Informational Barriers to Market Access: Experimental Evidence from Liberian Firms

Jonas Hjort, Vinayak Iyer, Golvine de Rochambeau

SciencesPo
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Jonas Hjort
Columbia U. & BREAD & CEPR & NBER

Vinayak Iyer
Columbia U.

Golvine de Rochambeau
Sciences Po

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Abstract

Evidence suggests that firms in poor countries stagnate because they cannot access growth-conducive markets. We hypothesize that overlooked heterogeneity in marketing ability distorts market access. To investigate, we gave a random subset of Liberian firms vouchers for a week-long program that teaches how to sell to corporations, governments, and other large buyers. Firms that participate win about three times as many contracts, but only firms with access to the Internet benefit. We use a simple model and variation in online and offline demand to show evidence that this is because ICT dampens traditional information frictions, but not marketing barriers.

*hjort@columbia.edu, vinayak.iyer@columbia.edu, golvine.derochambeau@sciencespo.fr

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1 Introduction

Firms in poor countries often grow slowly (Bloom *et al.*, 2010; Hsieh & Klenow, 2014; Verhoogen, 2020). One class of explanations focuses on productivity—the cost firms incur to produce goods and services—and another on ability to access markets. In the former line of research, many studies attempt to make firms more productive by loosening various production contraints, such as access to credit and management practices. The results have been mixed (McKenzie & Woodruff, 2014; Quinn & Woodruff, 2019).[1] The other strand of the literature instead assesses the importance of demand constraints. There is growing evidence that access to bigger and more quality-sensitive markets can raise firm growth (Verhoogen, 2008; Syverson, 2011; Hornbeck & Rotemberg, 2019; Goldberg & Reed, 2020), and small firms in particular appear to benefit from selling to large buyers (Hoekman & Sanfilippo, 2018; Alfaro-Urena *et al.*, 2019; Abebe *et al.*, 2020).

Why are some firms better able to access desirable markets than others? What are the factors that influence market access? The existing literature in large part considers infrastructure, tariffs, and other traditional trade costs that affect different types of firms differently (see e.g. De Loecker & Goldberg, 2014; Donaldson & Hornbeck, 2016). However, ability to market products appears to vary substantially even across firms of similar size and productivity that are located near each other. This suggests that overlooked forms of access barriers may constrain growth. The literature on information frictions in poor countries points towards one (Jensen, 2007; Allen, 2014; Startz, 2018; Atkin *et al.*, 2017b). Studies that experimentally vary contract allocation find, in particular, that randomly chosen small firms can successfully supply large buyers (Ferraz *et al.*, 2016; Atkin *et al.*, 2017a; Carrillo *et al.*, 2019). But firms themselves must normally sell their goods and services in the marketplace. Might heterogeneity in their ability to do so—marketing ability—distort access to markets?

In this paper we experimentally enhance Liberian firms' ability to market their products to corporations, governments, and other large buyers. This is to our knowledge the first attempt to investigate how exogenous variation in individual firms' ability to access a particular market affects their growth. The source of demand we focus on—buyers that purchase goods and services through tenders and other formal contracts—is an especially important one: public procurement alone makes up roughly 12 percent of worldwide GDP and more in low-income countries (Bosio *et al.*, 2020). Our analysis begins to characterize how limited marketing ability and its interaction with more widely studied forms

[1] The training and input programs that have shown bigger impacts on firm growth have generally been tailored to individual firms and/or very expensive (see e.g. Bloom *et al.* (2013) and Bruhn *et al.* (2018), and McKenzie & Woodruff (2014); Quinn & Woodruff (2019); Verhoogen (2020) for discussion.)

of information frictions excludes productive suppliers from growth opportunities.

The paper has five parts. First we present a simple theoretical framework in which a firm's probability of winning both formal bidding processes—tenders—and non-tender formal contracts the firm pursues depends on its underlying ability to identify and appeal to buyers' preferences. We then estimate the average impact of a seven-day training program that teaches Liberian firms how to construct good bids on tenders from large buyers. Next we show how the impact of the program varies with access to the Internet. We then use the model to illustrate why marketing knowledge may interact with firms' technological ability both (i) to access contracts that are publicized online—typically tenders—and (ii) to search for information about, be found by, and communicate with tender and non-tender buyers through ICT. Finally, we take advantage of trained firms' differential exposure to online demand shocks—arbitrary variation over time in the share of tenders that are publicized online—and the fact that we observe the composition of contracts firms win. This helps us empirically test for the *online market access* and *search and communication* channels through which ICT may mediate the impact of marketing ability on sales.

With 14 employees on average, the firms in our sample are by local standards medium-sized. The sample is drawn from a registry of firms in Monrovia—Liberia's capital city—which is maintained by Building Markets, the non-profit we work with. To be included in the registry, firms have to be formally registered and active. The sample firms come from a wide range of sectors, including "Construction and Renovation" (23 percent), "Food and Beverages" (15 percent), "Home Essentials" (13 percent), and "Handicrafts and Artisans" (12 percent). Like most small and medium-sized firms in poor countries, they have little experience supplying to large buyers and instead sell mostly to final consumers, thus struggling to build reputation (Macchiavello & Morjaria, 2015). Twelve percent held a contract awarded through a formal bidding process in the six months preceding the baseline survey.[2]

The seven day-long *Winning-contracts* training our analysis focuses on aims to change this. Run by the non-profit, it teaches firms how to bid on tenders from corporations, government entities, and other large buyers. The training is not sector-specific and focuses exclusively on how to participate and succeed in the procurement market. One part teaches fundamentals of bidding and common buyer preferences such as favoring "green" suppliers.[3] A second part provides practice and feedback on mock bids.

[2]A policy goal of the Government of Liberia is to steer public procurement contracts towards smaller, domestic firms. In 2014, they passed the "Small Business Empowerment Act", which mandates all government entities to allocate at least 25 percent of their total procurement budget to Liberian-owned small and medium-sized firms. However, very few government entities are in compliance with the law.

[3]This example is illustrative. Most firms in our sample use little energy and would therefore be consid-

The research team first visited the firms in the treatment group from June to August of 2016.[4] Research assistants gave the firms' managers a free voucher to attend the training and information about otherwise similar firms which took the training in the past. The non-profit then ran training sessions throughout the study period. The encouragement (voucher+information) persuaded about 20 percent of firms in the treatment group to take the training. They mostly did so during July – September 2016. Endline data collection took place from March – June 2017.

We use a simple model to frame our analysis. A buyer selects a supplier from a set of bidders based on requested prices and auxiliary features such as engaging in environmentally friendly production. Buyers don't have perfect information about bidders so the winning supplier can earn rents. These depend not only on production costs, but also marketing ability. Since tender-winning knowledge may also improve firms' ability to win non-tender formal contracts, the impact of the training on effort devoted respectively to bidding on tenders and pursuing other contracts is ambiguous.

In the first part of our empirical analysis, we show that firms that learn how to market their products to large buyers bid on more tenders; win more tenders; and win contracts of higher quality. Firms in the treatment group that take the training are for example more than twice as likely to win a contract lasting longer than six months. We also find that enhanced contract-winning knowledge significantly increases the number of contracts firms win through other means than formal tenders. Winning more and higher-quality contracts appears to ultimately improve firm performance. Our estimates suggest that treated firms that take the training earn about USD 10,000 in revenue from contracts over the course of six months above and beyond a control group mean of about USD 5,000, although this estimate is not statistically significant. The overall impact of the Winning-contracts training suggests that allocative efficiency may be considerably greater if all firms were able to competitively pursue formal contracts.[5]

In the second part of our analysis, we estimate how the benefits of enhanced marketing ability vary with Internet connectivity. If contract-winning knowledge constrains access to desirable buyers by amplifying information frictions, we a priori expect the impact of Winning-contracts training to positively interact with firms' access to ICT. Conversely, the Internet and similar technologies may themselves allow firms to overcome informational

ered "green", but few were aware of this before taking the training.

[4]We measure the initial characteristics of firms in the sample frame using pre-baseline periodical surveys conducted by the non-profit. These were also used to stratify the randomization.

[5]This is because the training program expands the set of potential contract-winners. The experiment was not designed to test the program's market-wide efficiency consequences. However, our findings suggest that these would likely be positive if contracts tend to be awarded to the most productive suppliers when all suppliers have the ability to effectively convey their qualifications to buyers (see Section 4).

barriers to marketing their products, in which case we would expect a negatively signed interaction effect. The distinction is important because Internet access is rapidly expanding in poor countries.

We find that the Winning-contracts training raises the number of tenders firms bid on, total contracts won, non-tender contracts won, and revenue from contracts only among firms that use the Internet for business purposes at baseline. A double-LASSO regularization procedure suggests that Internet use is the strongest predictor in our baseline data of a large treatment effect of the training (Chernozhukov *et al.*, 2018). Simultaneously including interactions between the treatment and other observable proxies for firm type that may correlate with Internet access barely affects the estimated coefficient on training$\times$Internet.

To guide our investigation of the mechanisms underlying these results, we expand the theoretical framework to include ICT. In our model, Internet access can "convert" marketing ability into sales for two reasons. First, through directly expanded market access: some contracts, and in particular many tenders, are only publicized online. Second, by facilitating suppliers' ability to search for information about, be found by, and communicate with buyers, whether or not the buyers publicize their contracts online. Firms with Internet access are then expected to bid on and win more tenders when their tender-winning knowledge is enhanced, while the effect on effort pursuing non-tender contracts is ambiguous. The latter effect is expected to be positive when online demand is low because of the search and communication function of Internet.

To test these predictions, we take advantage of variation over time in the share of tenders that are publicized online and offline (for example in newspapers). Treated firms are differentially exposed to (relative) online demand shocks because they take the Winning-contracts training at different times.[6]

We find evidence pointing towards a role for Internet's *search and communication* function in converting marketing ability into sales. In particular, the benefits of the Winning-contracts training are concentrated among firms with Internet access even when online demand is low. At such times ICT-connected firms with enhanced contract-winning knowledge win more non-tender contracts.

We further find evidence that Internet's *online market access* function also helps firms with enhanced marketing ability win formal contracts. Specifically, firms with Internet access win both more non-tender contracts and more tenders after learning how to craft competitive bids if online demand is high. Trained firms with Internet access also win

[6]We show that, relative to the time variation in online and offline tender postings, the timing of firms taking the Winning-contracts training appears arbitrary. Since firms themselves choose when to take the training, we nevertheless instrument for a firm's training date with the date the research team first visited the firm. The first visit date was unrelated to contract demand shocks.

higher-quality contracts when online demand is high, perhaps reflecting a difference between the attributes of tender and non-tender contracts. These shifts due to online demand shocks appear to persist in the longer-run—after the shocks themselves—pointing towards learning-by-doing dynamics in tender-winning (see also Foster *et al.*, 2016; Atkin *et al.*, 2017a).

In sum this paper documents that many productive firms face a limited market because they don't know how to sell their products to growth-conducive buyers. Liberian suppliers need both such marketing ability and the technology necessary to interact with large buyers to win more formal contracts. The implied inequality of opportunity may help explain the slow average growth of firms in poor countries.

We contribute to three related strands of the literature on information frictions and access to markets in the developing world. First, this paper documents the dramatic consequences of an overlooked informational barrier to selling to large buyers. We build on research on knowledge constraints that estimates how complex forms and procedures prevent disadvantaged individuals from conveying productive qualifications (see e.g. Jensen, 2010; Bettinger *et al.*, 2012; Kling *et al.*, 2012; Chetty & Saez, 2013).[7] We add to growing evidence that informational barriers can be surprisingly costly to overcome also for firms (see e.g. Atkin *et al.*, 2017b; Almunia *et al.*, 2019), and that information-constrained sales and marketing procedures may be especially consequential (Anderson *et al.*, 2018; DellaVigna & Gentzkow, 2019; Hortacsu *et al.*, 2019).[8] By documenting that large demand-side clients in effect speak another language than small firms, we connect the information-constrained decision-making literature with work on market access and firm growth.

Conversely, we advance the literature on the causes and consequences of access to buyers by establishing a particular reason why productive firms in developing countries rarely participate in growth-conducive value chains.[9] That access to demand can be im-

[7] Recent studies also suggest that supply-side—worker—variation in ability to convey productive qualifications to buyers—employers—severely distorts labor markets in developing countries (Hardy & McCasland, 2017; Abebe *et al.*, 2019; Bassi & Nansamba, 2019; Carranza *et al.*, 2019).

