Benefits and Costs of Dual and Informal Apprenticeship in Bénin*

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Abstract

Traditional apprenticeships are an important source of skills for early school leavers in developing countries. Usually private arrangements between parents and informal firms, apprenticeship quality and costs are not subject to oversight or regulation. Public reforms have aimed at improving access or quality of training, for example by complementing in-firm training with a weekly classroom component. We provide a detailed account of such a program conducted at national scale in Bénin. Using two waves of surveys with firm owners and apprentices, we analyze the human capital gains and material costs and benefits associated with training. We find no differences in human capital accumulation between apprentices who participated in the program to a sample of rejected applicants and non-applicants from the same firms. Firms which trained more dual apprentices did not grow more quickly or become more profitable. Additionally, we observe that allowances distributed to apprentices in lieu of wages appear to be considerably higher than training fees paid, especially at larger firms. This contradicts the common wisdom that informal firms rely on apprenticeship fees as a source of financing. Instead, apprentice productive contributions to the firm appear to be the primary incentive for firms to participate in training. **The dual training program needs improvement, not clear why more experienced (hence productive) apprentices are sent; balance must be struck between the effectiveness of classroom training (should be weekly) and the preferences of trainers, who apparently benefit from apprentice labor, not fees; as argued by others, increasing MC skin in the game may be key for masters to see the classroom component as a benefit.**

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1 Introduction

In sub-Saharan Africa (SSA), interest in apprenticeships is on the rise. In economies with largely informal economies, traditional apprenticeships (also referred to as apprenticeships in the informal sector 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). According to a survey of five countries, 20 percent of youth aged 25-34 had participated in apprenticeship; in contrast, only 1 percent of youth participate in formal TVET, and about 9 percent are enrolled in tertiary education (Filmer and Fox, 2014). 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, in the context of highly informal economies, are generally considered to be more effective than formal TVET at delivering the skills demanded by the labor market (Ahadzie, 2009).

The unregulated nature of traditional apprenticeships give rise to a number of potential market failures that negatively affect their provision, 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). Apprentice productivity may also be so low that subsistence levels (paid in the form of "chop money" by the firm owner) are greater returns from training, causing an under-provision of training. Another obstacle to training provision may involve fears of competing firms "poaching" newly trained apprentices, a problem particularly salient for small enterprises, which experience higher employee turnover and offer fewer opportunities for career advancement (Mcintosh et al., 2011), though evidence of this is limited for the African context. Quality is also affected by the unregulated nature of informal apprenticeships, and may have adverse consequences for participating youth. For instance, apprentices may be exposed to inexperienced trainers who keep them in their apprenticeship for too long (Bas, 1989), or experience limited labor market mobility into formal sector wage jobs due to the lack of formal accreditation systems (Acemoglu and Pischke, 2000; Alfonsi et al., 2020; World Bank, 2017).

A deeper understanding of the costs and benefits are critical for guiding reforms to address such market failures. Policies introducing competence-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, Côte d'Ivoire, Senegal, Tanzania, Togo, and Niger (ILO, 2020; Walther, 2011). 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 (baseline in 2019 and endline in 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.

Studies of vocational training interventions combining on-the-job and classroom teaching in middle-income countries have reported persistent if modest increases in earnings and mixed impacts on employment (Alzúa et al., 2016; Attanasio et al., 2017,

2011; Card et al., 2011; Ibarrarán et al., 2019, 2014), though similar interventions in LICs have been characterized by low take-up, high dropout, and low efficacy (see Blattman and Ralston, 2015; Ghisletta et al., 2021; Tripney and Hombrados, 2013 for an overview). These programs tend to be shorter (several months, rather than years) than the one studied in this paper, and focus on employment in the formal rather than the informal sector. To our knowledge, only one paper has addressed dual-system training in Sub-Saharan Africa. In a randomized experiment in Côte d'Ivoire, Crépon and Premand (2019) find that youth offered a stipend for an apprenticeship that combined 12 to 24 months of on-the-job training with theoretical classes at local training institutions earn 15 percent more after three years, partake in more complex and non-routine tasks[1], and receive training certification at a higher rate than non-treated youth. We study a similarly structured program, but one that is about twice as long and does not involve any direct subsidies or eliminate fees. Our study also contributes quantitative evidence regarding the effectiveness of the CQP to the discussion tracing the program's history and current implementation (Bankolé and Nouatin, 2020; David-Gnahoui and Ahouangnivo, 2017; Davodoun, 2011).

A related literature addresses the profitability of dual-system apprenticeships for the employer through the detailed accounting of the costs and benefits of training. A number of such studies have been conducted in the European context with the aid of surveys and simulations (see, e.g., Mühlemann, 2016; Mühlemann and Wolter, 2019, 2014), but have only recently begun to generate interest in lower-middle and low-income countries. Examples include Bolli et al. (2021), who find that training costs outweigh benefits in Serbia (with larger firms suffering smaller losses), and Bolli et al. (2020), who show that training firms in Nepal generally profit from training, with little variation

[1]The authors find 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, with the likelihood to undertake non-routine analytical tasks increasing by .24 standard deviations (SDs) and non-routine interpersonal tasks increasing by 0.08 SDs relative to non-treated traditional apprentices. A task intesity index was found to be .21 SDs lower for dual apprentices, suggesting that dual apprentices are involved in a wider range of tasks.

across firm size. To our knowledge, ours is the first rigorous cost-benefit study of dual-system training conducted in SSA.

We also contribute to the literature on informal apprenticeship in SSA as such by considering effect of training on both apprentices and firms. Evidence 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 the labor market outcomes of apprentices. Long-term returns to informal training have been shown to be quite heterogenous in Ghana, while benefiting youth with lower levels of education the most (Monk et al., 2008). An experimental study in Uganda finds that six months of in-firm training measurably improves skills, and that these skills persist two to three years after the end of training (Alfonsi et al., 2020). However, skills acquired in informal training tend to be firm-specific, and thus more likely to lead to self-employment than to quick career progression in the formal sector than formal schooling (Alfonsi et al., 2020; Frazer, 2006; Hardy et al., 2019).

Studies from SSA suggest that informal apprenticeship training may increase microenterprise size and profitability. Using data on formal manufacturing firms from Kenya, Zimbabwe and Ghana, Rosholm et al. (2007) observe a significant wage increase (of about 20%) in firms that trained in the previous 12 months, with large firms benefiting more than small firms. Hardy and McCasland (2022) find that assigning an apprentice to informal firms in Ghana increase firm size by about half a worker, and firm revenues by 5-15 percent per apprentice. While Crépon and Premand (2019) looks at the impact of fee subsidies on firm's apprentice and employee stocks, they do not estimate the change in size or revenues that a firm can expect from hiring additional apprentices. Our study is thus the first, to our knowledge, to report the impact of dual

system training on firm size and profits in SSA.

Finally, a number of studies have examined the financial arrangements between traditional apprentices and informal firms. Velenchik (1995) studies the structure of apprenticeship contracts in small informal firms in Ghana, and identifies three main transactions between apprentice and firm — apprentice wages, fees and allowances — and distinguishes between two broad types of contracts, namely those with and those without training fees. She finds that firms that do not charge fees are smaller and tend to offer more specific training. Velenchik (1995) and Frazer (2006) also suggest that training fees may be a substantial source of financing for some firms, but do not provide estimates of the allowances, wages and other training costs that these fees are meant to offset. This study attempts to fill this gap.

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 -454.58 $US to 295.69 $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 pre-

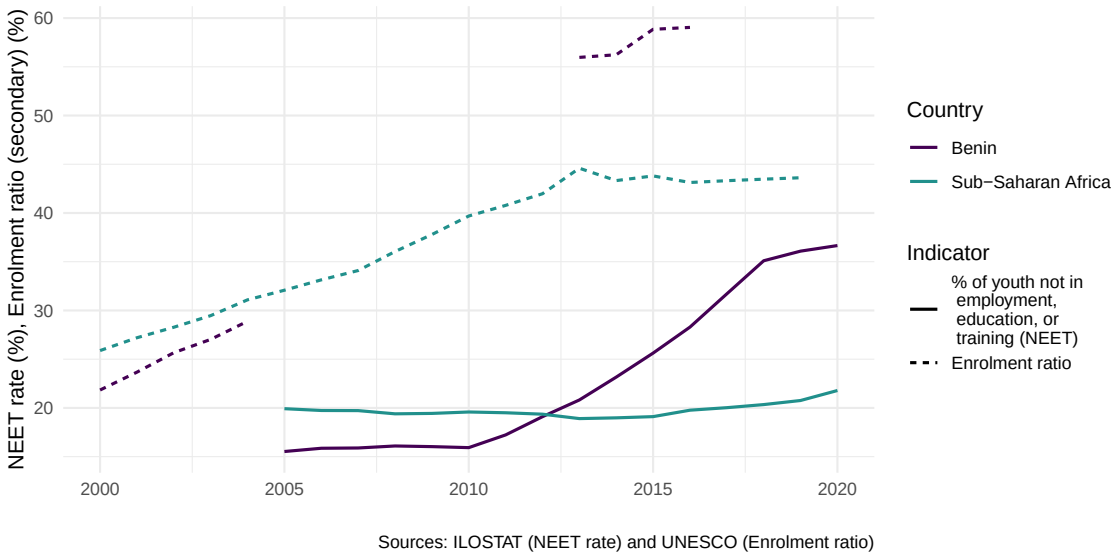
sented in Section 3. Section 4 concludes.

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



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 (G. 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 (G. 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)[2]. Cost sharing for the CQP program is shared by the state and the apprentice, with the state financing body for dual apprenticeship, FODEFCA, officially taking on 90 percent of the training costs (*KOF*, 2017). However, FODEFCA is largely reliant on external donor funding, and regular financing has been an issue for the program in recent years (David-Gnahoui and Ahouangnivo, 2017).

The financing of dual training comprises three main budget items: the firm/workshop, the training center and certification. While on-the-job training in the firm is paid for by the parents, training in the training center is largely financed through FODEFCA from various sources (national budget, donors, NGOs, etc.).

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 sec-

[2]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.

ond 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.

CQP Status	Explanation	Apprentice Survey Sampling	Firm Survey Sampling

CQP Status	Explanation	Apprentice Survey Sampling	Firm Survey Sampling
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.

CQP Status	Explanation	Apprentice Survey Sampling	Firm Survey Sampling
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 competence 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	-	73%	92%	69%	55%
Graduated	-	17%	6.7%	29%	21%
Dropped out	-	2.5%	1.1%	1.7%	3.6%
Unknown	-	7.1%	0%	0%	20%
Education					
Primary	22%	21%	21%	32%	17%
Secondary	57%	57%	66%	59%	45%
<Primary	15%	15%	6.0%	6.5%	30%
Technical	2.0%	2.5%	2.7%	0.9%	2.0%
Tertiary	1.5%	1.3%	3.4%	0.9%	0%
None	2.5%	3.3%	0%	0.9%	6.0%
Firms					
N	197	150			
Apprentices trained					
Total	5.4 (4.7)	5.5 (6.0)			
Selected	1.20 (1.82)	1.10 (1.55)			
Not Selected	1.47 (2.68)	1.41 (2.86)			
Did Not Apply	2.7 (3.1)	2.8 (3.1)			
Firm size					
Total (calculated)[1]	8.1 (7.3)	8.1 (8.5)			
Total (reported)	6.7 (7.5)	6.6 (7.1)			
Apprentices	5.4 (4.7)	5.5 (6.0)			
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%			

N; Mean (SD);

[1] Calculated by author by summing number of partners, permanent employees, paid and unpaid family workers, occasional workers, and apprentices reported to be working for MC (total firm size reported separately).

