Une prise électrique
- ○ Un interrupteur
- ○ Un domino
- ○ Un bouton poussoir
- ○ Je ne sais pas