[8] We know of one other paper that experimentally varies the marketing ability of firms in a poor country: Anderson *et al.* (2018). Their focus differs from ours: they study small-scale retail entrepreneurs rather than medium-sized, multi-sector formal firms, and analyze the impact of an intensive 10-week training, rather than a short program narrowly focused on accessing a particular market. However, Anderson *et al.* (2018)'s results are consistent with ours in that they find remarkably large impacts of marketing ability on sales and profits in South Africa. Some similarly hands-on consulting programs studied in the literature—e.g. in Bruhn *et al.* (2018)—include marketing among multiple modules in a tailored and/or broad training package, but do not study the impact of enhanced marketing ability itself.

[9] In addition to the more empirical work cited above—see Verhoogen (2008), Foster *et al.* (2016), and Pozzi & Schivardi (2016) for examples, and Syverson (2011); De Loecker & Goldberg (2014) for overviews of related literatures—there is a burgeoning theoretical literature focusing on how demand forces affect firm dynamics (see e.g. Drozd & Nosal, 2012; Gourio & Rudanko, 2014; Arkolakis *et al.*, 2018), and a growing body of work on industrial policy (see e.g. Lee, 2017; Lane, 2019).

portant for firm growth—a belief commonly reflected in policy (Lederman *et al.*, 2010)—is most clearly shown in studies that exploit random or quasi-random allocation of contracts (Ferraz *et al.*, 2016; Atkin *et al.*, 2017a; Carrillo *et al.*, 2019). This paper to our knowledge provides the first direct evidence on why some firms are able to sell goods and services to a particular market while similar firms in the same location are not.[10]

Finally, we begin to unpack *how* lack of information distorts input markets. Information frictions have first-order consequences for firms in developing countries (Jensen, 2007; Allen, 2014; Jensen & Miller, 2018; Hjort & Poulsen, 2019). Prior studies document the distortions arising from classical frictions—constrained contracting, matching, and search—in low-information markets (see e.g. Startz, 2018; Mitra *et al.*, 2018; Hansman *et al.*, 2019). We instead show how firms' own ability to sell goods and services affect participation in input markets, and how such marketing ability interacts with traditional information frictions that Internet's *online market access* and *search and communication* functions can help overcome.[11]

2 Context and Experimental Design

In this section we describe the context Liberian firms operate in, and the design of the experiment we use to investigate how informational barriers to marketing goods and services affect their access to demand.

2.1 Firms and procurement by large buyers in Liberia

Most firms in Liberia are small. In 2013, the country conducted a national economic census aimed at counting all businesses with a solid physical structure. The census reports data on about 21,500 firms and confirms common observations from other low-income economies. The average firm has 7.3 employees, 63 percent have less than three employees, and 98.5 percent have less than 50.

The non-profit we work with attempts to record all formal tenders in Liberia. In 2016, it recorded 1,381 tenders. Summary statistics of these tenders are shown in Table 1. A little

[10] As noted above, research on causes of market access has focused on traditional forms of trade barriers that differentially constrain the sales of firms of different types, for example those located in different areas (see e.g. Faber, 2014; Atkin & Donaldson, 2015; Donaldson & Hornbeck, 2016; Hornbeck & Rotemberg, 2019).

[11] Most existing research focuses on how *buyers'* access to information affects market outcomes like price dispersion and pass-through (see e.g. Aker, 2010). Jensen (2007) and Mitra *et al.* (2018) are closer to this paper in that they analyze how suppliers' access to information affects market outcomes. This paper is also related to Hjort & Poulsen (2019), but unlike them, we document *why* Internet connectivity can help firms in poor countries' access markets.

more than half are from public sector buyers such as ministries; a small minority (about 2 percent) from private companies; and the remainder from international organizations. Most tenders are posted publicly: 57 percent in newspapers and another 31 percent online. Twelve percent are publicized only through word-of-mouth.[12] Anecdotally, many large buyers report that they have a hard time finding small and medium-sized suppliers that meet the requirements to fulfill their contracts.

2.2 Sample

The sampling frame for the experiment we carried out was Building Markets' directory of active firms in Liberia. The organization's goal is to integrate local small and medium-sized firms into value chains by enabling them to win contracts. They maintain online directories of thousands of firms in several developing countries, akin to the Yellow Pages. The Liberian directory included more than 4,000 firms in 2017.

To be included in the sample, firms had to:

- Be listed on the non-profit's business directory
- Have at least one employee in addition to the owner
- Be located in Monrovia, the capital city
- Have not already taken the Winning-contracts training

In addition, since a lot of firms closed down after the 2014-2016 West African Ebola outbreak, only firms that had been in contact with the non-profit after April 2015 (when the outbreak subsided) were included in the sampling frame.

The firms in the sample span many different sectors, the largest being "Construction and Renovation" (23 percent), "Food and Beverages" (16 percent), and "Home Essentials" (13 percent). We show this and other summary statistics from before the experiment started in Table 2. These data come from periodical surveys the non-profit carries out to keep track of the firms in its directory. The mean number of employees is 14, and there is huge variation in this measure of firm size: the standard deviation is 43. Ninety percent of the firms have at least one Liberian owner. Thirty-four percent of the managers speak at least one local language in addition to Liberian English.

Relative to all firms in Liberia's economic census, firms with between five and 20 employees are over-represented in our sample, while the smallest and bigger firms are

[12]Public sector buyers publicize 85 percent of their tenders in newspapers and 14 percent online. International organizations publicize 32 percent of their tenders in newspapers and 45 percent online. The remaining tenders are only advertised through word-of-mouth.

under-represented. This is shown in Panel A of Figure 1. Relative instead to otherwise comparable firms which had participated in the non-profit's Winning-contracts training in the past—those that satisfy the other three sample requirements above—firms with fewer than 10 employees are overrepresented in our sample, as shown in Panel B.[13]

The firms in the sample have little experience supplying to large buyers. Twenty-one percent bid on one or more tenders in the six months before being interviewed, and 12 percent won one or more tenders. The average success rate—tenders won relative to tenders the firm bid on—is 32 percent.

2.3 The Winning-contracts training

We randomly assigned firms in the sample to treatment (772 firms) and control (420 firms) groups. The randomization was stratified on number-of-employees bins, sector, and the geographical zone within Monrovia in which the firm is located. The treatment and control groups are balanced, as shown in the first two columns of Table 3.

The research team visited the treatment group firms starting in June 2016 and gave each one a voucher allowing one person from the firm to attend the Winning-contracts training for free.[14] The firms were also asked to answer a survey and given information about the training. This information included the training's content, as well as statistics on how participation correlated with bidding and various measures of success for firms like theirs in the past, as measured in data from the non-profit's periodical surveys.[15]

The training content focuses exclusively on how to bid on and win formal contracts. It is not aimed at raising a firm's productivity: neither of the two training sessions are sector-specific, and there is no mention of management practices, financial planning, or product development. There is also no mention of how use of the Internet can help firms.

The first training session lasts five days and is referred to as *General Procurement* training. This session teaches participants the fundamentals of the process of bidding on tenders: how to find tenders and how to bid. The General Procurement session also provides information about supplier and bid characteristics that many buyers require or put weight on when awarding a contract. Examples include environmental awareness, ethical behav-

[13] More precisely, the benchmark firms in Panel B include both the firms in our sample and those that are listed on the non-profit's business directory; have at least one employee, and are located in Monrovia, but have taken the Winning-contracts training in the past. Doing so cost a fee of about USD 50.

[14] The voucher did not have an expiration date and could be used when desired.

[15] As specified in the pre-analysis plan, the voucher was combined with different statistics on how participation correlated with bidding on and winning contracts in the past in several different sub-treatments used to encourage firms to attend the training. However, we do not observe differences in effects of these sub-treatments in either take-up or effect of the treatment. In the analysis presented here, all sub-treatments are combined.

ior, and sensitivity to cultural differences or persons with disabilities. Clarifying these is an important aspect of the training because many participants say that they find such auxiliary buyer preferences confusing. For example, most small and medium-sized firms in Liberia use little energy and therefore would be considered "green" businesses, but many fail to mention this in their bids.

Completing the first week of training is required to participate in the second training session, called *Bid Compilation* training. This session lasts two days and offers a hands-on toolkit for producing bids. Participants do exercises in which they examine a mock tender, prepare a draft bid, learn to communicate with procurement officers, and undergo evaluation of their bid. The second training session in essence teaches firms how to engage with buyers at the different stages of the tender process.

Almost all firms in the sample that took the training did so from June 2016 to November 2016.[16] The non-profit offered two to three training sessions per month depending on demand, and a total of eight training sessions. On average 32 attendees from firms in 11 different sectors participated in each training session. Figure 2 summarizes the experimental design and the timeline of the experiment.

2.4 Data

Our analysis is based on data collected in three rounds: pre-baseline, baseline, and endline. Firms listed in the non-profit's directory are asked to answer a phone survey every three to six months. The data collected through these phone surveys were made available to the research team. We refer to the last round before the data collection for the experiment itself as the *pre-baseline* data.

The research team collected the baseline data starting in June 2016. When research assistants visited firms in the treatment group to give them the training voucher, they also asked the firms to answer a survey. By construction, this baseline data round only covers the firms in the treatment group.

Lastly, the research team attempted to re-interview all firms in the full sample for an endline survey conducted from March to June 2017. Out of the 1,192 firms in the sample, we successfully (re-) surveyed 831 firms: 295 in the control group, and 533 in the treatment group. The survey team's use of a battery of tracking techniques—both phone and in-person search, GPS devices, flexible scheduling of interviews, etc—kept attrition low. The firms which answered the endline survey are slightly different from firms which did not.[17]

[16] Three firms took the training in January 2017.

[17] This is shown in Appendix Table A.1. Appendix Table A.2 shows that the treatment and control groups are balanced also in the sample of firms that were interviewed at endline, as well as summary statistics for

However, there was no differential attrition across the treatment and control groups, as shown in the last two columns of Table 3.

3 Conceptual Framework Part 1: Bidding on Contracts

In this section we present a simple model that illustrates how firms may benefit from enhanced marketing knowledge.

A buyer selects a supplier from bids submitted by firms in an auction. The bids state the price and/or the quality of the products on offer, but also auxiliary features such as the firm's environmental awareness. Certain features may be required, while auxiliary features are substitutable. For example, conditional on the bidder being able to provide a certain quality, a buyer might be willing to choose a higher price bid if the bidder reports great environmental awareness. The tender market is also marked by information asymmetry since buyers don't have perfect information about bidders. Therefore winning bidders can earn rents, the size of which depend not only on the firm's production costs but also their knowledge of buyers' preferences over auxiliary features—marketing knowledge.

We now formalize these ideas in a simple bidding model.

3.1 Model set-up

A firm benefits from two types of contracts: those that are won through tenders in an auction, and non-tender contracts that do not require formal bidding. Its profit can thus be written as

$$Nr(a,b) + \pi(e,s) - \beta c(e + kb) \tag{1}$$

where N is the total number of open tenders and $r(a,b)$ the expected rent extracted from a bid. r depends on a, the tender-winning knowledge of the firm, and b, the number of bids submitted—a measure of the firm's effort to win contracts through tenders. $Nr(a,b)$ is thus the firm's expected rent over all open tenders. $\pi(e,s)$ is the profit a firm makes from non-tender contracts. π is a function of e, the firms' efforts to win contracts outside of the tender market, and s, the firm's non-tender contract-winning knowledge. The function $c(e + kb)$ measures the cost of seeking contracts for the firm. k measures the relative cost of effort devoted to winning contracts in the tender markets to that in non-tender markets. c depends on the weighted sum of the firm's marketing effort in and out of the tender market, and its weight in the profit function is β.

firms in this restricted sample.

We make standard assumptions on the shape of the functions r, π and c. r is increasing in the number of tenders the firm bids on and its tender-winning knowledge ($r_a,\ r_b > 0$) and concave in a and b ($r_{aa},\ r_{bb} < 0$). We also assume that tender-winning knowledge and bidding effort are complementary, so that the marginal rent from an additional bid is higher if firms have higher tender-winning knowledge ($r_{ab} > 0$). Similarly, we assume π is increasing ($\pi_e, \pi_s > 0$) and concave in both arguments ($\pi_{ee}, \pi_{ss} < 0$) and that knowledge and effort are complementary ($\pi_{es} \geq 0$). We assume the cost function to be increasing ($c' > 0$) and convex ($c'' > 0$).

3.2 Winning-contracts training

We think of both tender-winning knowledge and non-tender contract-winning knowledge as functions of a general marketing ability α. This ability represents, for example, the firm's capacity to identify and appeal to buyers' preferences, or to convey the firm's productive qualifications to buyers. Naturally, we suppose both forms of knowledge $s(\alpha)$ and $a(\alpha)$ to be increasing and concave in the general ability α.