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, 97.18% of firms employed a total of five or less (including the owner) at baseline and 99.53% 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 (Frazer, 2006, Velenchik (1995)). Moreover, the workforce of the average firm in the sample is domi-

nated by apprentices: at baseline, the average firm employs about four apprentices for every other type of employee (81.86% of calculated firm size at baseline and 85.45% 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[3]. 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 A3 in the Appendix likewise suggests that firm attrition was not correlated with key firm characteristics such as trade or the

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

number of CQP applicants (selected or non-selected).

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).

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 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%).

2.3 Estimating Apprentice Benefits

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

Human capital gains 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.

Competence 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 **??**). Apprentices are evaluated on each task by their master trainer[4] on a binary scale: they are either competent at realizing a given task (competence metric) or have already realized a given task in the past (experience metric), or not.

The knowledge score is based on a short battery of questions drawn from the official competence charts for each trade and posed directly to the apprentices. Each question

[4]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

was a multiple choice question, and between 4 and 5 knowledge questions were posed to each apprentice. The knowledge questions are reproduced in Appendix **??**. 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.

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. Allowances are transfers from the MC to the apprentices and cover general expenses, in which case they are often referred to as "pocket money" or "chop money", as well as specific expenses such as meals or transportation costs. These are described in greater detail in the next section.

2.4 Estimating Firm Benefits

Table 3: Components of net benefit accounting

			Model				
	Estimate	**Assumptions**	**I**	**II**	**III**	**IV**	**V**
Benefits							
Annual fees	Total fees / 4	Four year training duration	×	×	×	×	×
Annual apprentice productivity	Average of monthly wages of experienced and inexperienced employee × # of months/year operational	Wages equal to productivity. Apprentice prod. equal to that of untrained employees for first two years and trained employee for final two years			×	×	×
Costs							
Annual allowances	Daily allowances × 20 days × # of months/year operational	Apprentices work 20 days/month	×	×	×	×	×
Annual training expenses	Total monthly training expenses / # of apprentices × # of months/year operational	All reported training expenses are recurring		×		×	×
Annual lost trainer productivity	Monthly wages of experienced employee × estimated hours of training per month × # of trainers/apprentice × # of months/year operational	Wages equal to productivity. All trainers in firm stop working simultaneously when firm pauses activities to train apprentices.					×

Firm benefits were calculated using the accounting approach (Gambin et al., 2013; Mühlemann and Wolter, 2014), which relies on survey data from training firms to identify and quantify the costs and benefits arising from training provision. It has only recently started being applied in lower-middle income countries (Bolli et al., 2020, 2021; Renold et al., 2018). The accounting approach subtracts the costs of training from its benefits and is a simple way of estimating the value that training apprentices generates for the training firm. In a second step, we use regression analysis to assess the impact of hiring additional apprentices, both traditional and CQP dual trainees, on firm outcomes.

The components of the accounting approach used in this study are summarized in Table 3. Firms receive two primary benefits from training apprentices: apprenticeship fees and the apprentices' productive contributions to the firm. Training fees can be paid in full before the commencement of training or split into payment at the beginning, dur-

ing, and at the conclusion of training (Velenchik, 1995). Five categories of fees were reported by both apprentices and MCs: entry fees, formation (or general training) fees, liberation (or graduation) fees paid at the conclusion of training, fees as compensation for the materials and equipment used in training, contract fees, and application fees[5]. Fees were reported as the total paid for the entirety of the apprenticeship; we assume four-year apprenticeships to estimate annual ammounts.

The second benefit of training for firms, apprentices' net productive contributions, were not reported explicitly by the firm owners and thus needed to be estimated with the aid of several assumptions. First, we assume the competitive model of labor markets (with heterogeneous wages), in which workers are paid the marginal product of their labor. Second, 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 for the final two years[6], and we use detailed wage information reported by firm owners to estimate the average annual productivity over the course of a four-year apprenticeship. Under these assumptions, the annual productive value generated by apprentice work amounts to the average of these two wages.

Costs of apprenticeship for the firm are categorized into three categories: allowances, training expenses, and lost trainer productivity.

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

[5]Fees are often paid in kind rather than in cash.

[6]This is a simplification of the approach used by @bolli2020, in which apprentice productivity is estimated to increase linearly from that of an unskilled worker to that of a skilled worker between defined points in their training. 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.

months the training firm was operating in the past year to arrive at an annual estimate for each apprentice.

To identify the 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.

Lost trainer productivity is, like apprentice productivity, estimated using wage data. Hourly wages for skilled employees were calculated from monthly wage data and multiplied by the number of hours that the workshop stopped all productive activities to train apprentices in the previous week, as reported by MC. This estimate is burdened by the largest number of assumptions: it is uncertain whether all employees who train apprentices in the firm (a number reported by the MC) stop work entirely while the workshop takes a break to train; whether the majority of lost productivity occurs during these breaks, or in the otherwise normal operation of the firm during which they must also tend to the apprentices. Moreover, the total duration of these breaks in the past week is a very small sample from which to extrapolate to annual costs. Lacking a better method, we report these estimates as the final cost component.

Net benefits were calculated by subtracting some or all of the costs listed above from some or all of the benefits. The simplest model, Model I in 3 above, 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. Models II and III add training expenses and estimated apprentice productivity, respec-

tively, while Model IV combines all four components. Model V includes all costs and benefits, including lost trainer productivity.

Finally, we estimate the effect dual training on firm size and profits by running a 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 4: Change in apprentice human capital

	N	Baseline	N	Endline	Difference	p-value[3]
Competence[1]						
Electrical Installation	125	0.80 (0.24)	69	0.96 (0.09)	0.09	<0.001
Masonry	90	0.75 (0.22)	39	0.90 (0.18)	0.14	0.008
Carpentry	48	0.76 (0.28)	21	0.93 (0.15)	0.12	0.14
Plumbing	54	0.73 (0.29)	26	0.92 (0.15)	0.15	0.008
Metalwork	86	0.75 (0.22)	38	0.86 (0.21)	0.09	0.006
CQP Selected	143	0.81 (0.21)	82	0.95 (0.11)	0.11	<0.001
CQP Not Selected	95	0.84 (0.19)	56	0.94 (0.10)	0.06	0.017
Did Not Apply	165	0.68 (0.28)	55	0.84 (0.22)	0.16	<0.001
Overall	**403**	**0.76 (0.24)**	**193**	**0.92 (0.16)**	**0.11**	**<0.001**
Experience[1]						
Electrical Installation	125	0.77 (0.26)	69	0.96 (0.08)	0.11	<0.001
Masonry	90	0.72 (0.23)	39	0.91 (0.13)	0.20	<0.001
Carpentry	48	0.73 (0.31)	21	0.98 (0.06)	0.19	0.013
Plumbing	54	0.66 (0.30)	26	0.89 (0.17)	0.21	0.001
Metalwork	86	0.72 (0.24)	38	0.85 (0.15)	0.13	0.004
CQP Selected	143	0.78 (0.24)	82	0.93 (0.11)	0.15	<0.001
CQP Not Selected	95	0.80 (0.21)	56	0.94 (0.11)	0.10	0.001
Did Not Apply	165	0.65 (0.29)	55	0.87 (0.16)	0.21	<0.001
Overall	**403**	**0.73 (0.26)**	**193**	**0.92 (0.13)**	**0.15**	**<0.001**
Knowledge[2]						
Electrical Installation	77	0.90 (0.16)	49	0.93 (0.10)	0.01	0.4
Masonry	56	0.76 (0.19)	30	0.83 (0.20)	0.01	0.8
Carpentry	25	0.91 (0.18)	15	0.97 (0.09)	0.05	0.3
Plumbing	38	0.52 (0.12)	26	0.64 (0.16)	0.11	0.013
Metalwork	209	0.85 (0.18)	117	0.88 (0.15)	0.00	0.8
CQP Selected	144	0.75 (0.20)	84	0.80 (0.18)	0.03	0.10
CQP Not Selected	103	0.79 (0.22)	59	0.84 (0.19)	0.02	0.5
Overall	**247**	**0.77 (0.21)**	**143**	**0.81 (0.19)**	**0.03**	**0.078**

Mean (SD).

[1] Percent of trade-specific tasks apprentice is deemed competent in (competence) or has already successfully attempted (experience), as reported by MC. Total of 10-15 tasks, depending on trade.

[2] Percent of trade-specific knowledge questions answered correctly by apprentice. Total of 4 or 5 questions, depending on trade. Not available for apprentices who did not apply to the CQP, as they were not interviewed personally.

[3] Paired t-test

First, we investigate whether dual training was successful in realizing its primary objective — increasing the human capital of the apprentices. To do so, we study the changes in the three human capital indices described in Section 2.3 over the observed training period of three years. The changes in the human capital index scores presented in Table 4 indicate that informal apprenticeship training is successful in improving sector-specific human capital of the youth in our sample, both for dual training participants and traditional apprentices: overall competence scores increased by 0.46 baseline standard deviations (SDs), experience scores by 0.58 SDs, and knowledge by 0.13 SDs. Significant improvements in competence and experience are observed for apprentices who participated in, unsuccessfully applied to, and did not apply to the CQP alike, though apprentices who did not apply to the CQP show the largest gains in competence and experience as assessed by their MC. This result is in line with the observation that MCs appear to send relatively experienced youth to apply for dual training.

A paired t-test also indicates significant improvements in competence and experience between baseline and endline across all trades (improvement in competence for plumbing apprentices is marginally insignificant at standard significance levels). On the other hand, gains in the knowledge metric are not statistically significant for any trades except plumbing - hence, the overall increase in knowledge is driven by results from a single trade. As the average knowledge scores at baseline were significantly lower for plumbing apprentices than for apprentices in other trades, this result may indicate a shortcoming in the metric itself, which was composed of only up to five questions which did not seem to pose a major challenge for most apprentices not in the plumbing trade. Improvement in knowledge was marginally significant ($p < 0.10$) for CQP participants but not for unsuccessful CQP applicants ($p < 0.5$).

Although mean human capital accumulation is higher for participating CQP apprentices than non-selected CQP applicants across the three indices, this does not translate into statistically significant differences between the two group (Table A5 in the Ap-

pendix). Nor do we observe a significant effect of dual training on the competence and experience indices when apprentices who did not apply to the CQP are added to the control group. To check if apprentices agree with their MC's assessments of their ability, a self-assessment was included in the apprentice survey at endline. Table A6 in the Appendix suggests that the two assessments are in general agreement for both the experience and competence index.