Proposition 1. *The effect of Winning-contracts training on a firm's profits is unambiguously positive. However, with no further assumptions on $s'(\alpha)$ and $a'(\alpha)$, the effect of the training on the number of tenders the firm bids on and its effort pursuing non-tender contracts is ambiguous.*

Proof. Firms choose the number of tenders to bid on and the effort pursuing non-tender contracts to maximize profits, and satisfy the first order conditions:

$$\begin{aligned} N r_b - \beta k c' &= 0 \\ \pi_e - \beta c' &= 0 \end{aligned}$$

The Jacobian matrix $J(b,e)$ is $\begin{bmatrix} N r_{bb} - \beta k^2 c'' & -\beta k c'' \\ -\beta k c'' & \pi_{ee} - \beta c'' \end{bmatrix}$ whose determinant is

$$D = N r_{bb}(\pi_{ee} - \beta c'') - \beta k^2 c'' \pi_{ee} > 0$$

By the Implicit Function Theorem, there exist unique continuously differentiable functions $b(N, \alpha, \beta, k)$ and $e(N, \alpha, \beta, k)$ over an open set, such that

$$b_\alpha = -\frac{1}{D}\{N r_{ba} a_\alpha (\pi_{ee} - \beta c'') + \pi_{es} s_\alpha \beta k c''\} \tag{2}$$

$$e_\alpha = -\frac{1}{D}\{N r_{ba} a_\alpha \beta k c'' + (N r_{bb} - \beta k^2 c'')\pi_{es} s_\alpha\} \tag{3}$$

The first term in the bracket of (2) is negative while the second term is positive. With no further assumptions, whether or not Winning-contracts training increases the number of tenders firms bid on is thus ambiguous. Similarly, the sign of the effect on the effort to win non-tender contracts is also ambiguous.

Let $V(\alpha, b^*(\alpha), e^*(\alpha))$ denote the maximized profit of the firm. By the Envelope Theorem, the effect of the training on profit is therefore

$$\begin{aligned}\frac{dV}{d\alpha} &= Nr_a a_\alpha + Nr_b b_\alpha + \pi_e e_\alpha + \pi_s s_\alpha - \beta c'(e_\alpha + k b_\alpha) \\ &= Nr_a a_\alpha + \pi_s s_\alpha + b_\alpha[Nr_b - \beta k c'] + e_\alpha[\pi_e - \beta c'] \\ &= Nr_a a_\alpha + \pi_s s_\alpha > 0\end{aligned}$$

where the inequality is given by the FOCs. □

Proposition (1) shows that enhanced contract-winning knowledge is expected to increase firms' profit. The impact of Winning-contracts training may come from bidding on more tenders, exerting greater effort to win non-tender contracts, or both, depending on the relative increase in the marginal payoff to the two sales activities caused by the training. This intuition is further developed in the following proposition:

Proposition 2. *Winning-contracts training increases the number of tenders firms bid on if (i) the effect of the training on tender-winning knowledge is significantly bigger than the effect on non-tender contract-winning knowledge, (ii) the demand in the tender market is sufficiently large, and (iii) the search and communication costs necessary to win contracts are sufficiently small.*

Proof. From (1) we have that

$$b_\alpha > 0 \iff Nr_{ba} a_\alpha(\beta c'' - \pi_{ee}) > \pi_{es} s_\alpha \beta k c'' \tag{4}$$

The larger N—the number of open tenders—the more likely the above inequality is to hold, which shows part (ii) of Proposition 2.

Inequality (4) can be re-written

$$a_\alpha > C s_\alpha$$

where $C = \frac{\pi_{es} k c''}{Nr_{ba}(c'' - \frac{\pi_{ee}}{\beta})}$. This shows that the inequality holds if the effect of Winning-contracts training on tender-winning knowledge a_α is significantly bigger than the effect on non-tender contract-winning knowledge s_α, which shows part (i) of Proposition 2.

Further, since $\pi_{ee} < 0$, the denominator of C is larger when β is small. Therefore, the smaller the cost of seeking contracts β, the more likely b_α is to be positive, which shows part (iii) of Proposition 2. □

Given a small increase in the general marketing ability underlying both types of sales knowledge, firms reassign their efforts between pursuing non-tender contracts and bidding on tenders, depending on the new marginal payoff to these two types of effort. If the increase in general marketing ability improves tender-winning knowledge more, firms will shift effort from non-tender markets to the tender market.

3.3 Information frictions

The framework presented in this section focuses on a different form of information frictions than existing research: variation in marketing knowledge resulting in a "wedge" in the rents from contracts that differs across equally productive firms. However, the intuition underlying the model also suggests that such distortionary variation in marketing knowledge may interact with traditional information frictions and in particular the technologies used to dampen them in the modern economy. On the one hand, information technology may reduce the benefits of enhanced contract-winning knowledge if the Internet and other ICTs themselves allow firms to overcome informational barriers to marketing their products. On the other hand, information technology may increase the marginal benefit of enhanced contract-winning knowledge if firms with access to such technology can more easily find and bid on suitable contracts: firms that use the Internet may in effect have access to a bigger market and more easily be able to search for and communicate with buyers, for example. We investigate this empirically in Section 5 and return to the underlying theoretical intuition in Section 6. Before doing so, we test propositions 1 and 2 in the data from the experiment.

4 Average Impact of Winning-contracts Training

In this section we show that the opportunity to learn how to sell goods and services to large buyers induces Liberian firms to bid on and win more and higher-quality contracts. In Section 5 we explore heterogeneity in the impact of the Winning-contracts training we document in this section.

Where relevant we show results from both Intent-to-treat (ITT) regressions of the outcomes of interest on treatment status and Treatment-on-the-treated (TOT) regressions like

the following:

$$y_i = \beta_0 + \beta_1 \text{Winning-contracts Training}_i + \gamma X_i + \epsilon_i \quad (5)$$

Here y_i is a measure of firm i's expectations, behavior, or performance measured at endline. X_i is a set of controls measured before the experiment, including fixed effects for a firm's sector(s), location, and size bin fixed effects: we show results both with and without including these. Winning-contracts Training$_i$ is an indicator variable equal to one for firms that participate in the training, and β_1 is the coefficient of interest. We present tables with TOT estimates in the top panel, and ITT estimates in the bottom panel.

4.1 Take-up of training and expectations

Firms in the treatment group are significantly more likely to attend the Winning-contracts training. Those in the control group were not encouraged to attend the training, but four control group firms independently decided to pay to participate. Columns (1) and (2) of Table 4 show that the treatment—that is, the voucher and encouragement to attend the training—increases the probability that a firm participates by 19-20 percentage points, as recorded in the non-profit's attendance sheet.[18] Given this relatively high but incomplete take-up, the ITT estimates of impact are scaled down in magnitude relative to the TOT estimates that follow, but generally of similar statistical significance.

At endline, firms that were induced to participate in Winning-contracts training by the treatment expect to bid on and win more tenders in the future. Trained firms expect to bid on about one—or 40-50 percent—more tenders in the coming six months, and to win about 55 percent more of the tenders the firm bids on. We show this in Table 5.

4.2 Number of contracts won

Small- and medium-sized Liberian firms rarely bid on contracts awarded through a formal tender process. The control group firms in our sample bid on 0.35 tenders during the past six months on average. Winning a tender is even more rare: control group firms won an average of 0.16 contracts through a formal bidding process in the past six months.

[18] These numbers are for the first part of the Winning-contracts training, the General Procurement session. Panel A of Appendix Table A.3 shows the same coefficient for the second session, on Bid Compilation. Eighty-five percent of the firms that attend the first session also attend the second session, and treatment increases the probability of attending the second session by 17 percent (and to self-report participating in any type of training by about 15 percent, as we also show in Appendix Table A.3). In the results that follow, we estimate TOT effects for firms that embark on the Winning-contracts training. Note also that, following Abadie *et al.* (2017), we present robust standard errors as there are neither sampling design nor experimental design reasons for clustering in our context, although our results are robust to clustering at the sector level.

Enhanced contract-winning knowledge markedly increases in the number of contracts firms bid on and win. We show this in Table 6. First, as seen in columns (1) and (2), firms that are encouraged to participate in Winning-contracts training bid on 0.16 more tenders in the past six months—an increase of nearly 50 percent compared to the control group.[19] The estimated impact is even larger, as expected, for treated firms which took the training.

We find a large positive impact also on the total number of contracts won. Firms that take the Winning-contracts training because of the randomized encouragement win more than one additional formal contract over the course of six months—an increase of over 200 percent—as we show in columns (3) and (4) of Table 6. It thus appears that firms that learn how to market their products to large buyers can access a market that otherwise comparable firms cannot.

The benefits of enhanced contract-winning knowledge extend beyond a greater ability to win tenders, consistent with the framework in Section 3. To see this, we look at contracts won through other means than a tender process—those that do not require a formal bid—in columns (7) and (8) of Table 6. Being encouraged to participate in Winning-contracts training raises the number of non-tender contracts won by about 60 percent compared to the control group. As shown in columns (5) and (6), treated firms also win 53 percent more contracts through formal bidding processes, though this estimate is only marginally statistically significant.

4.3 Quality of contracts won

Learning how to market goods and services to large buyers increases not only the quantity, but also the quality of contracts Liberian firms win. First, treated firms that take the Winning-contracts training more than double their chances of winning long-lasting (six months or more) contracts, our primary measure of contract quality. We show this in Panel A of Table 7.

Second, participating in the training also doubles firms' chances of winning contracts from international clients, from 29 to 58 percent. We show this in Appendix Table A.4. Exporting often enables firm "upgrading" (Atkin *et al.*, 2017a; Verhoogen, 2020), and growing evidence suggests that supplying to foreign buyers operating in the home market can similarly benefit firms in poor countries (Abebe *et al.*, 2020; Alfaro-Urena *et al.*, 2019).

Finally, we find that firms that learn how to market their products to large buyers bid

[19] The first column of Appendix Table A.4 shows results on the extensive margin of bidding on tenders. The probability of bidding on any tenders is estimated to increase by about 75 percent. This estimate is not statistically significant, but the magnitude suggests that the training likely positively affects the extensive margin as well.

on and win a greater proportion of all tenders advertised for goods and services the firm specializes in. We show this in Appendix Table A.4. The outcome variable is now the number of tenders a firm bids on or wins as a proportion of the total number advertised within the primary sector the firm operates in, as measured in the non-profit's database of tenders. The proportion of all own-sector contracts bid on and won is respectively around 500 and 600 percent higher among firms induced to take the Winning-contracts training by the randomized encouragement.

4.4 Revenue earned

Learning how to market products to large buyers—and bidding on and winning more formal contracts—appears to ultimately increase firms' revenue considerably. We show this in Panel B of Table 7. The estimates suggest that the total value of contracts won is around USD 10,000, or 200 percent, higher in treated firms that take the Winning-contracts training. Although remarkably large, this estimate is not statistically significant, perhaps because—as is common in firm surveys—many managers were unwilling to answer questions about the value or sources of their contracts.[20]

The evidence we have presented in Section 4 shows that learning how to access large buyer markets is remarkably beneficial for small- and medium-sized Liberian firms. Firms that are given the opportunity to participate in Winning-contracts training expect to bid on and win more tenders, and do in fact bid on and win more tender and non-tender contracts, and contracts of higher quality. These gains may come in part at the expense of status quo contract-winners. The firms that would have won the relevant formal contracts had treated firms not learned to compete for contracts are most likely larger firms outside of our sample—the experimental design minimized any direct impact on control group firms.[21] While the experiment was not designed to test the market-wide consequences of Winning-contracts training, the results in this section point towards possible allocative efficiency improvements from removing informational barriers to market access. Suppose that contracts will tend to be awarded to the most productive firms if every firm in the economy has the ability to bid. If so, the treatment effects we have shown—Winning-

[20] We treat such missing values as zeroes. Firms in the treatment group were 21 percent more likely not to answer value-of-contracts-won questions, suggesting that we may be underestimating the impact on value of contracts won.

[21] Recall from Sub-section 2.4 that the research team did not collect data from the control group until the endline, suggesting that control group firms were most likely unaware that another group of firms was being taught how to bid on tenders. Combined with control group firms rarely bidding on—and even more rarely winning—formal contracts in the status quo, this suggests that increased bidding on and winning contracts by treatment group firms generally did not come at the expense of control group firms.

contracts training enabling some firms that ex ante lack sufficient contract-winning knowledge to bid on and win contracts—may reduce misallocation if scaled up.[22]

In the next section we show how a firm's contract-winning knowledge interacts with its ability to access contracts and search for and communicate with buyers through the Internet.

5 How the Impact of Winning-contracts Training Varies with Information Technology

In this section we show evidence that, in Liberia, only firms with access to modern information technology—the Internet—benefit from learning how to market their products to large buyers.