Table 5: Effects of training on human capital development

	Experience			Competence			Knowledge		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CQP Selected (reference)									
CQP Not Selected	−0.02	−0.01	−0.01	−0.004	0.01	0.02	0.002	−0.01	−0.001
	(0.03)	(0.04)	(0.05)	(0.03)	(0.04)	(0.05)	(0.03)	(0.04)	(0.05)
CQP Did Not Apply	−0.05	−0.05	−0.06	−0.09***	−0.07*	−0.08*			
	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)			
Endline	0.21***	0.19***	0.18***	0.14***	0.13***	0.11**	0.06*	0.08*	0.05
	(0.03)	(0.05)	(0.05)	(0.03)	(0.05)	(0.05)	(0.03)	(0.05)	(0.04)
CQP Selected x Endline		0.02	0.03		0.05	0.04		−0.04	−0.01
		(0.07)	(0.07)		(0.07)	(0.08)		(0.07)	(0.06)
CQP Did Not Apply x Endline		0.03	0.10		−0.03	0.08			
		(0.07)	(0.08)		(0.07)	(0.08)			
Baseline Experience[1]	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.02	0.02	−0.001
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)
Years of Schooling	0.005	0.01	−0.01	0.02	0.02	0.01	0.001	−0.0002	0.01
	(0.02)	(0.02)	(0.04)	(0.02)	(0.02)	(0.04)	(0.03)	(0.03)	(0.03)
Firm Size[2]	0.01***	0.01***	0.04	0.01***	0.01***	0.05	0.01***	0.01***	0.004
	(0.002)	(0.002)	(0.04)	(0.002)	(0.002)	(0.04)	(0.003)	(0.003)	(0.04)
Total Apprentices in Firm	0.54***	0.53***	0.52**	0.57***	0.56***	0.44**	0.64***	0.65***	0.73***
	(0.05)	(0.05)	(0.20)	(0.05)	(0.05)	(0.21)	(0.06)	(0.06)	(0.21)
Firm FE	NO	NO	YES	NO	NO	YES	NO	NO	YES
Observations	228	228	228	228	228	228	148	148	148
R^2	0.35	0.35	0.77	0.32	0.32	0.73	0.08	0.09	0.89
F Statistic	20.00***	15.00***	3.60***	17.00***	13.00***	2.90***	2.60**	2.20**	4.20***

Note: *p<0.1; **p<0.05; ***p<0.01
[1]Years of training prior to baseline survey
[2]Excluding apprentices.

The estimated effects of training presented in Table 5 confirm that apprentice human capital increases after three years, as measured by the three indices, and that apprentices who do not apply to the CQP program score lower to begin with. Higher baseline experience and competence scores for CQP applicants suggest that trainers send their more able apprentices to apply for dual training. The selection process for the program

itself, however, does not favor more experienced apprentices according to our metrics (i.e. is as good as random).

Participation in the CQP program is shown to have no detectable effect on human capital accumulation; in fact, when controlling for individual effects, we find that apprentices who did not apply to the CQP make larger gains on the competence and experience indices relative to non-selected CQP applicants, while CQP participants do not (columns (3) and (6) in Table 5). The regression estimates also suggest that apprentice experience and the number of other apprentices training in the firm are correlated with somewhat higher index scores. Table A7 in the Appendix show the same regression estimates using a restricted sample of CQP program applicants (successful and unsucessful) only, with the same result: there is no detectable effect of dual training on apprentice experience or competence.

Table 6: Annual costs and benefits accruing to apprentice

Characteristic	Overall	CQP Selected	CQP Not Selected	Did Not Apply	p-value[3]
Apprentice survey:					
Total Fees	72.02 (47.76)	70.52 (48.98)	74.24 (46.09)	-	0.6
Entry	4.22 (13.77)	3.35 (8.35)	5.52 (19.15)	-	0.3
Formation	41.80 (37.40)	40.32 (35.60)	43.98 (40.02)	-	0.5
Liberation	9.86 (19.87)	10.00 (19.64)	9.65 (20.32)	-	>0.9
Materials	6.97 (8.48)	7.31 (9.39)	6.47 (6.94)	-	0.4
Contract	6.32 (15.24)	6.42 (15.67)	6.17 (14.65)	-	>0.9
Application	2.85 (3.94)	3.12 (4.14)	2.45 (3.61)	-	0.2
Allowances[1]	207.28 (289.76)	206.68 (319.95)	208.09 (245.55)	-	>0.9
Allowances net fees[2]	**134.17 (310.94)**	**141.60 (348.47)**	**123.60 (249.63)**	**-**	**0.7**
Firm survey:					
Total Fees	66.06 (44.54)	52.53 (36.63)	56.72 (38.85)	83.08 (48.31)	<0.001
Entry	2.74 (4.11)	2.33 (3.30)	2.82 (5.29)	3.03 (3.91)	0.3
Formation	35.95 (38.04)	20.10 (27.58)	29.04 (33.19)	53.47 (41.22)	<0.001
Liberation	9.26 (18.70)	9.44 (18.61)	7.26 (17.86)	10.30 (19.28)	0.4
Materials	6.56 (9.31)	6.35 (9.47)	6.20 (8.83)	6.95 (9.49)	0.8
Contract	8.46 (16.92)	11.01 (18.70)	8.70 (17.52)	6.18 (14.60)	0.050
Application	3.09 (4.24)	3.30 (4.25)	2.70 (4.00)	3.14 (4.38)	0.6
Allowances	278.07 (388.14)	243.10 (412.21)	341.82 (458.15)	272.50 (332.72)	0.3
Food	70.57 (147.07)	61.57 (158.26)	89.31 (190.63)	68.07 (113.25)	0.5
Transport	60.88 (195.20)	46.23 (188.52)	79.61 (227.49)	62.18 (184.29)	0.6
Pocket money	145.96 (183.74)	135.30 (169.17)	172.89 (197.68)	140.85 (186.83)	0.5
Other	0.65 (10.64)	0.00 (0.00)	0.00 (0.00)	1.39 (15.52)	0.6
Allowances net fees[2]	**345.30 (406.83)**	**304.02 (444.23)**	**384.89 (476.66)**	**354.07 (346.81)**	**0.5**

Mean (SD). Amounts in $US per apprentice per year, calculated using responses from baseline survey. Annual fees assume apprenticeship duration of four years.

[1] Apprentices were only asked about total allowances received.

[2] Rows missing all allowance or all fee data were excluded from net benefit calculation. Mean net benefit may deviate from difference in mean allowances and mean fees as a result.

[3] Student's t-test for apprentice survey data, analysis of variance for firm survey data

We also estimate the apprentices' net cost of training, taking into account material costs in the form of the various training fees, and material benefits in the form of various allowances disbursed by the MC over the course of the training period, as outlined in Section 2.3. Table 6 showing annual fees and allowances reported by both the apprentice and MC indicate that trainees in fact receive more in allowances from their trainer than they (or their parents) pay in total fees (assuming a four-year training duration). Formation, or general training, fees comprise the largest sum transfer from the apprentice to the MC. Apprentices report significantly higher fees than the MC, for the training fee in particular. Firms may underreport fees to avoid accusations of gauging, but are at the same time likely to have more direct knowledge of all fees than apprentices, whose

parents and relatives usually pay the craftsmen directly.

Overall, apprentices are estimated to receive about 80,000 FCFA (134 $US) more in allowances than they pay in fees annually, according to their own estimates; MCs estimate this number to be as much as 210,000 FCFA annually (345 $US). MCs report that about half of all allowances are in the form of general "pocket money".

CQP participants do not report higher fees or allowances than unsuccessful applicants, while MCs report significantly different sums paid by non-applicants in fees, especially for formation (general training) fees. We observe no statistically significant difference between allowances disbursed to CQP participants relative to the other two groups.

3.2 Impact of Informal and Dual Training on Firms

Table 7: Annual costs and benefits per apprentice accruing to firm

Characteristic	N	Overall	CQP Selected	CQP Not Selected	Did Not Apply	p-value[2]
Benefits						
Fees[1]	403	65.30 (44.66)	50.74 (36.67)	57.68 (39.33)	83.08 (48.31)	<0.001
Entry	391	2.74 (4.11)	2.33 (3.30)	2.82 (5.29)	3.03 (3.91)	0.3
Formation	391	35.95 (38.04)	20.10 (27.58)	29.04 (33.19)	53.47 (41.22)	<0.001
Liberation	391	9.26 (18.70)	9.44 (18.61)	7.26 (17.86)	10.30 (19.28)	0.4
Materials	391	6.56 (9.31)	6.35 (9.47)	6.20 (8.83)	6.95 (9.49)	0.8
Contract	391	8.46 (16.92)	11.01 (18.70)	8.70 (17.52)	6.18 (14.60)	0.050
Application	391	3.09 (4.24)	3.30 (4.25)	2.70 (4.00)	3.14 (4.38)	0.6
Apprentice prod.	114	1,075.59 (1,172.98)	869.20 (1,050.46)	1,246.57 (1,294.84)	1,118.48 (1,183.45)	0.4
Total	**104**	**1,140.89 (1,198.06)**	**939.01 (1,059.45)**	**1,302.16 (1,343.08)**	**1,195.75 (1,212.34)**	**0.5**
Costs						
Allowances[1]	360	489.37 (1,021.21)	583.89 (1,398.96)	632.85 (949.56)	272.50 (332.72)	0.012
Food	266	70.57 (147.07)	61.57 (158.26)	89.31 (190.63)	68.07 (113.25)	0.5
Transport	266	60.88 (195.20)	46.23 (188.52)	79.61 (227.49)	62.18 (184.29)	0.6
Pocket money	266	145.96 (183.74)	135.30 (169.17)	172.89 (197.68)	140.85 (186.83)	0.5
Other	266	0.65 (10.64)	0.00 (0.00)	0.00 (0.00)	1.39 (15.52)	0.6
Training costs	229	110.69 (233.24)	110.95 (251.60)	149.32 (249.61)	82.63 (196.58)	0.2
Rent	229	26.83 (59.79)	24.18 (52.84)	40.90 (80.34)	19.55 (47.29)	0.10
Equipment	226	32.61 (81.94)	24.75 (50.81)	56.15 (129.04)	24.98 (63.74)	0.046
Books	224	8.93 (44.17)	7.65 (40.66)	12.32 (51.90)	7.96 (42.41)	0.8
Raw materials	223	44.10 (140.23)	55.07 (187.93)	46.60 (107.48)	30.62 (92.12)	0.5
Lost trainer prod.	245	36.08 (45.78)	37.68 (47.11)	30.40 (38.00)	37.97 (48.74)	0.6
Total	**96**	**666.56 (698.44)**	**676.45 (673.07)**	**876.90 (805.36)**	**464.40 (582.52)**	**0.082**
Net Benefits						
Model I	341	-437.12 (1,047.68)	-547.64 (1,422.47)	-588.98 (979.25)	-195.68 (337.65)	0.008
Model II	198	-480.28 (661.41)	-571.18 (764.74)	-638.96 (670.01)	-237.96 (413.50)	0.001
Model III	75	726.77 (1,275.80)	444.72 (1,169.03)	811.85 (1,468.62)	1,005.74 (1,162.53)	0.3
Model IV	31	631.55 (1,406.07)	78.33 (1,264.37)	1,209.68 (1,683.05)	588.84 (691.70)	0.14
Model V	28	686.67 (1,378.91)	-8.33 (1,298.95)	1,525.25 (1,460.55)	580.85 (688.28)	0.031

Mean (SD). Amounts in $US per apprentice per year. Calculated using responses from baseline survey, except training costs which were not elicited until endline. Net benefits not computed for rows missing data for any of the categories used included in a given model (some combination of fees, apprentice productivity, allowances, training costs, and lost trainer productivity). Mean net benefit may deviate from sum of means of the relevant categories as a result.

[1] Fees and allowances reported by firm owner. Annual fees assume apprenticeship duration of four years, annual allowances assume apprentices work 20 days a month.

[2] Analysis of variance

Next, we study the net benefits accruing to firms from apprenticeship training, and whether the presence of dual-system apprentices in the firm impacts productivity relative to firms with fewer or no CQP participants. To measure benefits in the accounting sense, we refer to two categories of benefits — fees and apprentice productivity — and three categories of costs — allowances, training costs, and lost trainer productivity — as measured at baseline and described in detail in Section 2.4. Because productivity and training costs are particularly sensitive to assumptions and prone to non-response

issues, these categories are combined in different permutations to give the five "models" referenced in Table 3.