If complex input procurement procedures limit access to large buyers by amplifying information frictions, we expect the Winning-contracts training to interact with suppliers' ability to find contracts and communicate with buyers. In the baseline survey, firms were asked how often they use the Internet for business purposes. Respondents could choose between seven answers, ranging from "Every Day" to "Never". The distribution of answers is shown in Figure 3. There is wide variation in access, with about 45 percent of firms reporting that they use the Internet for business purposes daily and 30 percent that they never do so.

Firms that use the Internet for business purposes are typically larger, and bid on and win more tenders at baseline, as we show in Appendix Table A.5. Such firms also report to find it easier to access tenders; to have sufficient time to prepare bids; and to better understand the requirements in tender documents.

We now explore how the impact of Winning-contracts training differs for firms with access to the Internet. In Sub-section 5.2 we investigate whether any such heterogeneity is due only to differences between the types of firms that do and don't have access to the Internet or also to the technology itself.

[22] In general, the impact of programs favoring potential bidders that a priori are unlikely to win contracts on participation in procurement auctions and the price buyers ultimately pay is theoretically ambiguous (see e.g. McAfee & McMillan, 1989; Best *et al.*, 2019). However, auction theory also suggests that the documented increase in the pool of *potential* bidders likely makes buyers better off and may improve allocative efficiency if buyers award their contracts to the most qualified bidder.

5.1 Number and quality of contracts won and Internet access

The impact of Winning-contracts training is markedly different for firms with Internet access. To show this, we estimate the following regression:

$$\begin{aligned} y_i = \beta_0 + \beta_1 &\text{Winning-contracts training}_i \\ + \beta_2 &\text{Winning-contracts training}_i \times \text{Internet}_i + \gamma X_i + \epsilon_i \end{aligned} \tag{6}$$

We normalize the recorded measure of firms' Internet use to unit scale so that $\text{Internet}_i = 1$ if firm i uses the Internet for business purposes every day at baseline and $\text{Internet}_i = 0$ if the firm never does so at baseline.[23] We restrict attention to the ITT results hereafter for simplicity.

Winning-contracts training induces firms that use the Internet daily to bid on 0.5-0.7 additional tenders over the course of six months, compared to the treatment's impact on bidding by firms without Internet access. In fact, the estimates from (6) indicate that the opportunity to learn how to bid on formal tenders has no impact on the number of tenders firms that do not use the Internet bid on. At baseline firms had bid on 0.35 tenders in the past six months. The relative and total effect for firms with Internet access is thus large. We show these results in Table 8.[24]

Winning-contracts training also enables firms with Internet access to *win* more contracts, but has no such effect for firms that do not use the Internet. Columns (3)-(8) of Table 8 show that the total number of contracts won; the number of contracts won through a tender; and the number of non-tender contracts won all tend to double or triple when a firm with Internet access is encouraged to learn how to bid on and win tenders. In contrast, contracts won are unaffected for treated firms that do not use the Internet.

The impact of enhanced marketing ability on the quality of contracts won as measured by contract length is considerably greater for firms that use the Internet. Such firms are 26 percentage points or around twice as likely to win a contract lasting longer than six months if encouraged to learn how to bid on tenders, as seen in Panel A of Appendix Table A.6. Firms that use the Internet also bid on and win a greater proportion of all

[23] Here X_i includes Internet_i so that β_2 captures the pure interaction effect.

[24] Interestingly, the estimated effect of the treatment for firms without access to the Internet on most of the outcomes in Table 8 is negative, though small in magnitude and statistically insignificant. A possible explanation is that participating in Winning-contracts training leads firms without Internet access to divert their sales effort from bidding on particular tenders that they are especially likely to win towards attempting to win more non-tender formal contracts (consistent with the model in Section 3). Since such firms ultimately do not *win* more non-tender formal contracts after taking the training—the estimated effect on non-tender contracts won is zero or slightly positive, though imprecisely estimated—this could explain a possible decrease in total contracts won, in addition to in bidding on and winning tenders.

tenders advertised for goods and services the firm specializes in. However, we do not find evidence that the increase in the probability of winning a contract from an international buyer is greater for firms that use the Internet.

Learning how to access large buyers has a remarkably big ultimate impact on the value of contracts won for firms with Internet access, but little effect for firms without Internet access. In Panel B of Appendix Table A.6 we show that treated firms that use the Internet win contracts worth about USD 10,000 or 200 percent more than control firms, while the impact on contract revenue is small and statistically insignificant for firms that do not use the Internet. The average impact on revenue we documented in Section 4 is thus driven entirely by firms with access to a technology that helps them search for, be found by, and communicate with buyers.

5.2 Use of the Internet versus differential access by firm type

We now show evidence suggesting that Internet technology itself helps firms use their marketing ability to win contracts from large buyers. To do so, we start by repeating regression (6) with additional controls included. These capture the interaction between the Winning-contracts training and a wide range of baseline firm characteristics that may correlate with Internet access: firm size as measured by employment, the firm's counties of operation, the gender of the owner, sectors the firm operates in, languages used for business, the geographical zone the firm is located in, and the extent to which the firm bids on tenders at baseline.[25] With these interactions included we continue to find, as in Table 8, that the increase in tender bids submitted, total number of contracts won, contracts won through a tender, and the total value of contracts won is significantly greater for firms that use the Internet. The estimated coefficient on Winning-contracts training$_i$ $\times$ Internet$_i$, shown in Appendix Table A.7, is in fact bigger in magnitude with these additional interaction terms included.

We next show that Internet access is in fact the best predictor of firms' conditional average treatment effect (CATE) among the full set of firm characteristics captured in the data we use.[26] Following the LASSO procedure in Chernozhukov *et al.* (2018), we estimate the best linear predictor of the CATE of the treatment on the number of tenders a firm bids on as follows:

1. We first split the full sample into two parts, the *auxiliary* sample and the *main* sample.

[25] Recall from the introduction that we measure the initial characteristics of firms using pre-baseline periodical surveys conducted by the non-profit that are available both for the treatment and control groups.

[26] The additional firm characteristics we interacted the treatment with in Appendix Table A.7 cover a wide range, but nevertheless represent a selection of such characteristics subjectively chosen by the authors.

The two are used respectively as the training set and the hold-out set.

2. We then use a LASSO regression of the number of bids on baseline observables estimated on the control group part of the auxiliary sample to predict the number of bids for the full auxiliary sample (control and treatment). A second LASSO regression of number of bids on (i) the predicted output of the first LASSO regression and (ii) the interaction of treatment and baseline observables selects variables which best predict the heterogeneity of the treatment effect observed.

3. We then test the predictive power of the heterogeneity variables selected in the auxiliary sample in step 2 on the main sample. Predicted number of bids is generated on the main sample using the variables selected in step 2 with their associated coefficients from the auxiliary sample. The observed number of bids in the main sample is regressed on the predicted number of bids based on the auxiliary sample. This allows us to test whether variables selected in step 2 accurately describe the observed heterogeneity in treatment effects.[27]

4. Finally, we run a cross-validation procedure wherein the main sample is used as the training set and the auxiliary sample as the hold-out set.

The results of this procedure depends on the random split of the sample. We thus bootstrap by repeating the procedure 100 times. Since each of these includes two estimations, the total number of LASSO estimations is 200. Out of these 200 estimations, 196 were validated by the test for the hold-out set heterogeneity variables as good predictors of heterogeneity. Appendix Table A.8 shows how many times each firm characteristic was selected in the set of variables that best explain heterogeneity in treatment effects in the training set. Internet access is by far the variable selected the most times, 194.

In sum, the evidence in Appendix Tables A.7 and A.8 suggests that, in isolation, the broader ways in which firms with and without Internet access differ are unlikely to fully explain the $\text{training}_i \times \text{Internet}_i$ interaction effect. The instrumental functions of Internet technology itself appear to also help "connected" firms use contract-winning knowledge to better access markets.

[27] A variable is said to accurately describe the observed heterogeneity if the p-value of its coefficient on the main sample is smaller than 0.01.

6 Conceptual Framework Part 2: Bidding on Contracts with and without Information Technology

In this section, we build on the framework introduced in Section 3 to formalize intuition for why firms with access to information technology may benefit more from marketing ability.

6.1 Information technology

We consider two general ways in which information technology such as the Internet can give firms a better starting point for accessing markets—greater potential for winning contracts. First, firms that invest in information technology are able to access some contracts—a set of tenders—that can only be accessed online, directly expanding the market they face.[28] Second, information technology reduces search and communication frictions, for example making it easier to correspond with buyers and possible to visit them in person less frequently. *Online market access* can be modeled by simply decomposing the total number of tenders N as $N_{on} + N_{off}$, where N_{on} is the number of tenders only available online, and N_{off} is the number of tenders also available to firms not investing in Internet access. Easier *search and communication* can be modeled as a difference in β, the weight in front of the cost function. If we denote the firm's Internet access choice by i, we can now write the profit function in (1) with:

$$N = \begin{cases} N_{on} + N_{off} & i = 1 \\ N_{off} & i = 0 \end{cases}$$

and

$$\beta = \begin{cases} \beta_1 & i = 1 \\ \beta_0 & i = 0 \end{cases}$$

with $\beta_1 < \beta_0$.

[28] The non-profit notifies the suppliers in its registry that belong to the relevant sector by SMS whenever a tender is published. This system operates separately from our experiment, and both treatment and control group firms receive such notifications. It is thus not surprising that Winning-contracts training itself had no impact on the probability that a supplier in our sample reports to have found out about a tender from the non-profit. The reason why SMS notifications leave scope for Internet access helping firms find suitable tenders to bid on may be that the firms in our sample generally find the SMS notifications unhelpful. Few suppliers report to have found out about a tender they bid on from the non-profit, and many told us that they treat the SMS notifications as spam.

Proposition 3. *The interactive effect of Winning-contracts training and Internet access on the number of tenders firms bid on is unambiguously positive, while that on effort to win non-tender contracts is ambiguous. This last effect depends on the magnitude of the (a) greater (online) market access and (b) lower search and communication costs firms with Internet access face.*

Proof. The interactive effect of training and Internet is given by comparing b_α between firms with and without Internet access. From the Mean Value Theorem, this is given by:

$$b_\alpha(N_1, \beta_1) - b_\alpha(N_0, \beta_0) = b_{\alpha N}(\tilde{N}, \tilde{\beta}) N_{on} + b_{\alpha\beta}(\tilde{N}, \tilde{\beta}) \Delta\beta \tag{7}$$

where $(\tilde{N}, \tilde{\beta})$ is a point between (N_0, β_0) and (N_1, β_1). Further, we have $\Delta\beta = \beta_1 - \beta_0 < 0$ and we have that:

$$b_{\alpha\beta} = -\frac{\pi_{es} s_\alpha k c'' N r_{bb} \pi_{ee} + k^2 c'' N r_{ba} a_\alpha \pi_{ee}^2}{D^2} < 0$$

$$b_{\alpha N} = \frac{(\pi_{ee} - \beta c'') \beta k c'' (r_{ba} a_\alpha k \pi_{ee} + r_{bb} \pi_{es} s_\alpha)}{D^2} > 0$$

Therefore, (7) is positive.

Similarly, the difference in the treatment effect on effort pursuing non-tender contracts is given by :

$$e_\alpha(N_1, \beta_1) - e_\alpha(N_0, \beta_0) = e_{\alpha N} N_{on} + e_{\alpha\beta} \Delta\beta \tag{8}$$

Since $e_{\alpha\beta}$ and $e_{\alpha N}$ are both negative, the sign of (8) depends on the relative magnitude of each term. □

Corollary 4. *(1) **Online Market Access Channel** : If the impact of Winning-contracts training for firms with Internet access is larger following an increase in online demand, then the online market access channel must exist.*
*(2) **Search and Communication Channel** : If the effect of Winning-contracts training for firms with Internet access is larger than that for firms without Internet access for non-tender contracts, then the search and communication channel must exist. This holds regardless of the level of online demand.*

Intuitively, if the Internet did not help convert marketing ability into access to buyers via an online market access effect then online demand shocks should not differentially benefit trained Internet firms compared to non-Internet firms. Conversely, if the Internet did not help convert marketing ability into access to buyers via a search and communication channel then trained Internet firms should not have a comparative advantage in

winning non-tender contracts compared to non-Internet firms.

Proof. **Proof of (1):**
The effect of an increase in online demand ∂N_{on} on the interactive effect of the Winning-contracts training and Internet access, assuming that $\partial b_{\alpha\beta} \simeq 0$, can be written

$$\partial[b_\alpha(N_1, \beta_1) - b_\alpha(N_0, \beta_0)] = b_{\alpha N}\partial N_{on} + \partial b_{\alpha N} N_{on} \tag{9}$$

b_{aN} is decreasing in N so that $\partial b_{\alpha N} < 0$. So if the equation (9) above is positive, then it has to be that $\partial N_{on} > 0$: there is an online market access channel of the Internet.

Proof of (2):
In equation (8), the first term $e_{\alpha N} N_{on}$ is negative, while the second term $e_{\alpha\beta}\Delta\beta$ is positive. Hence, if (8) is positive overall, it has to be that $e_{\alpha\beta}\Delta\beta > 0$ and Internet firms benefit from lower search and communication costs (i.e. $\Delta\beta < 0$). □

It is worth noting that this framework can easily be extended to a context where firms' general marketing ability α is endogenously influenced by firms' experience in applying to and winning contracts. Suppose for example that contract-winning is subject to learning-by-doing effects. The intuition underlying the predictions laid out in this section then implies that firms with Internet access which take the Winning-contracts training win more contracts also in the long-run if they experience positive demand shocks early on. We investigate this possibility empirically in Sub-section 7.2. Before doing so, we test Proposition 3 and Corollary 4 by exploiting variation in the composition of demand over time.

7 Why the Impact of Winning-contracts Training Varies with Information Technology

In this section we show evidence that Liberian firms that learn how to sell their products to large buyers can use the Internet to win formal contracts both because additional tenders are accessible online and because suppliers can search for and communicate with buyers online.

In Section 4 we saw evidence that learning how to bid on and win formal tenders also improves firms' ability to win non-tender contracts. The framework in sections 3 and 6 then predicts that Winning-contracts training should unambiguously increase effort to win non-tender contracts if the Internet facilitates market access through a *search and communication* function, especially when online tender demand is low. If in addition it

does so through an *online market access* function, the framework predicts that effort bidding on tenders may increase when online tender demand is high. To investigate, we thus use the non-profit's database of tenders published in Liberia. It records the date a tender is publicized, the medium it is publicized through (newspaper, online or other), and the relevant supplier sector(s).

7.1 Online market access, search, and communication

Figure 4 shows the variation across time in the number of tenders publicized in 2016 for an average sector in Liberia. About one-third of tenders are publicized online, but this proportion varies markedly from week to week. We use this variation to construct firm-specific online demand shocks. Non-tender contracts are rarely publicized online or in other public fora; contracts that are publicized online are almost always awarded through a formal tender process.

To investigate how firms' effort pursuing contracts and bidding on tenders changes with online demand, we estimate the following regression:

$$\begin{aligned} y_i = \beta_0 &+ \beta_1 \text{Winning-contracts Training}_i \\ &+ \beta_2 \text{Winning-contracts Training}_i \times \text{Online Demand}_i \\ &+ \beta_3 \text{Winning-contracts Training}_i \times \text{Internet}_i \\ &+ \beta_4 \text{Winning-contracts Training}_i \times \text{Internet}_i \times \text{Online Demand}_i \\ &+ \beta_5 \text{Internet}_i + \gamma X_i + \epsilon_i \end{aligned} \tag{10}$$

Here Online demand$_i$ is defined as the number of tenders for firm i's sector(s) that are publicized online in the three months after the firm's training. Each supplier can—and most do—list two sectors in the registry, and we include any that they list in the construction of Online demand$_i$. Individual firms are thus assigned the demand corresponding to one out of a wide array of sector combinations during the period after taking the training. We use "sector" as shorthand for these sectors and sector-combinations corresponding to firms.

X_i is a set of controls that includes the ones used in previous sections.[29] Here X_i additionally includes the number of tenders for firm i's sector(s) that are publicized offline in the three months after the firm's training (defined analogously to Online demand$_i$) so that we focus on *relative* online demand in the analysis.[30]

[29] These are employment, counties of operation, gender of the owner, sector fixed effects, languages used for business, geographical zone fixed effects, and the number of submitted bids, all measured at baseline.

[30] Note also that we specifically focus on variation in online demand when a firm's marketing abil-

The effect of an increase in online demand is identified by within-sector variation in firms' training timing since we control for sector fixed effects. Firms which took the training earlier may have experienced more or less online demand in the three months period following their training than firms which took the training later. A possible concern with exploiting this across-firm variation is that particular types of firms may be able to forecast future online demand and choose when to take the Winning-contracts training accordingly. Note first that our measure of firm-specific online demand shocks is uncorrelated with firms' behavior and performance at baseline, as shown in Appendix Table A.9. Nevertheless, we next construct an instrument for post-training online demand by exploiting the arbitrary order in which firms were visited and encouraged to participate.[31] Specifically, we instrument our online demand measure with the number of online tenders published in the three-months period that starts 40 days after the date of the encouragement visit—the average number of days between encouragement and the last day of training.

Appendix Table A.10 shows that our instrumented online demand shock variable is not correlated with training take-up, suggesting that training dates endogenously timed to match variation in demand does not confound our IV regressions. Note also that our focus on post-training and post-encouragement demand does not imply an assumption that time variation in demand does not matter for control group firms which do not take the training. Instead the assumption is simply that the timing of the encouragement visit is essentially random. To see this, recall that these demand variables are defined and calculated at the sector level and that we include sector fixed effects in the regression.

We find evidence that Liberian firms with Internet access can use marketing knowledge to access the large buyer market both because information technology allows them to find expressions-of-interest that are otherwise out of reach and also because ICT facilitates search for and communication with buyers. We show this in Table 9. Since neither the variable Online Demand$_i$ nor Internet$_i$ are dummy variables, we show the average treatment effect for the group of firms with access to the Internet and with a positive online demand shock in the table footer for easier interpretation of the results.[32]

In Column (1) we find that newly-trained Internet firms bid on a significantly higher number of tenders during an online demand shock, while firms without Internet access do

ity is enhanced—here, by the Winning-contracts training—consistent with the model in sections 3 and 6. Since post-training demand is undefined for firms which do not take the training, the terms Online Demand$_i$ and Internet$_i$ $\times$ Online Demand$_i$ are included in (10) only through their interaction with Winning-contracts Training$_i$.

[31]The order in which the firms were visited was determined by the logistics of the surveying effort and thus unrelated to contract demand shocks.

[32]The average treatment effect computed is the sum of the table's coefficients for each variable multiplied by the average value of that variable when the variable is positive.

not. Internet firms also *win* more tenders at such times, as shown in Column (3). Following part (1) of Corollary 4 in Section 6, the fact that an online demand shock exclusively benefits Internet firms points towards the *online market access* effect of the Internet.

Column (4) of Table 9 shows that Internet firms win significantly more non-tender contracts than non-Internet firms as a result of Winning-contracts training, regardless of the level of online demand. Following part (2) of Corollary 4, this points towards the *search and communication* effect of the Internet, which facilitates finding, bidding on, and winning both online and offline contracts. Trained firms with Internet access win more non-tender contracts also when online demand is high.

Contracts that are won through tenders may be of particular importance, as they are used by buyers that small and medium-sized firms are otherwise unlikely to gain access to. In Table 9 we also show that firms that use the Internet and have learned how to competitively bid on formal contracts win significantly more high-quality, long-lasting contracts when relative online demand is high. The estimates in Column (5) suggest that such firms are on average twice as likely to win high quality contracts as firms in the control group.

When viewed through the lens of the framework in sections 3 and 6, the results in Table 9 indicate that both greater online market access and easier search and communication for "connected" firms help explain the positive interaction effect between the Winning-contracts training and Internet access we established in Section 5. A natural question to ask is whether these results may in part reflect fluctuations in total rather than online demand. In Appendix Table A.11 we repeat (10) but define the demand shock to include both online and offline tenders. The results are qualitatively similar to those in Table 9. In light of our framework, insofar as the results in Table 9 are driven in part by total demand, these patterns in Appendix Table A.11 simply point towards the search and communication channel, with little to say about online market access. Since we control for offline demand in (10), we find the interpretation above more plausible.

7.2 Learning-by-doing dynamics in contract-winning

We now show that demand shocks appear to affect also the longer-run trajectory of ICT-connected firms that have learned how to sell their products to large buyers. In Subsection 7.1 we saw that Winning-contracts training induces this particular group—firms with access to the Internet—to win more tenders in the months after training when a greater share of demand is online during these same months. To explore learning-by-doing dynamics in contract-winning, in this sub-section we restrict attention to bids and

contracts won several months after the period during which we measure demand shocks—during the three months before the endline interview.[33]

We find evidence indicating that short-run online demand shocks may increase the extent to which firms with access to the Internet win more tenders because they have learned how to craft formal bids even in the longer run. We show this in Table 10. Such learning-by-doing dynamics are not seen for other firms—neither those that lack access to the Internet, nor those that have not learned how to bid on formal tenders. This points towards longer-run benefits of ability to appeal to large buyers with early access to demand. The estimates in Table 10 are smaller than those in Table 9 and not statistically significant, but the patterns are otherwise similar, with one important difference. Firms with access to the Internet that experience an online demand shock soon after Winning-contracts training do not win more non-tender contracts nor more total contracts in the longer run. They do, however, appear to bid on and win more tenders. This suggests that learning-by-doing dynamics in contract-winning may be especially forceful for formal tenders.[34]

In Section 5 we saw that marketing knowledge and the technological ability to access and interact with buyers positively interact, together increasing Liberian firms' sales. In this section we have shown that they do so both because Internet use directly expands the size of the market firms face, and because it facilitates search and communication with buyers. We have also shown that firms that are given the opportunity to win formal tenders tend to keep winning tenders also in the longer run (see also Atkin *et al.*, 2017a). These results suggest that the Internet dampens traditional information frictions, but—perhaps surprisingly—not marketing barriers that prevent information-constrained suppliers in low-income countries from selling to growth-conductive large buyers. This may make such barriers the limit to many firms' market in an increasingly online world.

[33] At endline, we asked firms for the dates since the baseline interview on which they bid on tenders and won contracts. For a subset of tenders, we also observe the opening and closing dates. Ninety percent of the tenders in our sample are open for bidding less that 30 days, with a mean of 15 days. The tenders that form part of short-run demand shocks as we measure them and the ones that form part of the outcome we consider in this sub-section are thus very unlikely to overlap.

[34] Note that, while Table 10 is otherwise identical to Table 9 except with the outcome measured during a later period of time, Table 10 does not include the Quality of Contracts outcome from Table 9. The reason is that we cannot be sure when the reported high quality contracts—contracts that last for six months or more—are won. The endline survey simply asked if the firm had ever won such a contract. We thus take the conservative approach of assuming that high quality contracts are won in the short run rather than the long run as defined here.

8 Conclusion

Growing evidence suggests that many productive firms stagnate because of constrained access to existing demand. Small firms in poor countries rarely win contracts from large buyers—a particularly growth-conducive form of demand—instead choosing to sell directly to final consumers. In this paper we uncover an overlooked part of the explanation. We do so through a randomized-controlled trial of a week-long training program that teaches disadvantaged Liberian firms how to sell their products to large buyers by bidding on formal tenders. We show that learning how to market products to governments, corporations, and other large buyers—the details of tender procedures, auxiliary features of bids many buyers put weight on, and so on—enables Liberian firms to win more and higher-quality tender and non-tender contracts. This suggests that small and medium-sized firms face informational barriers to accessing markets that differ from traditional forms of information frictions. However, we also find that distortionary variation in marketing ability interacts with more widely studied information frictions. Converting contract-winning knowledge into market access appears to be difficult without modern information technology. We show that the treatment effect of the *Winning-contracts* training we study is found only among firms that use the Internet, both because such firms can access a bigger market and because they can more easily search for and communicate with buyers. We thus begin to unpack how information frictions distort input markets and thereby exclude firms in poor countries from value chains.