We first analyze net benefits per apprentice. Table 7 estimates the annual costs and benefits per apprentice for each category and subcategory for all sample apprentices in the first column, using baseline responses; for successful and unsuccessful applicants to the CQP in the second and third columns, respectively; and for non-applicants in the fourth column. It shows that apprentice productivity (a benefit to the firm) and apprentice allowances (a cost to the firm) are the most important factors in determining whether an apprentice contributes a net benefit to the training firm. Estimated net benefits per apprentice range from -437 $US to 687 $US per apprentice per year, depending on the model used. The sign of the estimate depends on the inclusion of apprenticeship productivity (not included in Models I and II; included in Models III-V). Training fees are significantly higher and allowances are significantly lower for apprentices who did not apply to the CQP, resulting in higher net benefits for this subgroup.

Next, we look at the individual categories in more detail. Formation 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. In contrast to the dual training program studies by Crépon and Premand (2019), the CQP program did not eliminate fees or directly subsidize apprentices.

Fees: We observe significant differences between apprentice types for overall fees (driven by higher training fees for dna) and contract fees (higher fees for CQP applicants), but not total benefits. A t-test for differences between the CQP participants and CQP applicants shows that formation fees are significantly higher (but only $9 difference annually) for unsuccessful CQP applicants; otherwise benefits are not measureably different (though nearly $400 higher for CQP non-selected, driven by productivity.)

Apprentice productivity: trainee productivity is calculated using firm-level wage information, an approach similar to apprenticeship cost-benefit studies by Wolter and Mühlemann (2015), Mühlemann et al. (2018), Bolli et al. (2020), and Bolli et al. (2021) and described in Section 2.3. The annual productivity estimates reported in Table 7 are based on the number of months the training firm reported being open in the previous year and are an order of magnitude higher than the estimated annual benefits from training fees. Because many small firms did not report the wage data necessary to estimate apprentice productivity, however, apprentice productivity can only be estimated for about a quarter of the sample. The estimated productivity for CQP apprentices is lower than for other trainees, but the difference is not statistically significant.

Allowances: annual allowances are estimated by multiplying the total firm-reported daily allowances for each apprentice by an assumed 20 days worked a week and the reported number of months open in the previous year. Alternative estimates using different workload assumptions and apprentice responses are shown in Table A9 and Table A10.

Table 7 shows that allowances disbursed to CQP participants and CQP applicants are estimated to be significantly higher than those disbursed to non-applicants. This suggests that older and more experienced apprentices receive higher remuneration (i.e. are already more productive when they apply to the program). (There is no difference between CQP apprentices and unsuccessful CQP applicants). CQP apprentices train, on average, in firms which pay less for equipment (whether only unsuccessful CQP appli-

cants are all other apprentices are the control group), suggesting that the dual system may be preferred by firms with less access to machinery and capital.

Training costs: Table 7 estimates that firm training expenditures, including materials and equipment costs, are an order of magnitude smaller than total allowances on a per-apprentice basis. There is no difference between types of apprentices. 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.

The various costs of training reported by the MCs are depicted per apprentice in Figure A2 in the Appendix. 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 **??** 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.

Trainer productivity: similar to apprentice productivity, lost trainer productivity due to work stoppages is estimated using firm-level wage information and the number of months the training firm reported being open in the previous year. It also extrapolates from the reported number of hours of training on the last day the firm stopped all activities to train apprentices and the estimated number of days per week such a

stoppage takes place (multiplied by an assumed four weeks per month that the firm is open).

Thus estimated, lost trainer productivity per apprentice is on the same order as the total other training costs (about 30 $US per year) and an order of magnitude smaller than the allowances disbursed by the MCs to each apprentice. Lost productivity is comparable for CQP participants, applicants and non-applicants.

Net benefits: estimated mean benefits per apprentice ranges from -404.86 $US per year to 403.62 $US per year, depending on the model used. Whether our estimate returns positive or negative net benefits hinges on the inclusion of apprentices' productive contributions: Models I and II exclude this factor, resulting in drastically lower estimated benefits.

The distributions of per-apprentice net benefits have long left tails for Models I and II and long right tails for Models III-V (plotted with their means in Figure A4 in the Appendix). The left tails are a consequence of the high number of apprentices in a number of firms generating unrealistic annual allowance totals; these are more than compensated by apprentice productivity estimates when included in Models III-V, skewing the distribution to the right for these models.

For models excluding apprentices' productive contributions to the firm (Model I and Model II), we find that apprentices who applied to the CQP program (Selected and Not Selected) are significantly more costly to train (incur higher net costs) on average than non-applicants, on account of the higher allowances MCs report they receive. There is no difference between Selected and Not Selected.

Estimates for Models III-V are only available for a small number of apprentices due to the requirement that net benefits only be computed when data for all cost and benefit categories included in the respective model are available. The variance in benefits is high, ranging 4007.02 $US to net costs of 2005.37 $US per apprentice per year. Mean net benefits per apprentice per year range from -8.33 $US to 444.72 $US for CQP appren-

tices, 1525.25 $US to 811.85 $US for unsuccessful CQP applicants, and 580.85 $US to 1005.74 $US for non-applicants. Though large in magnitude, the differences in means between the three groups are not statistically significant for Models III and IV due to the limited sample and high variance. Model V, which includes all cost and benefit categories, generates statistically different estimates for net benefits for the three categories: CQP apprentices are nearly break-even, while unsuccessful CQP applicants generate benefits of -8.33 $US and non-applicants generate 580.85 $US. This is only based on a total sample of 28 observations, however.

CQP participants generate significantly lower benefits when unsuccessful CQP applicants only are used as the comparison group according to Models IV and V (A12.

Only 5-11% of apprentices generate positive net benefits when productivity is left unaccounted for; this rises to about 70% (at baseline) for Models III-V. According to Model I, 11.14% and 11.88% of apprentices are estimated to generate a positive net benefit during training at baseline and endline, respectively; using Model II, 5.05% and 8.91% of apprentices are estimated to do so; using Model III, 70.67% and 66.67% of apprentices are estimated to do so; using Model IV, 70.97% and 45.61% of apprentices are estimated to do so; using Model V, 67.86% and 42.31% of apprentices are estimated to do so.

Further tabulations can be found in the Appendix: Table A13 shows baseline and endline results, while Table A14 reports cost and benefit estimates by trade.

Table 8: Annual net benefits per firm

		Firm size[1]			
	Overall, N = 192	(**1,4**], N = 54	(**4,6**], N = 51	(**6,10**], N = 44	(**10,107**], N = 43
Firm Accounts					
Revenues	3,919 (4,754)	2,059 (1,656)	2,700 (2,301)	4,034 (5,233)	7,815 (6,745)
Wage bill	991 (2,379)	272 (473)	610 (958)	783 (994)	2,594 (4,499)
Non-wage expenses	1,443 (2,596)	810 (734)	968 (1,306)	1,473 (2,037)	2,762 (4,583)
Total expenses	2,441 (4,136)	1,082 (959)	1,590 (1,786)	2,256 (2,615)	5,397 (7,376)
Profits (reported)	1,678 (2,648)	951 (966)	1,374 (1,247)	1,567 (1,957)	3,144 (4,751)
Profits[2] (calculated[2])	1,681 (3,055)	993 (1,390)	1,393 (1,776)	1,861 (4,551)	2,787 (3,556)
Projected benefits					
Fees	350 (367)	116 (102)	248 (177)	374 (249)	715 (518)
Apprentice prod.	8,540 (13,118)	191 (165)	1,405 (1,344)	2,804 (3,099)	17,280 (16,049)
Total	9,080 (13,324)	363 (255)	1,480 (1,422)	3,148 (3,203)	17,860 (16,023)
Projected costs					
Allowances	3,237 (7,778)	871 (2,083)	2,177 (3,577)	2,681 (4,607)	7,823 (14,026)
Training costs	518 (1,122)	191 (322)	395 (542)	810 (1,887)	837 (1,239)
Lost trainer prod.	183 (423)	72 (86)	100 (103)	136 (190)	423 (768)
Total	3,190 (4,441)	927 (626)	2,302 (2,299)	5,566 (8,254)	5,546 (3,806)
Net benefits					
Model I	-2,975 (7,798)	-774 (2,180)	-1,954 (3,586)	-2,324 (4,536)	-7,187 (14,014)
Model II	-3,199 (8,563)	-574 (518)	-2,163 (2,403)	-3,267 (5,625)	-8,315 (16,940)
Model III	5,724 (12,157)	-571 (792)	-110 (1,224)	1,134 (4,091)	11,488 (15,537)
Model IV	6,431 (12,457)	-1,039 (757)	-574 (1,290)	1,225 (6,979)	11,520 (14,510)
Model V	6,593 (12,285)	-1,108 (777)	-617 (1,296)	4,001 (4,911)	11,187 (14,678)

Mean (SD). Net benefits per firm estimated using baseline data. Projected costs, benefits, and net benefits calculated as mean values for all observed apprentices in firm times reported number of apprentices trained. Amounts in $US.

[1] Firms size calculated by author as sum of all reported workers in firm, including apprentices and occasional and family workers.

[2] Profits recalculated by author as difference between reported revenues (first row) and reported expenses (second row).

In Table **??**, we also investigate the total net benefits from training accruing to the firm. We do this by averaging apprentice-level fee and allowance data for each firm and multiplying it by the total number of apprentices training in that firm (training costs were already reported at the firm level, while apprentice and trainer productivity estimates were based on firm-level wages and training schedules). We arrive at estimated firm-level net benefits of training by combining the various categories of costs and benefits using Models I-V from before.

Mean estimated benefits per firm average range from -2409.23 $US per year to 3180.04 $US per year, with the large variance in estimates driven once more by apprentice productivity estimates. Table **??** reports estimates by firm size, showing

that the largest firms in the sample, through significantly higher reported wages, have significantly higher estimated apprentice productivity.

Allowances are, as in the individual-level estimations, by far the largest cost related to training. Firm-level aggregation suggests that our methodology may in fact overestimate apprentice allowances: for all but the smallest firms, total estimated allowances are on average higher than total firm expenditures reported by the firm.

As with the individual-level estimates, the majority of firms are clustered around zero net benefits for all cost-benefit models, with long left and right tails depending on the model used. Models I and II exhibit long left tails, while models III-V have long right tails, albeit for fewer observations (plotted with their means in Figure A5 in the Appendix).

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, -1940.17 $US using Model I, -2409.23 $US using Model II, 3180.04 $US using Model III, 959.22 $US using Model IV, and 1254.27 $US using Model V.

According to Model I, 6.09% and 3.33% of firms are estimated to earn a positive net benefit from training (positive net benefits) at baseline and endline, respectively; using Model II, 1.02% are estimated to do so at baseline and 2.67% at endline, using Model III, 9.64% are estimated to do so at baseline and 11.33% at endline; using Model IV, 2.03% are estimated to do so at baseline and 8% at endline; using Model V, 1.52% are estimated to do so at baseline and 4.67% at endline.

Apprentice training 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 1.78 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 3.17. At the low-benefit extreme (Model II), the average ratio of total net training benefits to total firm revenues is 0.41 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 3.41.

Using calculated instead of reported profits, the average ratio of total net training benefits (Model II) to total firm revenues is 1.66 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 3.17. At the low-benefit extreme (Model II), the average ratio of total net training benefits to total firm revenues is 0.91 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 3.41.