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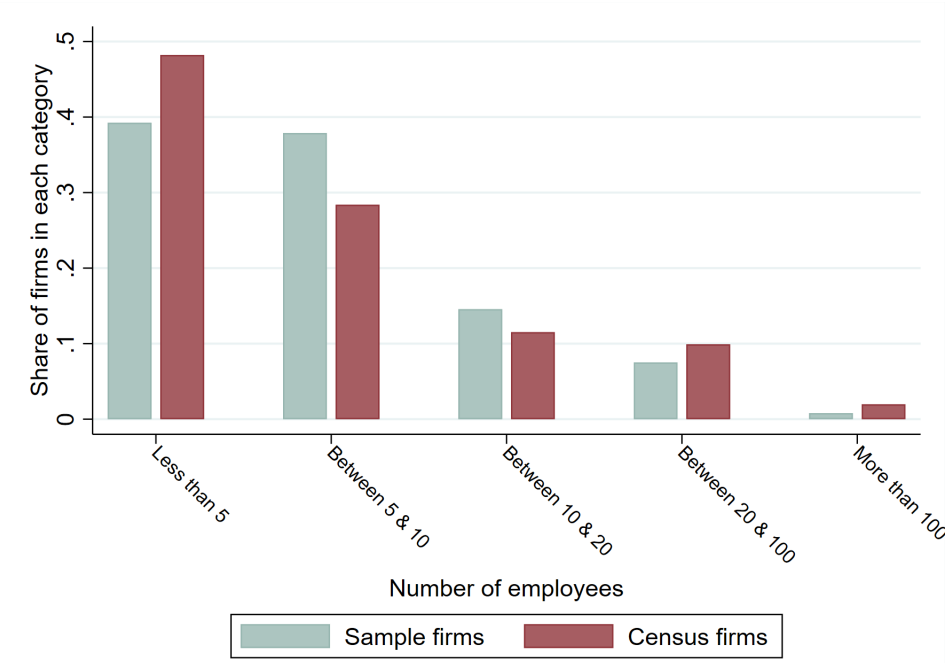
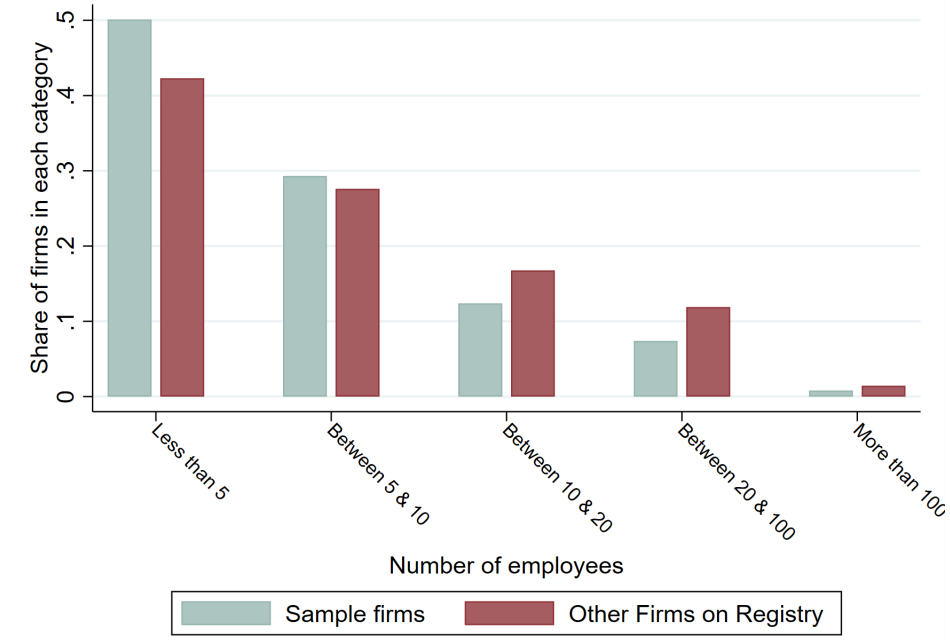
FIGURE 1: SIZE OF FIRMS IN THE SAMPLE

Panel A : Sample vs Census Firms



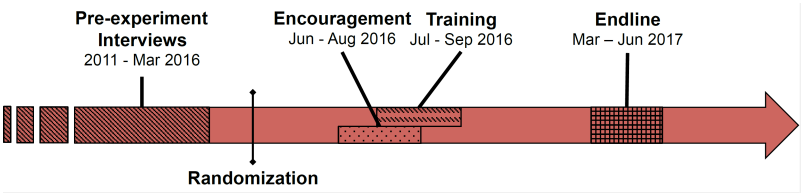
Panel B : Sample vs Other Firms on Registry



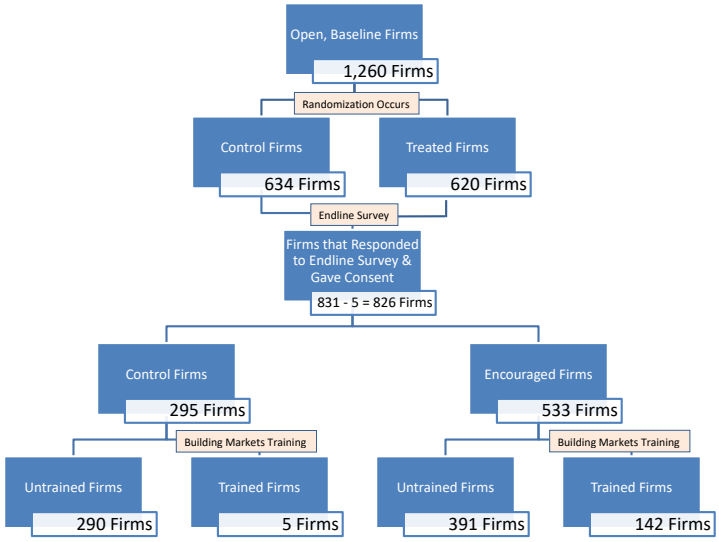
The two panels in this figure compare the size of firms in the sample with firms in the census (Panel A) and other firms listed in the non-profit's directory who have more than one employee and are located in Monrovia (Panel B). In both panels, bars show the share of firms in our sample in each category and the share of the comparison sample.

FIGURE 2: TIMELINE AND EXPERIMENTAL DESIGN

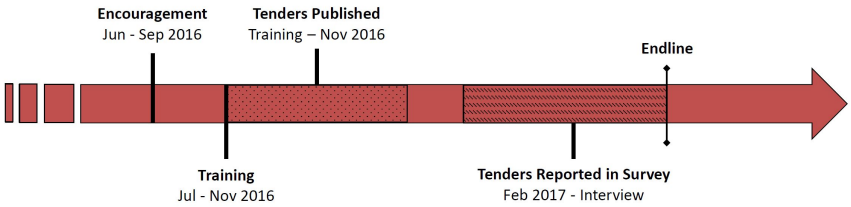
Panel A : Timeline



Panel B : Randomization Design

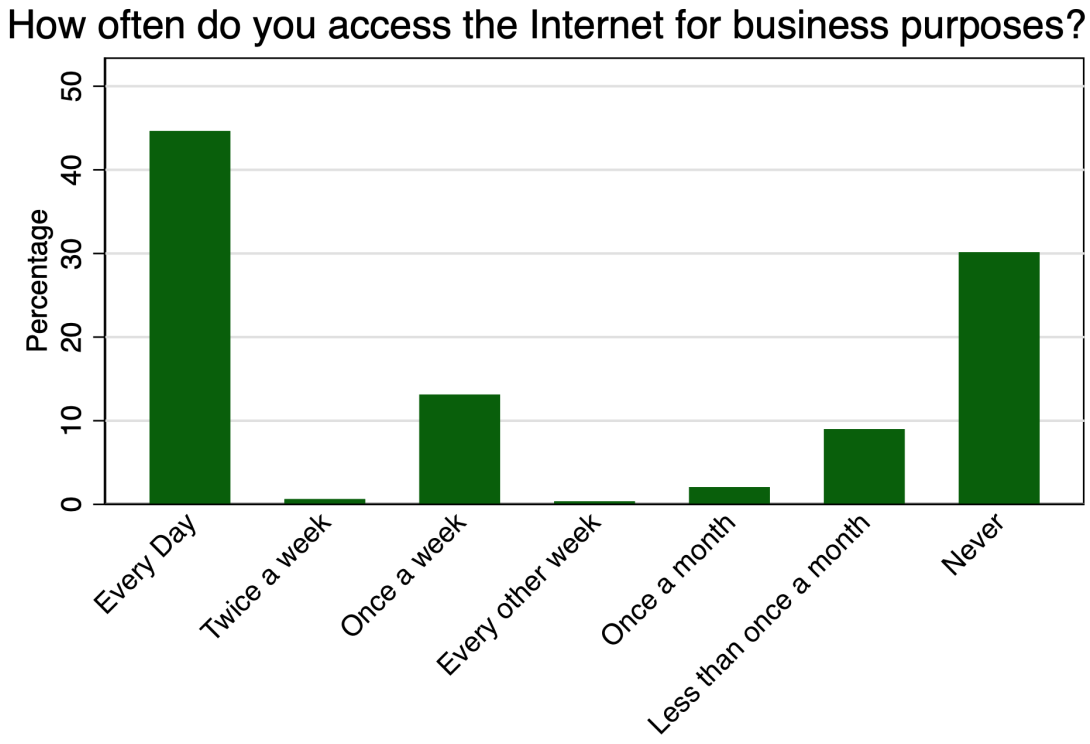


Panel C : Example of Timeline for one firm



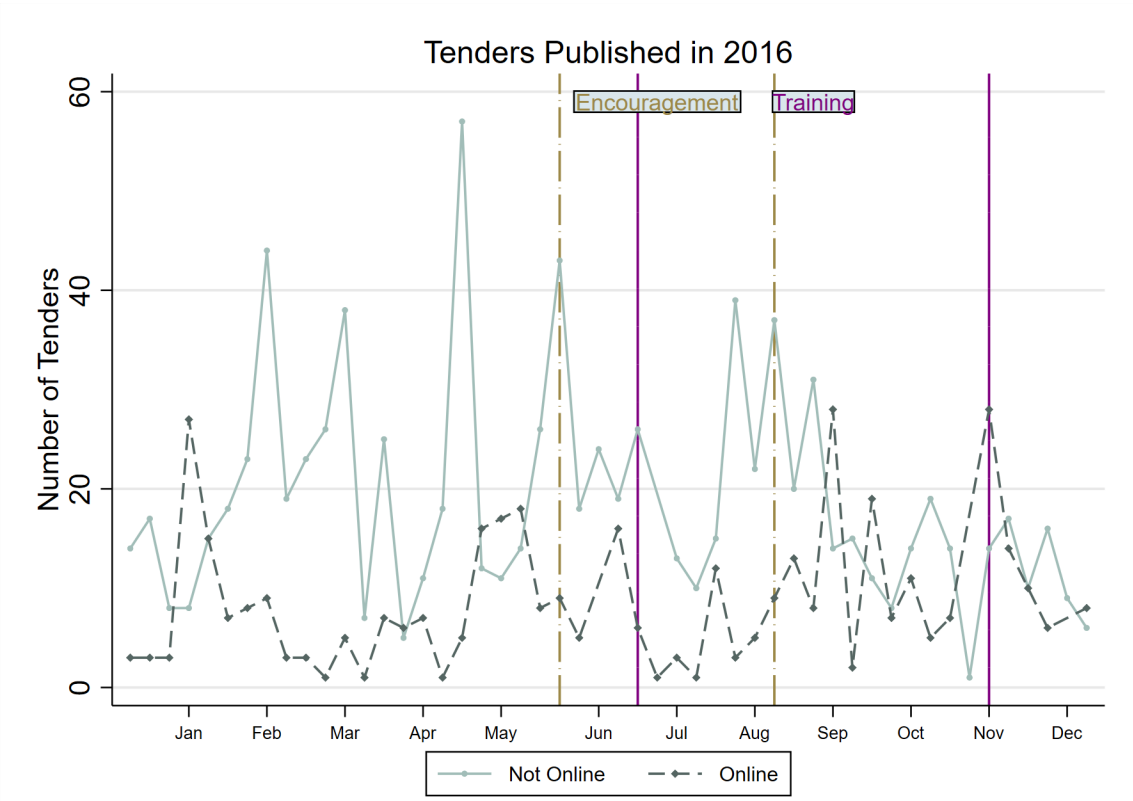
Panel A shows the timeline of the experiment evaluated in this paper. The experiment spanned from June 2016 to June 2017, with some pre-baseline interviews conducted before April 2016 by the non-profit. Panel B shows the number of firms in the sample at every step of the experiment. Open baseline firms are the firms which were in the non-profits' directory, which never took the training, which have at least one employee and which are located in Monrovia. These firms were randomly selected for treatment or control. For the endline survey, the research team tried to reach these firms and was able to track down and interview only 66% of them. Out of the 533 firms which interviewed at endline that were in the treatment group (the encouraged firms), 142 firms had taken the training. Panel C shows the timeline for a particular firm.

FIGURE 3: INTERNET ACCESS AT BASELINE



This graph plots the distribution of internet usage in the sample measured at baseline.

FIGURE 4: TIME SERIES OF TENDERS



This figure plots the time series of tenders published in 2016 from the non-profit's database aggregated at a weekly level. The trend for tenders published online and offline are plotted separately. The dotted lines represent the period of time when firms were encouraged to take the training while the solid lines mark the time period when the firms in our sample took the training.

TABLE 1: SUMMARY STATISTICS ON TENDERS

	Mean
Buyer	
Public Sector Buyers	0.51
International Organizations	0.47
Source	
Newspaper	0.57
Website	0.31
Word of mouth	0.12
Sectors	
Construction and Renovation	0.23
Automotive	0.11
Business and Consulting	0.10
Printing and Copying	0.09

This table presents summary statistics of 1,381 tenders published in Liberia in 2016. The data is based on a database of tenders compiled by the non-profit.

TABLE 2: SUMMARY STATISTICS ON SAMPLE FIRMS

	Mean	SD	Observations
Sectors			
Construction and Renovation	0.23	(0.42)	1192
Food and Beverages	0.16	(0.36)	1192
Home Essentials	0.13	(0.33)	1192
Handicrafts and Artisans	0.11	(0.32)	1192
Business and Consulting Services	0.09	(0.29)	1192
Owner Nationality			
Liberian	0.90	(0.30)	1192
Lebanese	0.05	(0.21)	1192
Nigerian	0.02	(0.14)	1192
Indian	0.01	(0.11)	1192
Other			
Total Number of Employees	14.19	(42.62)	1187
Bid on a tender in the past 6 months (Y=1; N=0)	0.21	(0.40)	847
Number of tenders bid on in the past 6 months	0.65	(1.62)	847
Won a tender in the past 6 months (Y=1; N=0)	0.12	(0.32)	876
Number of tenders won in the past 6 months	0.30	(1.16)	876
Proportion of tenders won (conditional on applying)	0.32	(0.37)	174
Ever won a contract lasting 6 months or more	0.76	(0.43)	179
Speaks at least one Liberian local language	0.34	(0.47)	1192
Accessed Internet for business purposes (1=Every day ; 7= Never)	3.61	(2.67)	1118

This table presents summary statistics of firms in the sample. The data is based on interviews conducted by the non-profit. A nationality of the business is determined if at least one of the owners has that particular nationality. The number of employees includes the owner or manager of the firm.

TABLE 3: BALANCE TABLE

	Full Sample		Restricted Sample	
	Diff. (T - C)	Std. Error	Diff. (T - C)	Std. Error
Sectors				
Construction and Renovation	-0.00	0.03	-0.02	0.03
Food and Beverages	-0.02	0.02	0.02	0.03
Home Essentials	0.00	0.02	0.02	0.03
Handicrafts and Artisans	0.00	0.02	0.00	0.02
Business and Consulting Services	0.00	0.02	0.02	0.02
Owner Nationality				
Liberian	-0.01	0.02	-0.01	0.02
Lebanese	-0.00	0.01	0.00	0.01
Nigerian	-0.00	0.01	-0.00	0.01
Indian	-0.00	0.01	-0.00	0.01
Other				
Total Number of Employees	-1.79	2.59	-0.66	2.73
Bid on a tender in the past 6 months (Y=1; N=0)	-0.02	0.02	-0.03	0.03
Number of tenders bid on in the past 6 months	-0.08	0.12	-0.13	0.15
Won a tender in the past 6 months (Y=1; N=0)	-0.01	0.02	-0.01	0.03
Number of tenders won in the past 6 months	0.09	0.08	0.14	0.11
Proportion of tenders won (conditional on applying)	-0.02	0.06	-0.04	0.07
Ever won a contract lasting 6 months or more	-0.04	0.07	0.01	0.09
Speaks at least one Liberian local language	-0.01	0.03	-0.06	0.03
Accessed Internet for business purposes (1=Every day ; 7= Never)	0.04	0.17	0.03	0.20

This table presents balance between firms of the treatment and control groups. "Full Sample" refers to the total sample at baseline, "Restricted Sample" refers to firms who responded to the endline survey. The data is based on phone interviews conducted by the non-profit. A nationality of the business is determined if at least one of the owners has that particular nationality. The number of employees includes the owner or manager of the firm.

TABLE 4: EFFECT OF VOUCHER + ENCOURAGEMENT ON TRAINING TAKE-UP

	Winning-Contracts Training	
	(1)	(2)
Voucher + Encouragement for Training	0.19***	0.20***
	(0.02)	(0.02)
Controls	NO	YES
Control Group Mean	0.01	0.01
Observations	1192	1143

Standard errors are in parentheses and are robust. This table presents coefficients of the regression of training take-up as recorded by the non-profit on encouragement. Controls include employment, counties of operation, gender of the owner, sectors, languages used for business, geographical zone and the number of submitted bids. All controls are measured before baseline.

TABLE 5: EFFECT OF WINNING-CONTRACTS TRAINING ON EXPECTED FUTURE BIDDING ON AND WINNING TENDERS

	How many tenders do you expect your firm to bid on in the next 6 months?		Of these, how many do you expect you will win?	
	(1)	(2)	(3)	(4)
	Treatment-on-the-Treated			
Winning-Contracts Training	0.85*	1.00**	0.86**	0.83**
	(0.46)	(0.44)	(0.40)	(0.38)
	Intent-to-Treat			
Voucher + Encouragement	0.22*	0.28**	0.22**	0.23**
	(0.12)	(0.12)	(0.10)	(0.11)
Controls	NO	YES	NO	YES
Control Group Mean	2.04	2.04	1.51	1.51
Observations	788	753	788	753

Standard errors are in parentheses and are robust. This table shows results from estimating Equation (5). The top panel presents the Treatment-on-the-Treated while the bottom panel presents the Intent-to-Treat estimates of attending the training. Controls include employment, counties of operation, gender of the owner, sectors, languages used for business, geographical zone and the number of submitted bids. All controls are measured before baseline. All outputs are referring to the period of 6 months preceding the interview. Columns (1) & (2) refer to the refer to the expectations of the manager about the future bids of the firm. Columns (3) & (4) refer to the expectations of the manager about the firm's future contracts won through tenders.

TABLE 6: EFFECT OF WINNING-CONTRACTS TRAINING ON CONTRACTS BID-ON AND CONTRACTS WON

	# of tenders bid on		Total # of contracts won		# of tenders won		# of contracts won w/o tender	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Treatment-on-the-Treated							
Winning-Contracts Training	0.53*	0.59**	1.19***	1.01***	0.24	0.28*	0.95***	0.72**
	(0.30)	(0.26)	(0.38)	(0.35)	(0.17)	(0.16)	(0.31)	(0.29)
	Intent-to-Treat							
Voucher + Encouragement	0.14*	0.16**	0.31***	0.28***	0.06	0.08*	0.25***	0.20**
	(0.08)	(0.07)	(0.09)	(0.10)	(0.04)	(0.05)	(0.08)	(0.08)
Controls	NO	YES	NO	YES	NO	YES	NO	YES
Control Group Mean	0.35	0.35	0.48	0.48	0.15	0.15	0.33	0.33
Observations	787	752	788	753	789	754	788	753

Standard errors are in parentheses and are robust. This table shows results from estimating Equation (5). The top panel presents the Treatment-on-the-Treated while the bottom panel presents the Intent-to-Treat estimates of the effect of training for firms who took the training. Controls include employment, counties of operation, gender of the owner, sectors, languages used for business, geographical zone and the number of submitted bids. All controls are measured before baseline. All outputs are referring to the period of 6 months preceding the interview. Columns (1) & (2) refer to the number of bids submitted for tenders. Columns (3) to (8) refer to the number of contracts won overall, through a tender process and without a tender process.

TABLE 7: EFFECT OF WINNING-CONTRACTS TRAINING ON THE QUALITY OF AND REVENUE FROM CONTRACTS WON

	PANEL A : QUALITY OF CONTRACTS	
	Won Long Lasting Contract	
	(1)	(2)
	Treatment-on-the-Treated	
Winning-Contracts Training	0.33**	0.30***
	(0.13)	(0.11)
	Intent-to-Treat	
Voucher + Encouragement	0.08***	0.08***
	(0.03)	(0.03)
Controls	NO	YES
Control Group Mean	0.23	0.23
Observations	789	754
	PANEL B : REVENUE FROM CONTRACTS	
	(1)	(2)
	Treatment-on-the-Treated	
Winning-Contracts Training	11058.0	10362.3
	(7989.81)	(6473.52)
	Intent-to-Treat	
Voucher + Encouragement	2866.0	2843.4
	(2067.38)	(1852.81)
Controls	NO	YES
Control Group Mean	5322.46	5322.46
Observations	789	754

Standard errors are in parentheses and are robust. This table shows results from estimating Equation (5). Panel A presents the Treatment-on-the-Treated and the Intent-to-Treat estimates of the effect of training on the quality of contracts for firms who attended the training. Quality of contracts is measured as whether firms won long lasting contracts i.e. contracts for longer than 6 months. Panel B presents the results for Treatment-on-the-Treated and Intent-to-Treat estimates of the training on the revenue from contracts. Controls include employment, counties of operation, gender of the owner, sectors, languages used for business, geographical zone and the number of submitted bids. All controls are measured before baseline. All outputs are referring to the period of 6 months preceding the interview. Appendix Table (A.4) reports results for additional measures of contract quality.

TABLE 8: HOW THE EFFECT OF WINNING-CONTRACTS TRAINING VARIES WITH INTERNET ACCESS

	# of tenders bid on		Total # of contracts won		# of tenders won		# of contracts won w/o tender	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Voucher + Encouragement for Training	-0.06	-0.13*	0.05	-0.06	-0.04	-0.06	0.10	-0.00
	(0.07)	(0.07)	(0.14)	(0.14)	(0.04)	(0.05)	(0.11)	(0.12)
Voucher + Encouragement × Internet	0.49***	0.70***	0.48**	0.65***	0.24**	0.31***	0.24	0.33*
	(0.18)	(0.19)	(0.23)	(0.24)	(0.11)	(0.12)	(0.19)	(0.20)
Controls	NO	YES	NO	YES	NO	YES	NO	YES
Control Group Mean	0.35	0.35	0.48	0.48	0.15	0.15	0.33	0.33
Observations	739	710	740	711	741	712	740	711

Standard errors are in parentheses and are robust. This table shows results from estimating Equation (6). Controls include employment, counties of operation, gender of the owner, sectors, languages used for business, geographical zone and the number of submitted bids. All controls are measured before baseline. Columns (1) & (2) refer to the number of bids submitted for tenders. Columns (3) to (8) refer to the number of contracts won overall, through a tender process and without a tender process.

TABLE 9: HOW THE EFFECT OF WINNING-CONTRACTS TRAINING VARIES WITH INTERNET ACCESS AND ONLINE DEMAND SHOCKS

	# of tenders bid on	Total # of contracts	# of tenders won	# of contracts won w/o tender	Won long-lasting ontract
	(1)	(2)	(3)	(4)	(5)
Voucher + Encouragement for Training	-0.20	-0.31	0.053	-0.36**	-0.02
	(0.18)	(0.21)	(0.09)	(0.18)	(0.06)
Voucher + Encouragement × Online Demand	-0.02	0.02	-0.08	0.09	-0.02
	(0.11)	(0.08)	(0.05)	(0.08)	(0.03)
Voucher + Encouragement × Internet	-0.17	0.43	-0.16	0.58**	0.07
	(0.37)	(0.31)	(0.18)	(0.27)	(0.11)
Voucher + Encouragement × Online Demand × Internet	0.24*	0.02	0.15**	-0.13	0.06*
	(0.14)	(0.09)	(0.06)	(0.08)	(0.03)
Controls	YES	YES	YES	YES	YES
Control Mean	0.35	0.48	0.15	0.33	0.23
Observations	710	711	712	711	712
Computed ATE (Internet, +ve Demand)	1.44	0.36	0.27	0.12	0.26

This table shows results from estimating Equation (10). It presents the heterogeneity of treatment effect with respect to Internet access at baseline and the online demand shock. Standard errors are in parentheses and are robust. Controls include employment, counties of operation, gender of the owner, sectors, languages used for business, geographical zone, the number of submitted bids, total number of tenders published in the sector from the predicted date of training, share of different types of tenders in the sector (tenders from local or international organizations, local or international governments, local or international private firms, local or international NGOs. All controls are measured before baseline. Columns (1) refers to the number of bids submitted for tenders. Columns (2) to (4) refer to the number of contracts won overall, through a tender process and without a tender process. Column (5) refers to whether firms won a contract lasting longer than 6 months.