Table 9: Firm-level regressions

	log revenues (USD)		log profits (USD)		log Firm size[1]	
	(1)	(2)	(3)	(4)	(5)	(6)
Non-CQP apprentices	0.03**		0.03		0.02	
	(0.01)		(0.02)		(0.01)	
CQP selected	0.02		0.03		0.03	
	(0.03)		(0.05)		(0.02)	
Total apprentices		0.03***		0.03*		0.002
		(0.01)		(0.02)		(0.01)
Endline	0.48***	0.50***	−0.06	−0.12	−0.05	−0.05
	(0.13)	(0.12)	(0.22)	(0.21)	(0.10)	(0.12)
log Firm size[1]	0.48***	0.54***	0.48**	0.53***		
	(0.11)	(0.10)	(0.19)	(0.16)		
Constant	7.50***	7.40***	6.90***	6.80***	1.20***	1.40***
	(0.18)	(0.16)	(0.29)	(0.27)	(0.08)	(0.10)
Firm FE	NO	NO	NO	NO	NO	NO
Observations	126	134	94	101	142	155
R^2	0.26	0.30	0.10	0.14	0.03	0.002
F Statistic	10.00***	18.00***	2.50**	5.10***	1.60	0.12

Note: *p<0.1; **p<0.05; ***p<0.01
[1]Excluding apprentices.

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).

Pooled OLS estimation results are shown in Columns 1, 3 and 5 of Table **??**, 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 454.58 $US per apprentice per year, and a total of 2409.23 $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 -295.69 $US per apprentice per year, and even a net benefit of 1254.27 $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. How-

ever, 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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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
Primary	91 (22%)	51 (21%)	
Secondary	230 (57%)	136 (57%)	
<Primary	61 (15%)	35 (15%)	
Technical	8 (2.0%)	6 (2.5%)	
Tertiary	6 (1.5%)	3 (1.3%)	
None	10 (2.5%)	8 (3.3%)	
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: Likelihood of apprentice attrition

	All apprentices		Excluding non-applicants	
	(1)	(2)	(3)	(4)
CQP Selected (reference)				
CQP Not Selected	0.22	−0.51	−0.56	−0.85
	(0.26)	(0.42)	(0.45)	(0.62)
CQP Did Not Apply	0.46**	0.18		
	(0.23)	(0.41)		
Masonry (reference)				
Carpentry		0.04	0.52	0.55
		(0.52)	(0.70)	(0.91)
Plumbing		−0.82	−1.10*	−0.72
		(0.51)	(0.66)	(0.89)
Metalwork		0.94	2.50**	2.50**
		(0.60)	(1.10)	(1.30)
Electrical Inst.		−0.37	−0.39	−2.00
		(0.45)	(0.62)	(1.20)
Baseline Experience[1]		0.05	0.001	0.03
		(0.14)	(0.19)	(0.35)
log Firm size[2]		0.37	0.24	0.68
		(0.32)	(0.43)	(0.60)
Apprentices in Firm		−0.03	−0.02	0.05
		(0.03)	(0.04)	(0.06)
Household Size				0.15
				(0.09)
No. of Children				0.59
				(1.30)
Years of Schooling				−0.19*
				(0.12)
Expected finish before 2022				0.10
				(1.10)
Constant	−0.42**	−0.05	0.06	−0.02
	(0.17)	(0.60)	(0.73)	(2.10)
Observations	427	166	101	72
Log Likelihood	−292.00	−107.00	−60.00	−37.00

Note: *p<0.1; **p<0.05; ***p<0.01

The table reports coefficients from logit regressions where the dependent variable is equal to 1 if the apprentice was not observed in the endline survey and 0 otherwise.

[1]Years of training prior to baseline survey

[2]Excluding apprentices

Table A3: Firm attrition

Characteristic	**Baseline**, N = 197	**Endline**, N = 150	**p-value**
Apprentices trained			
Total	5.4 (4.7)	5.5 (4.6)	0.7
Selected	1.20 (1.82)	1.08 (1.55)	0.9
Not Selected	1.47 (2.68)	1.44 (2.84)	0.8
Did Not Apply	2.7 (3.1)	2.9 (3.2)	0.6
Firm size			
Total (calculated)	8.1 (7.3)	8.0 (7.5)	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

Table A4: Likelihood of firm attrition

	attr				
	(1)	(2)	(3)	(4)	(5)
Total apprentices	−0.05				
	(0.05)				
No. of CQP Selected	0.18*	0.15*	0.16	0.26**	0.20**
	(0.11)	(0.09)	(0.11)	(0.13)	(0.10)
No. of CQP Not Selected		0.02	0.03	−0.03	0.01
		(0.06)	(0.06)	(0.07)	(0.06)
No. of CQP Did Not Apply		−0.09	−0.09	−0.19**	−0.11*
		(0.06)	(0.07)	(0.09)	(0.06)
log Annual Profits (reported)			−0.18		
			(0.17)		
log Firm Size[1]				0.25	
				(0.50)	
Masonry (reference)					
Carpentry					−0.38
					(0.60)
Plumbing					−1.30**
					(0.68)
Metalwork					−0.88
					(0.54)
Electrical Inst.					−0.52
					(0.46)
Constant	−1.10***	−1.10***	1.30	−0.89	−0.58
	(0.26)	(0.26)	(2.20)	(0.65)	(0.37)
Observations	182	182	150	85	182
Log Likelihood	−100.00	−100.00	−80.00	−49.00	−97.00

Note: *p<0.1; **p<0.05; ***p<0.01

The table reports coefficients from logit regressions where the dependent variable is equal to 1 if the firm was not observed in the endline survey and 0 otherwise.

[1]Excluding apprentices

Figure A1: Firm size distributions

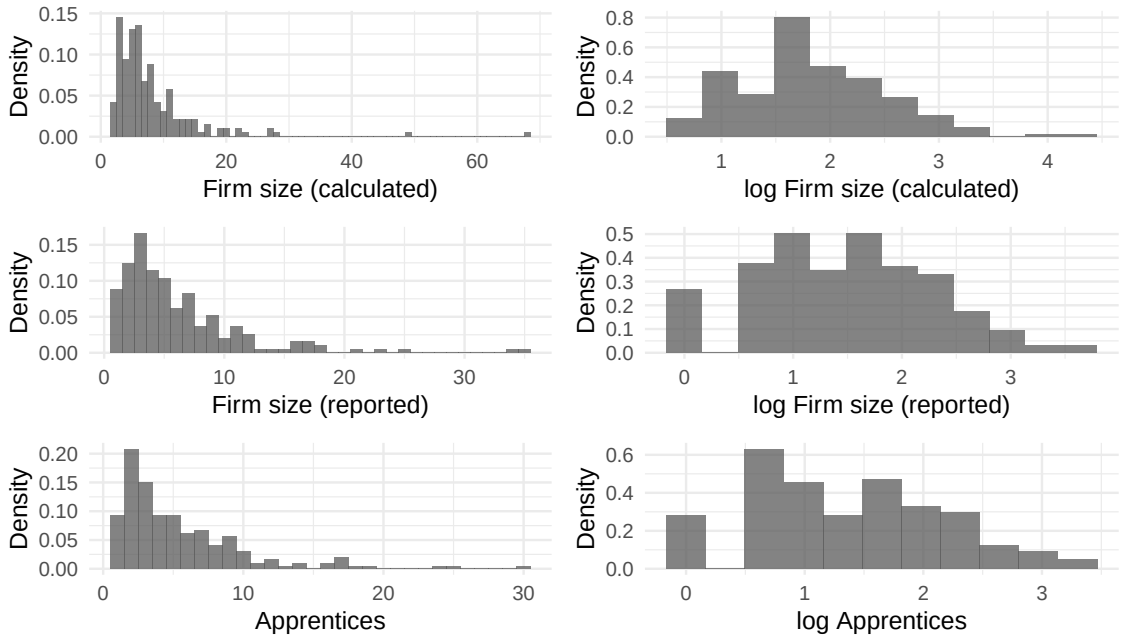


Table A5: Change in apprentice human capital scores

	CQP Selected, N = 150	**CQP Not Selected**, N = 112	**Did Not Apply**, N = 172	**p-value**[3]
Competence[1]	0.110 (0.201)	0.060 (0.165)	0.158 (0.325)	0.12
Experience[1]	0.148 (0.222)	0.104 (0.207)	0.206 (0.314)	0.12
Competence[1]	0.110 (0.201)	0.060 (0.165)		0.3
Experience[1]	0.148 (0.222)	0.104 (0.207)		0.5
Knowledge[2]	0.034 (0.185)	0.017 (0.166)		0.8

Mean (SD). Change in human capital indices between baseline and endline.

[1] Percent of trade-specific tasks apprentice is deemed competent in (competence) or has already successfully attempted (experience), as reported by MC. Total of 10-15 tasks, depending on trade.

[2] Percent of trade-specific knowledge questions answered correctly by apprentice. Total of 4 or 5 questions, depending on trade.

[3] Analysis of variance for three groups, Wilcoxon rank sum test for two groups

Table A6: Competence and experience, MC vs. apprentice assessment

Group	Trade	N	Apprentice	N	Firm	p-value[3]
Competence	Electrical Installation	49	0.97 (0.06)	46	0.98 (0.05)	0.7
	Masonry	28	0.95 (0.08)	28	0.94 (0.10)	>0.9
	Carpentry	14	0.92 (0.13)	16	0.95 (0.08)	0.5
	Plumbing	25	0.95 (0.13)	22	0.92 (0.15)	0.7
	Metalwork	21	0.90 (0.17)	26	0.92 (0.15)	0.4
	CQP Selected	79	0.95 (0.11)	82	0.95 (0.11)	0.6
	CQP Not Selected	58	0.95 (0.10)	56	0.94 (0.10)	0.9
	Overall	**137**	**0.95 (0.11)**	**138**	**0.95 (0.11)**	**0.6**
Experience	Electrical Installation	49	0.97 (0.06)	46	0.97 (0.06)	0.9
	Masonry	28	0.95 (0.09)	28	0.93 (0.11)	0.9
	Carpentry	14	0.95 (0.12)	16	0.99 (0.03)	0.5
	Plumbing	25	0.98 (0.06)	22	0.89 (0.17)	0.019
	Metalwork	21	0.89 (0.16)	26	0.89 (0.11)	0.8
	CQP Selected	79	0.96 (0.10)	82	0.93 (0.11)	0.2
	CQP Not Selected	58	0.95 (0.09)	56	0.94 (0.11)	>0.9
	Overall	**137**	**0.95 (0.10)**	**138**	**0.94 (0.11)**	**0.3**

Mean (SD). Proportion of tasks reported by apprentices and firms at endline. Comparison only possibly at endline as apprentices were not asked to self-assess competence and experience at baseline.

[1] Percent of trade-specific tasks apprentice is deemed competent in (competence) or has already successfully attempted (experience), as reported by MC. Total of 10-15 tasks, depending on trade.

[2] Percent of trade-specific knowledge questions answered correctly by apprentice. Total of 4 or 5 questions, depending on trade.

[3] Wilcoxon rank sum test

Table A7: Effects of training on human capital, excluding CQP non-applicants

	Experience			Competence		
	(1)	(2)	(3)	(4)	(5)	(6)
CQP Not Selected	−0.003	−0.002	0.002	0.003	0.01	0.004
	(0.02)	(0.03)	(0.04)	(0.02)	(0.02)	(0.03)
Endline	0.14***	0.14***	0.12***	0.12***	0.11***	0.07**
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
CQP Selected x Endline		0.003	0.03		0.02	0.05
		(0.04)	(0.04)		(0.04)	(0.03)
Baseline experience[1]	0.04***	0.04***	0.05***	0.03***	0.03***	0.04**
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)
Firm size[2]	−0.01**	−0.01**	−0.01*	−0.002	−0.002	−0.0003
	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)	(0.004)
Total apprentices in firm	0.004**	0.004**	0.03	0.004**	0.004**	0.02
	(0.002)	(0.002)	(0.05)	(0.002)	(0.002)	(0.05)
Constant	0.69***	0.69***	0.62	0.72***	0.72***	0.73*
	(0.03)	(0.03)	(0.43)	(0.03)	(0.03)	(0.39)
Firm FE	NO	NO	YES	NO	NO	YES
Observations	338	338	338	338	338	338
R^2	0.19	0.19	0.75	0.16	0.16	0.75
F Statistic	15.00***	13.00***	2.80***	13.00***	11.00***	2.80***

Note: *p<0.1; **p<0.05; ***p<0.01
Omitted category: CQP Selected.
[1]Years of training prior to 2019.
[2]Excluding apprentices

Table A8: Monthly allowances

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

Mean (SD). Amounts in $US.

Table A9: 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	290.91 (158.68)	284.93 (158.68)	301.90 (158.68)
	mid	316.18 (208.26)	304.39 (208.26)	338.72 (208.26)
	upper	397.15 (257.85)	384.34 (257.85)	421.61 (257.85)
(F) months/year | 20 days/month	lower	249.51 (158.68)	238.87 (145.45)	269.08 (158.68)
	mid	271.07 (168.60)	256.64 (163.64)	298.65 (197.11)
	upper	340.26 (236.36)	324.79 (198.35)	369.81 (257.85)
12 months/year | 4 x (F) weeks/month	lower	343.66 (190.41)	335.06 (190.41)	359.47 (190.41)
	mid	373.36 (249.92)	357.68 (249.92)	403.29 (249.92)
	upper	468.69 (309.42)	451.42 (309.42)	501.69 (309.42)
(F) months/year | 4 x (F) weeks/month	lower	297.10 (185.12)	282.53 (174.55)	323.87 (190.41)
	mid	322.42 (196.36)	303.11 (180.50)	359.30 (240.99)
	upper	404.36 (257.85)	383.22 (226.12)	444.73 (309.42)
12 months/year | 4 x (A) weeks/month	lower	364.41 (222.15)	337.82 (206.28)	451.37 (222.15)
	mid	394.66 (247.60)	360.43 (236.03)	515.74 (291.57)
	upper	496.89 (309.42)	455.98 (277.69)	641.56 (360.99)
firm months | 4 x (A) weeks/month	lower	317.89 (166.61)	287.89 (166.61)	415.98 (166.61)
	mid	344.25 (183.47)	309.03 (180.50)	468.83 (218.68)
	upper	432.46 (239.34)	390.97 (206.28)	579.15 (309.42)

Mean (Median). (F): reported by firm; (A): reported by apprentices. Amounts in $US.

Table A10: 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	199.00 (198.35)	187.81 (158.68)	251.95 (238.02)
	mid	264.77 (238.02)	252.64 (198.35)	322.18 (317.36)
	upper	330.49 (277.61)	317.41 (237.94)	392.33 (396.61)
(F) months/year | 4 weeks/month	lower	164.96 (119.01)	153.26 (115.70)	220.33 (218.18)
	mid	221.36 (158.68)	208.59 (145.45)	281.80 (290.91)
	upper	277.71 (198.27)	263.87 (181.75)	343.20 (363.56)

[1] Mean (Median)

Mean (Median). (F): reported by firm; (A): reported by apprentices. Amounts in $US.

Figure A2: Breakdown of mean annual training costs per apprentice

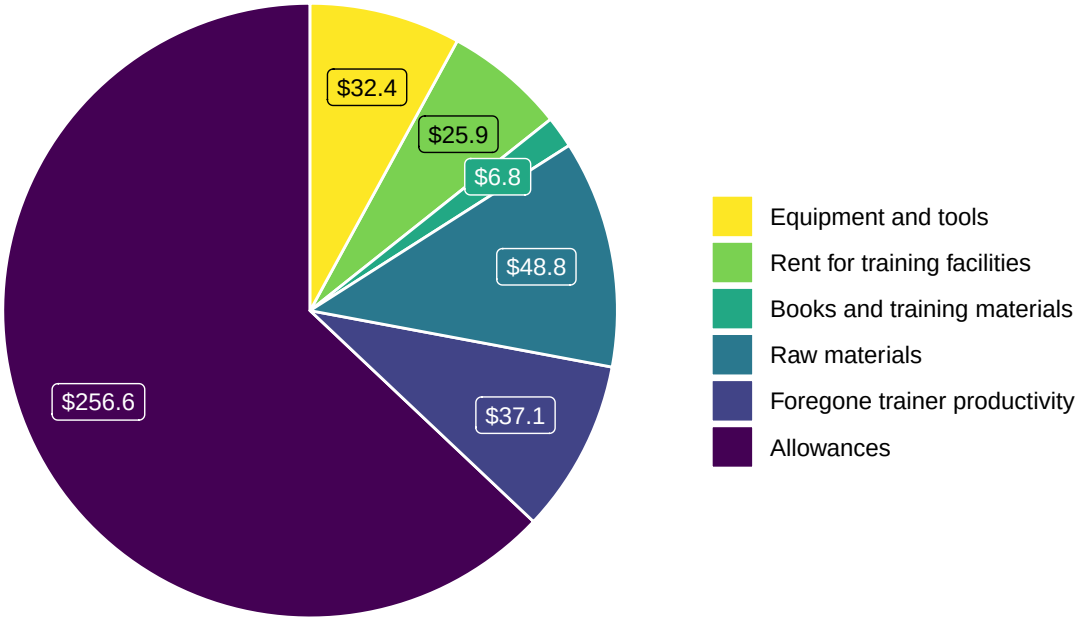


Figure A3: Breakdown of mean annual training costs per firm

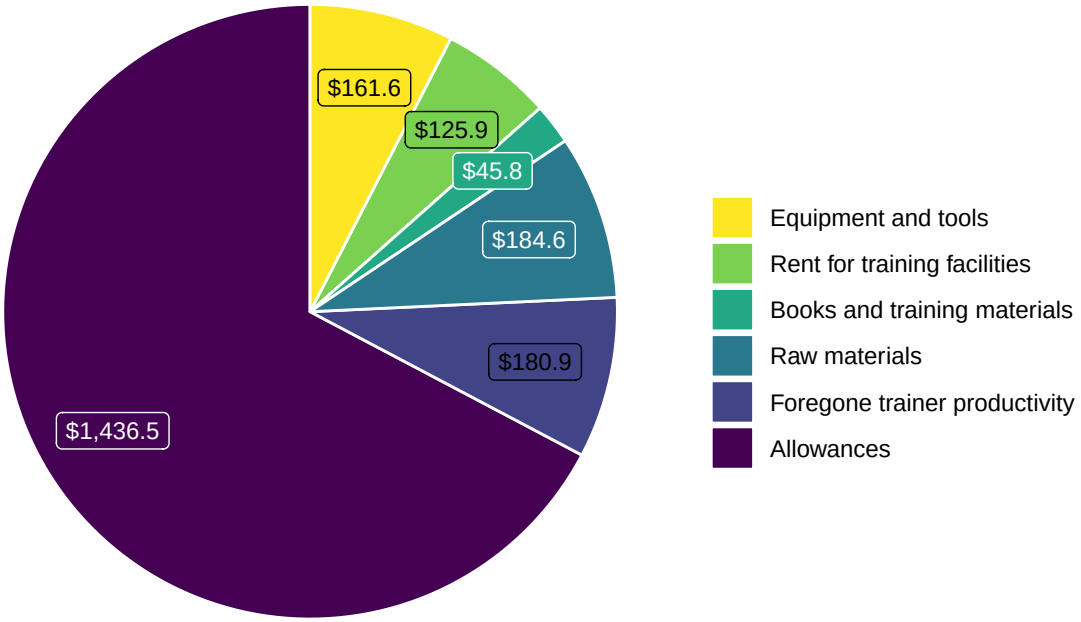
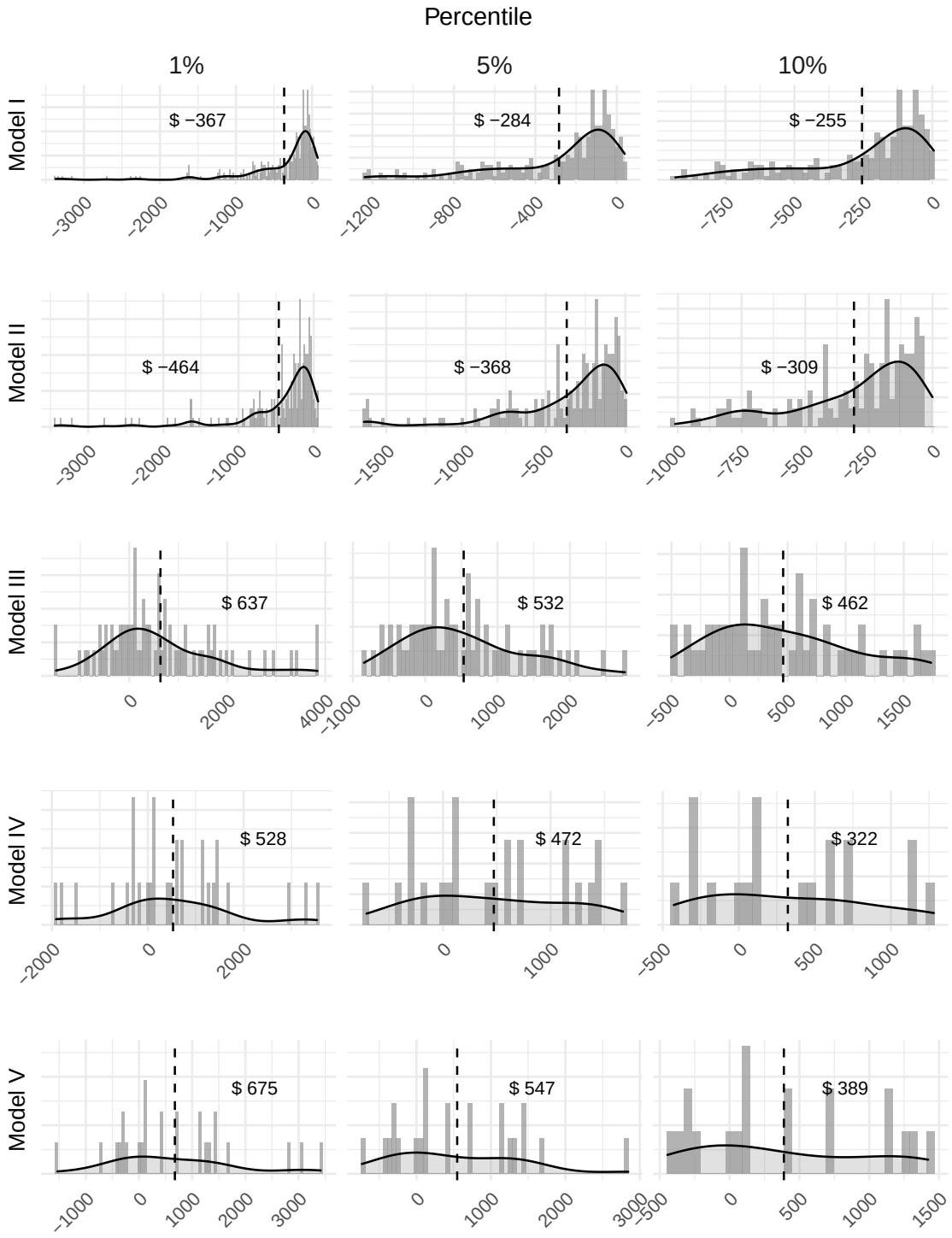
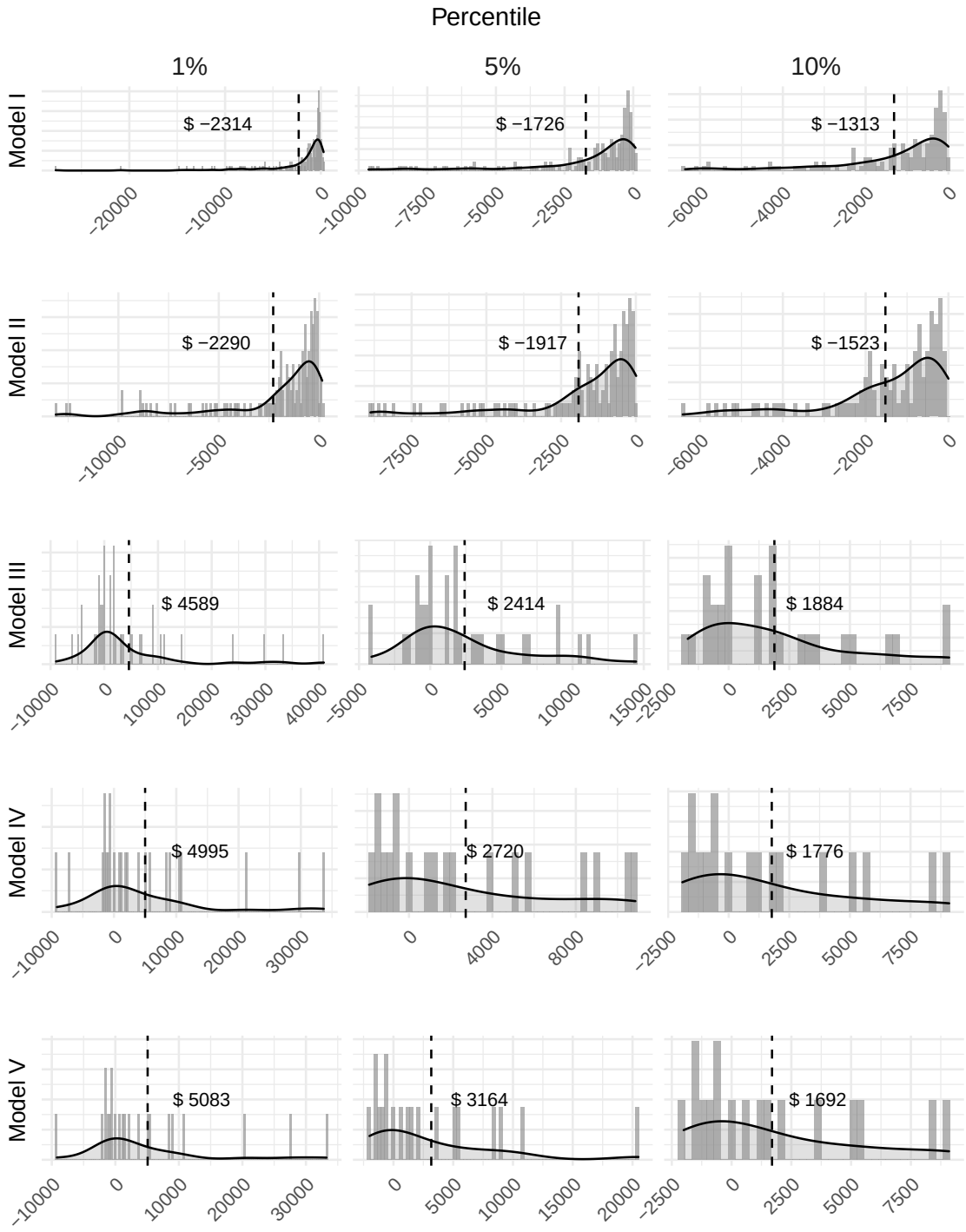


Figure A4: Distribution of net benefits per apprentice



Net benefits estimated using baseline data and truncated at first, fifth and tenth percentiles. Density on y−axis. Labelled dotted line indicates mean of truncated distribution.

Figure A5: Distribution of net benefits per firm



Net benefits estimated using baseline data and truncated at first, fifth and tenth percentiles. Firm benefits calculated as mean net benefits of all observed apprentices in firm times reported number of apprentices trained. Density on y−axis. Labelled dotted line indicates mean of truncated distribution.

Table A11: 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 \\$US.

Table A12: Annual costs and benefits per apprentice, CQP applicants only

Characteristic	N	Overall	N	CQP Selected	N	CQP Not Selected	p-value
Benefits							
Fees[1]	243	53.60 (37.86)	143	50.74 (36.67)	100	57.68 (39.33)	0.2
Entry	231	2.53 (4.24)	135	2.33 (3.30)	96	2.82 (5.29)	0.4
Formation	231	23.82 (30.29)	135	20.10 (27.58)	96	29.04 (33.19)	0.027
Liberation	231	8.54 (18.29)	135	9.44 (18.61)	96	7.26 (17.86)	0.4
Materials	231	6.29 (9.19)	135	6.35 (9.47)	96	6.20 (8.83)	>0.9
Contract	231	10.05 (18.22)	135	11.01 (18.70)	96	8.70 (17.52)	0.3
Application	231	3.05 (4.15)	135	3.30 (4.25)	96	2.70 (4.00)	0.3
Apprentice prod.	62	1,039.62 (1,172.56)	34	869.20 (1,050.46)	28	1,246.57 (1,294.84)	0.2
Total	**59**	**1,099.04 (1,195.77)**	**33**	**939.01 (1,059.45)**	**26**	**1,302.16 (1,343.08)**	**0.3**
Costs							
Allowances[1]	235	604.73 (1,225.89)	135	583.89 (1,398.96)	100	632.85 (949.56)	0.8
Food	141	72.79 (171.96)	84	61.57 (158.26)	57	89.31 (190.63)	0.3
Transport	141	59.73 (205.04)	84	46.23 (188.52)	57	79.61 (227.49)	0.3
Pocket money	141	150.50 (181.49)	84	135.30 (169.17)	57	172.89 (197.68)	0.2
Other	141	0.00 (0.00)	84	0.00 (0.00)	57	0.00 (0.00)	
Training costs	147	126.35 (250.66)	88	110.95 (251.60)	59	149.32 (249.61)	0.4
Rent	147	30.89 (65.54)	88	24.18 (52.84)	59	40.90 (80.34)	0.13
Equipment	144	36.96 (90.62)	88	24.75 (50.81)	56	56.15 (129.04)	0.042
Books	143	9.48 (45.27)	87	7.65 (40.66)	56	12.32 (51.90)	0.5
Raw materials	142	51.79 (161.19)	87	55.07 (187.93)	55	46.60 (107.48)	0.8
Lost trainer prod.	141	34.69 (43.60)	83	37.68 (47.11)	58	30.40 (38.00)	0.3
Total	**66**	**758.45 (730.85)**	**39**	**676.45 (673.07)**	**27**	**876.90 (805.36)**	**0.3**
Net Benefits							
Model I	223	-564.88 (1,254.43)	130	-547.64 (1,422.47)	93	-588.98 (979.25)	0.8
Model II	133	-598.70 (725.90)	79	-571.18 (764.74)	54	-638.96 (670.01)	0.6
Model III	53	610.97 (1,312.97)	29	444.72 (1,169.03)	24	811.85 (1,468.62)	0.3
Model IV	24	644.01 (1,566.27)	12	78.33 (1,264.37)	12	1,209.68 (1,683.05)	0.076
Model V	21	721.95 (1,555.49)	11	-8.33 (1,298.95)	10	1,525.25 (1,460.55)	0.020

Mean (SD). Amounts in $US per apprentice per year, calculated using responses from baseline survey.
[1] Fees and allowances reported by firm owner. Annual fees assume apprenticeship duration of four years, annual allowances assume apprentices work 20 days a month.

Table A13: Annual costs and benefits per apprentice, by wave

	N	Overall	N	Baseline	N	Endline	p-value
Benefits							
Fees[1]	591	64.73 (43.35)	403	65.30 (44.66)	188	63.51 (40.49)	0.9
Entry	579	3.11 (6.23)	391	2.74 (4.11)	188	3.90 (9.15)	0.2
Formation	579	36.05 (38.19)	391	35.95 (38.04)	188	36.26 (38.61)	0.6
Liberation	579	9.19 (20.76)	391	9.26 (18.70)	188	9.03 (24.54)	0.012
Materials	579	6.07 (8.16)	391	6.56 (9.31)	188	5.07 (4.85)	0.4
Contract	579	7.30 (15.69)	391	8.46 (16.92)	188	4.87 (12.43)	0.020
Application	579	3.51 (4.18)	391	3.09 (4.24)	188	4.38 (3.93)	<0.001
Apprentice prod.	241	760.05 (977.48)	114	1,075.59 (1,172.98)	127	476.80 (644.26)	<0.001
Total	**203**	**841.72 (996.42)**	**104**	**1,140.89 (1,198.06)**	**99**	**527.44 (585.80)**	**<0.001**
Costs							
Allowances[1]	470	463.58 (955.16)	360	489.37 (1,021.21)	110	379.17 (693.82)	0.023
Food	368	77.08 (134.55)	266	70.57 (147.07)	102	94.05 (92.90)	<0.001
Transport	368	52.46 (170.87)	266	60.88 (195.20)	102	30.51 (73.78)	>0.9
Pocket money	368	157.37 (380.71)	266	145.96 (183.74)	102	187.12 (660.95)	0.001
Other	368	0.47 (9.05)	266	0.65 (10.64)	102	0.00 (0.00)	0.5
Training costs	466	109.15 (219.01)	229	110.69 (233.24)	237	107.65 (204.80)	>0.9
Rent	466	28.54 (63.68)	229	26.83 (59.79)	237	30.20 (67.31)	>0.9
Equipment	460	32.38 (75.06)	226	32.61 (81.94)	234	32.16 (67.92)	0.8
Books	456	8.80 (41.76)	224	8.93 (44.17)	232	8.68 (39.40)	>0.9
Raw materials	454	41.08 (135.13)	223	44.10 (140.23)	231	38.16 (130.26)	>0.9
Lost trainer prod.	331	33.60 (45.59)	245	36.08 (45.78)	86	26.54 (44.52)	0.12
Total	**135**	**622.24 (647.58)**	**96**	**666.56 (698.44)**	**39**	**513.15 (492.00)**	**0.2**
Net Benefits							
Model I	442	-404.86 (980.27)	341	-437.12 (1,047.68)	101	-295.95 (700.14)	0.011
Model II	299	-454.58 (679.06)	198	-480.28 (661.41)	101	-404.20 (713.08)	0.2
Model III	132	403.62 (1,203.22)	75	726.77 (1,275.80)	57	-21.58 (954.96)	0.003
Model IV	88	121.25 (1,180.94)	31	631.55 (1,406.07)	57	-156.28 (940.73)	0.005
Model V	54	295.69 (1,111.39)	28	686.67 (1,378.91)	26	-125.38 (457.68)	0.012

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

[1] Fees and allowances reported by firm owner. Annual fees assume apprenticeship duration of four years, annual allowances assume apprentices work 20 days a month.

Table A14: Annual costs and benefits per apprentice, by trade

		Trade					
	Overall	**Masonry**	**Carpentry**	**Plumbing**	**Metalwork**	**Electrical Inst.**	**p-value**
Benefits							
Fees[1]	65.30 (44.66)	70.17 (38.53)	56.97 (42.03)	49.98 (28.28)	52.06 (44.50)	78.34 (49.66)	<0.001
Entry	2.74 (4.11)	1.80 (2.65)	1.74 (2.18)	2.47 (3.58)	1.05 (1.75)	4.62 (5.45)	<0.001
Formation	35.95 (38.04)	36.74 (29.00)	33.28 (30.91)	21.31 (32.39)	27.26 (33.17)	46.84 (45.52)	<0.001
Liberation	9.26 (18.70)	15.04 (20.84)	9.87 (17.95)	1.99 (5.77)	7.81 (17.74)	9.38 (20.44)	0.001
Materials	6.56 (9.31)	8.39 (9.26)	5.34 (5.86)	2.89 (3.35)	7.16 (12.96)	6.90 (8.88)	<0.001
Contract	8.46 (16.92)	3.68 (10.44)	7.78 (17.15)	19.21 (22.95)	6.74 (14.86)	8.24 (16.72)	0.3
Application	3.09 (4.24)	4.62 (3.96)	4.39 (4.09)	2.10 (3.72)	2.99 (3.98)	2.28 (4.48)	<0.001
Apprentice prod.	1,075.59 (1,172.98)	1,480.90 (1,306.63)	1,118.65 (1,328.96)	1,666.12 (298.76)	482.72 (382.95)	819.63 (1,087.83)	<0.001
Total	**1,140.89 (1,198.06)**	**1,683.73 (1,396.03)**	**1,013.33 (1,182.41)**	**1,694.46 (319.67)**	**537.43 (366.98)**	**884.07 (1,110.78)**	**<0.001**
Costs							
Allowances[1]	489.37 (1,021.21)	502.98 (868.71)	264.34 (237.20)	429.50 (708.59)	264.85 (342.57)	749.79 (1,564.54)	<0.001
Food	70.57 (147.07)	82.21 (82.86)	34.68 (54.89)	38.02 (67.32)	68.44 (79.16)	99.56 (266.47)	<0.001
Transport	60.88 (195.20)	49.33 (84.00)	46.62 (65.40)	57.22 (82.98)	4.39 (26.35)	133.42 (369.79)	<0.001
Pocket money	145.96 (183.74)	230.00 (228.63)	101.14 (114.89)	80.15 (68.54)	90.81 (147.42)	169.81 (201.63)	<0.001
Other	0.65 (10.64)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	2.71 (21.69)	0.5
Training costs	110.69 (233.24)	139.64 (200.16)	126.09 (339.41)	52.95 (99.52)	75.19 (107.92)	137.34 (289.99)	0.090
Rent	26.83 (59.79)	18.82 (40.33)	3.99 (9.65)	6.31 (26.40)	28.76 (47.40)	45.48 (83.14)	<0.001
Equipment	32.61 (81.94)	68.13 (140.03)	6.60 (18.41)	21.98 (39.25)	11.26 (25.83)	41.26 (86.88)	<0.001
Books	8.93 (44.17)	8.29 (25.58)	0.35 (1.78)	6.90 (14.26)	0.00 (0.00)	18.30 (71.27)	0.006
Raw materials	44.10 (140.23)	44.40 (73.39)	115.15 (325.67)	17.76 (51.85)	35.17 (78.39)	37.61 (113.62)	0.030
Lost trainer prod.	36.08 (45.78)	34.05 (34.14)	62.78 (76.69)	53.48 (59.14)	27.94 (30.68)	31.36 (48.34)	0.4
Total	**666.56 (698.44)**	**648.85 (324.48)**	**479.98 (618.49)**	**551.68 (594.94)**	**337.80 (222.65)**	**1,191.18 (1,084.98)**	**<0.001**
Net Benefits							
Model I	-437.12 (1,047.68)	-450.07 (917.78)	-216.41 (251.65)	-378.49 (710.13)	-215.64 (353.20)	-682.98 (1,580.38)	0.001
Model II	-480.28 (661.41)	-468.88 (294.90)	-304.93 (417.16)	-464.94 (817.96)	-263.52 (221.37)	-659.02 (849.99)	0.019
Model III	726.77 (1,275.80)	1,186.96 (1,374.17)	741.15 (1,073.05)	1,424.71 (275.21)	-228.78 (682.42)	164.80 (1,177.03)	0.001
Model IV	631.55 (1,406.07)	822.50 (1,449.81)	148.02 (1,560.68)	1,273.66 (163.37)	-82.23 (291.90)	465.08 (1,747.39)	0.4
Model V	686.67 (1,378.91)	830.37 (1,575.09)	122.88 (1,602.28)	1,254.03 (141.56)	-107.30 (320.73)	703.77 (1,563.70)	0.6

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

[1] Fees and allowances reported by firm owner. Annual fees assume apprenticeship duration of four years, annual allowances assume apprentices work 20 days a month.

Table A15: Annual net benefits per firm, by wave

	N	Overall	N	Baseline	N	Endline	p-value
Firm Accounts							
Revenues	300	4,405 (4,917)	159	3,989 (4,820)	141	4,875 (5,000)	0.002
Wage bill	344	1,365 (2,999)	196	972 (2,352)	148	1,886 (3,629)	<0.001
Non-wage expenses	342	1,640 (3,179)	196	1,593 (3,152)	146	1,704 (3,224)	0.2
Total expenses	340	3,027 (5,183)	195	2,572 (4,453)	145	3,639 (5,989)	<0.001
Profits (reported)	303	1,429 (2,159)	167	1,672 (2,634)	136	1,132 (1,317)	0.029
Profits (calculated[2])	297	1,549 (3,249)	158	1,701 (3,056)	139	1,375 (3,459)	0.7
Projected benefits							
Fees	317	370 (451)	189	347 (366)	128	403 (553)	>0.9
Apprentice prod.	128	5,655 (13,455)	47	8,359 (13,033)	81	4,086 (13,526)	0.011
Total	117	6,063 (13,708)	46	8,887 (13,241)	71	4,234 (13,786)	0.011
Projected costs							
Allowances	269	2,783 (6,783)	185	3,207 (7,741)	84	1,848 (3,803)	0.006
Training costs	292	497 (1,071)	144	511 (1,116)	148	483 (1,029)	>0.9
Lost trainer prod.	169	199 (506)	111	181 (421)	58	233 (640)	0.6
Total	103	3,430 (4,838)	70	3,190 (4,441)	33	3,938 (5,628)	0.6
Net benefits							
Model I	258	-2,500 (6,838)	180	-2,947 (7,759)	78	-1,469 (3,814)	0.005
Model II	206	-2,681 (7,150)	128	-3,174 (8,534)	78	-1,870 (3,861)	0.034
Model III	86	2,773 (9,640)	43	5,574 (12,052)	43	-28 (5,171)	0.10
Model IV	68	2,040 (9,146)	25	6,431 (12,457)	43	-513 (5,158)	0.034
Model V	43	2,717 (10,714)	23	6,593 (12,285)	20	-1,740 (6,316)	0.013

Mean (SD). Net benefits per firm estimated using baseline data. Projected costs, benefits, and net benefits calculated as mean values for all observed apprentices in firm times reported number of apprentices trained. Amounts in $US.

[1] Firms size calculated by author as sum of all reported workers in firm, including apprentices and occasional and family workers.

[2] Profits recalculated by author as difference between reported revenues (first row) and reported expenses (second row).

Table A16: Annual net benefits per firm, by trade

		Trade					
	Overall, N = 197	**Masonry**, N = 45	**Carpentry**, N = 24	**Plumbing**, N = 26	**Metalwork**, N = 39	**Electrical Inst.**, N = 63	**p-value**
Firm Accounts							
Revenues	3,989 (4,820)	4,924 (5,760)	4,999 (4,256)	2,696 (3,246)	3,498 (4,993)	3,477 (4,447)	0.021
Wage bill	972 (2,352)	2,304 (4,254)	880 (1,392)	642 (1,182)	277 (560)	609 (1,147)	<0.001
Non-wage expenses	1,593 (3,152)	1,318 (2,216)	1,415 (1,757)	653 (828)	1,131 (1,338)	2,528 (4,882)	0.016
Total expenses	2,572 (4,453)	3,622 (5,559)	2,333 (2,835)	1,295 (1,770)	1,411 (1,607)	3,138 (5,639)	0.002
Profits (reported)	1,672 (2,634)	2,567 (4,557)	2,243 (1,408)	1,202 (1,428)	1,007 (1,381)	1,266 (1,158)	<0.001
Profits (calculated[2])	1,701 (3,056)	1,243 (2,957)	2,569 (2,369)	1,449 (1,506)	1,967 (4,672)	1,662 (2,572)	0.14
Projected benefits							
Fees	347 (366)	317 (256)	212 (178)	219 (195)	273 (332)	526 (485)	<0.001
Apprentice prod.	8,359 (13,033)	8,719 (11,196)	11,109 (22,156)	9,124 (2,244)	4,161 (6,282)	7,990 (13,047)	0.4
Total	8,887 (13,241)	9,472 (11,545)	11,347 (22,106)	9,235 (2,157)	4,531 (6,864)	8,542 (13,216)	0.4
Projected costs							
Allowances	3,207 (7,741)	2,529 (3,775)	1,640 (2,966)	4,733 (17,348)	1,541 (2,198)	4,865 (6,332)	<0.001
Training costs	511 (1,116)	532 (723)	404 (564)	215 (367)	341 (659)	792 (1,739)	0.2
Lost trainer prod.	181 (421)	148 (200)	408 (1,038)	254 (477)	96 (92)	194 (435)	>0.9
Total	3,190 (4,441)	3,144 (2,226)	1,236 (854)	2,009 (2,835)	1,910 (3,123)	6,173 (7,359)	0.005
Net benefits							
Model I	-2,947 (7,759)	-2,373 (3,872)	-1,470 (3,004)	-4,515 (17,220)	-1,245 (2,052)	-4,454 (6,299)	0.004
Model II	-3,174 (8,534)	-2,748 (2,869)	-995 (910)	-5,419 (19,345)	-1,465 (2,461)	-4,325 (5,315)	<0.001
Model III	5,574 (12,052)	6,553 (9,848)	8,494 (17,498)	7,780 (1,858)	291 (4,639)	4,190 (13,916)	0.3
Model IV	6,431 (12,457)	7,385 (11,698)	2,772 (7,030)	7,368 (2,441)	767 (1,901)	7,792 (17,945)	0.8
Model V	6,593 (12,285)	6,835 (12,160)	2,733 (7,067)	7,290 (2,552)	682 (1,909)	9,426 (17,584)	0.8

Mean (SD). Net benefits per firm estimated using baseline data. Projected costs, benefits, and net benefits calculated as mean values for all observed apprentices in firm times reported number of apprentices trained. Amounts in $US.

[1] Firms size calculated by author as sum of all reported workers in firm, including apprentices and occasional and family workers.

[2] Profits recalculated by author as difference between reported revenues (first row) and reported expenses (second row).

Table A17: Firm-level regressions with firm fixed effects

	log revenues (USD)		log profits (USD)		log Firm size[1]	
	(1)	(2)	(3)	(4)	(5)	(6)
Non-CQP apprentices	−0.01		−0.93**		−0.33*	
	(0.21)		(0.37)		(0.18)	
CQP Selected		−0.11		−0.94**		−0.33**
		(0.18)		(0.38)		(0.16)
Total apprentices	0.38*	0.36*	−2.10***	−2.00***	−0.20	−0.30*
	(0.20)	(0.19)	(0.48)	(0.48)	(0.15)	(0.15)
Endline	0.32	0.30	−0.88	−1.00		
	(0.24)	(0.23)	(0.78)	(0.77)		
Firm FE	YES	YES	YES	YES	YES	YES
Observations	126	134	94	101	142	155
R^2	0.20	0.24	0.74	0.69	0.11	0.14
F Statistic	1.90	2.60*	6.50**	6.00**	2.00	3.20*

Note: *p<0.1; **p<0.05; ***p<0.01
[1]Excluding apprentices

Appendix B