TABLE 10: HOW THE EFFECT OF WINNING-CONTRACTS TRAINING VARIES WITH INTERNET ACCESS AND ONLINE DEMAND SHOCKS IN THE LONG-TERM

	# of tenders bid on	Total # of contracts	# of tenders won	# of contracts won w/o tender
	(1)	(2)	(3)	(4)
Voucher + Encouragement for Training	0.00	-0.12	0.04	-0.16
	(0.11)	(0.13)	(0.04)	(0.12)
Voucher + Encouragement × Online Demand	-0.06	-0.03	-0.03	0.00
	(0.08)	(0.06)	(0.03)	(0.05)
Voucher + Encouragement × Internet	-0.03	0.35*	-0.04	0.39**
	(0.28)	(0.21)	(0.10)	(0.18)
Voucher + Encouragement × Online Demand × Internet	0.17	0.03	0.05	-0.03
	(0.11)	(0.06)	(0.03)	(0.05)
Controls	YES	YES	YES	YES
Control Mean	0.13	0.22	0.06	0.16
Observations	712	712	712	712
Computed ATE (No Internet, No Demand)	0.67	-0.01	0.11	-0.12

This table presents the heterogeneity of treatment effect with respect to Internet access at baseline and the online demand shock on outputs measured after the demand shock. At endline, we asked firms for the dates since the baseline interview on which they bid on tenders and won contracts. For a subset of tenders, we also observe the opening and closing dates. Ninety percent of the tenders in our sample are open for bidding less that 30 days, with a mean of 15 days. The tenders that form part of short-run demand shocks as we measure them and the ones that form part of the outcome we consider in this sub-section are thus very unlikely to overlap. Two firms in our sample took the training in November, 2016 (the last date training date offered by the non-profit we partner with), which does not allow us to properly ensure that there is no overlap. For these two firms, we only count tenders and contracts applied to and won on or after February 2017. Standard errors are in parentheses and are robust. Controls include employment, counties of operation, gender of the owner, sectors, languages used for business, geographical zone, the number of submitted bids, total number of tenders published in the sector from the predicted date of training, share of different types of tenders in the sector (tenders from local or international organizations, local or international governments, local or international private firms, local or international NGOs. All controls are measured before baseline. Column (1) refers to the number of bids submitted for tenders. Columns (2) to (4) refer to the number of contracts won overall, through a tender process and without a tender process.

A Appendix

TABLE A.1: ATTRITION

	Not Interviewed	Interviewed	Diff.	P-Val.
Sectors				
Construction and Renovation	0.20	0.25	-0.05**	0.04
Food and Beverages	0.16	0.16	0.00	0.97
Home Essentials	0.12	0.13	-0.01	0.69
Handicrafts and Artisans	0.11	0.12	-0.01	0.58
Business and Consulting Services	0.08	0.10	-0.02	0.22
Owner Nationality				
Liberian	0.87	0.92	-0.04**	0.02
Lebanese	0.05	0.04	0.01	0.29
Nigerian	0.04	0.01	0.02**	0.01
Indian	0.01	0.01	-0.01	0.18
Other				
Total Number of Employees	12.08	15.11	-3.03	0.26
Bid on a tender in the past 6 months (Y=1; N=0)	0.17	0.22	-0.05	0.12
Number of tenders bid on in the past 6 months	0.55	0.70	-0.14	0.23
Won a tender in the past 6 months (Y=1; N=0)	0.09	0.13	-0.04*	0.07
Number of tenders won in the past 6 months	0.19	0.35	-0.15*	0.07
Proportion of tenders won (conditional on applying)	0.29	0.33	-0.04	0.57
Ever won a contract lasting 6 months or more	0.82	0.73	0.09	0.21
Speaks at least one Liberian local language	0.30	0.36	-0.05*	0.07
Accessed Internet for Business Purposes (1 = Every day ; 7 = Never)	3.69	3.57	0.12	0.48
Treatment Group	0.67	0.64	0.03	0.34

This table presents differential attrition between firms who responded to endline interviews and firms who did not. The data is based on phone interviews conducted by the non-profit. A nationality of the business is determined if at least one of the owners has that particular nationality. The number of employees includes the owner or manager of the firm.

TABLE A.2: SUMMARY STATISTICS OF NON - ATTRITERS

	Mean	SD	Observations
Sectors			
Construction and Renovation	0.25	(0.43)	828
Food and Beverages	0.16	(0.36)	828
Home Essentials	0.13	(0.34)	828
Handicrafts and Artisans	0.12	(0.32)	828
Business and Consulting Services	0.10	(0.30)	828
Owner Nationality			
Liberian	0.92	(0.28)	828
Lebanese	0.04	(0.20)	828
Nigerian	0.01	(0.11)	828
Indian	0.01	(0.12)	828
Other			
Total Number of Employees	15.11	(45.69)	825
Bid on a tender in the past 6 months (Y=1; N=0)	0.22	(0.41)	587
Number of tenders bid on in the past 6 months	0.70	(1.65)	587
Won a tender in the past 6 months (Y=1; N=0)	0.13	(0.34)	609
Number of tenders won in the past 6 months	0.35	(1.31)	609
Proportion of tenders won (conditional on applying)	0.33	(0.37)	129
Ever won a contract lasting 6 months or more	0.73	(0.45)	119
Speaks at least one Liberian local language	0.36	(0.48)	828
Accessed Internet for Business Purposes (1 = Every day ; 7 = Never)	3.57	(2.67)	741

This table presents summary statistics of firms who responded to the endline survey. The data is based on phone interviews conducted by the non-profit. A nationality of the business is determined if at least one of the owners has that particular nationality. The number of employees includes the owner or manager of the firm.

TABLE A.3: EFFECT OF VOUCHER + ENCOURAGEMENT ON TRAINING TAKE-UP

PANEL A : BASED ON ATTENDANCE				
	General Procurement Training (Part 1/2)		Bid Compilation Training (Part 2/2)	
	(1)	(2)	(3)	(4)
Voucher + Encouragement for Training	0.19***	0.20***	0.16***	0.17***
	(0.02)	(0.02)	(0.01)	(0.02)
Controls	NO	YES	NO	YES
Control Group Mean	0.01	0.01	0.01	0.01
Observations	1192	1143	1192	1143
PANEL B : SELF-REPORTED				
	Did Your Firm Go Through Training		How Many Training Sessions did Your Firm Attend	
	(1)	(2)	(3)	(4)
Voucher + Encouragement for Training	0.14***	0.16***	0.33***	0.36***
	(0.04)	(0.04)	(0.11)	(0.11)
Controls	NO	YES	NO	YES
Control Group Mean	0.51	0.51	0.68	0.68
Observations	789	754	789	754

Standard errors are in parentheses and are robust. This table presents coefficients of the regression of training take-up as recorded by the non-profit on encouragement. Controls include employment, counties of operation, gender of the owner, sectors, languages used for business, geographical zone and the number of submitted bids. All controls are measured at baseline. Panel A measures training attendance using data collected by the non-profit, while Panel B measures attendance based on self-reported attendance by the Firms. Columns (1) to (4) refer to the two parts of the training delivered by the non-profit. Columns (1) and (2) refer to the "General Procurement" training. Column (3) and (4) refer to the "Bid Compilation" training. The General Procurement training is a requirement for the Bid Compilation training. Panel B refers to training take-up as reported by the firm. This includes all types of training, not only the training studied in the scope of this paper.

TABLE A.4: EFFECT OF WINNING-CONTRACTS TRAINING ON BIDDING ON TENDERS, PROPORTION OF ALL RELEVANT TENDERS BID-ON AND WON, AND ON WORKING WITH INTERNATIONAL CLIENTS

	Bid on tenders in the past 6 months		Proportion of all relevant tenders bid on		Proportion of all relevant tenders won		Ever worked with international clients	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Treatment-on-the-Treated							
Winning-Contracts Training	0.09	0.13	0.05**	0.05**	0.02*	0.02**	0.31**	0.29**
	(0.11)	(0.10)	(0.02)	(0.02)	(0.01)	(0.01)	(0.13)	(0.12)
	Intent-to-Treat							
Voucher + Encouragement	0.02	0.04	0.01**	0.01**	0.01*	0.01**	0.08**	0.08**
	(0.03)	(0.03)	(0.01)	(0.01)	(0.00)	(0.00)	(0.03)	(0.03)
Controls	NO	YES	NO	YES	NO	YES	NO	YES
Control Group Mean	0.17	0.17	0.01	0.01	0.00	0.00	0.29	0.29
Observations	787	752	787	752	789	754	789	754

Standard errors are in parentheses and are robust. This table shows results from estimating Equation (5). The top panel presents the Treated on the Treated Estimate while the bottom panel presents the Intent to Treat estimate. Controls include employment, counties of operation, gender of the owner, sectors, languages used for business, geographical zone and the number of submitted bids. All controls are measured at baseline. All outputs are referring to the period of 6 months preceding the interview. Columns (1) & (2) refer to whether the firm submitted bids for tenders. Columns (3) & (4) refer to the proportion of tenders the firm applied to over total number of tenders in its sector(s). Columns (5) & (6) refer to the proportion of tenders the firm won over total number of tenders in its sector(s). Columns (7) & (8) refer to whether the firm ever worked with international clients.

TABLE A.5: BASELINE CORRELATION BETWEEN FIRM CHARACTERISTICS AND INTERNET ACCESS

	Total # of employees	# of tenders bid on	# of tenders won	# of contracts won w/o tender	Ability to access tenders easily (1-10)
	(1)	(2)	(3)	(4)	(5)
Internet	14.05***	1.06***	0.32***	0.08	1.93***
	(3.92)	(0.14)	(0.06)	(0.12)	(0.53)
Constant	5.09***	0.13**	0.04*	0.50***	5.71***
	(1.04)	(0.06)	(0.02)	(0.08)	(0.39)
Observations	546	546	544	546	265

Standard errors are in parentheses and are robust. This table looks at the correlation of baseline Internet usage with firm characteristics correlated with unobservable firm quality. All variables are measured at baseline.

TABLE A.6: HOW EFFECT OF WINNING-CONTRACTS TRAINING ON CONTRACT QUALITY VARIES WITH INTERNET ACCESS

	PANEL A : QUALITY OF CONTRACTS	
	Won Long Lasting contract	
	(1)	(2)
Voucher + Encouragement for Training	-0.01	-0.03
	(0.04)	(0.04)
Voucher + Encouragement × Internet	0.21***	0.26***
	(0.08)	(0.08)
Controls	NO	YES
Control Group Mean	0.23	0.23
Observations	741	712
	PANEL B : REVENUE FROM CONTRACTS	
	(1)	(2)
Voucher + Encouragement	-812.82	-1431.60
	(742.22)	(1121.16)
Voucher + Encouragement × Internet	9917.22**	10523.54**
	(4454.00)	(4281.64)
Controls	NO	YES
Control Group Mean	5322.46	5322.46
Observations	741	712

Standard errors are in parentheses and are robust. The table presents results from estimating Equation (5) Controls include employment, counties of operation, gender of the owner, sectors, languages used for business, geographical zone and the number of submitted bids. All controls are measured at baseline. All outputs are referring to the period of 6 months preceding the interview. In Panel A, the outcome variable is an indicator for whether or not the firm ever had a contract longer than 6 months. In Panel B, the outcome variable is the revenue from contracts over the past 6 months.

TABLE A.7: HOW EFFECT OF WINNING-CONTRACTS TRAINING VARIES WITH INTERNET ACCESS CONTROLLING FOR INTERACTION WITH OTHER FIRM CHARACTERISTICS

	# of tenders bid on	Total # of contracts	# of tenders won	# of contracts won w/o tender	Won long lasting contract	Revenue from contracts (USD)
	(1)	(2)	(3)	(4)	(5)	(6)
V + E for Training	0.19	-0.18	0.02	-0.20	-0.06	-1711.25
	(0.21)	(0.31)	(0.12)	(0.27)	(0.09)	(4401.27)
Voucher + Encouragement × Internet	0.41*	0.52*	0.29***	0.23	0.28***	9649.83***
	(0.21)	(0.26)	(0.11)	(0.22)	(0.09)	(3552.41)
Controls	YES	YES	YES	YES	YES	YES
Controls Interacted w/ Treatement	YES	YES	YES	YES	YES	YES
Control Group Mean	0.35	0.48	0.15	0.33	0.23	5322.46
Observations	739	740	741	740	741	741

Standard errors are in parentheses and are robust. Controls include employment, counties of operation, gender of the owner, sectors, languages used for business, geographical zone and the number of submitted bids. All controls are measured at baseline. The interaction of all controls with treatment are also included. Column (1) refers to the number of bids submitted for tenders. Columns (2) to (4) refer to the number of contracts won overall, through a tender process and without a tender process. Column (5) refers to whether firms won long term contracts while column (6) refers to the total value of contracts won by firms.

TABLE A.8: RESULTS OF LASSO PROCEDURE

Variable	Times_Kept	Average_Coefficient
Of the total number of employees, how many are permanent employees?	1	0.00260
Of the total number of employee, how many are temporary employees?	1	0.00590
Of the total number of employees how many are family members of the owner(s)?	0	.
Have you ever responded to a tender or submitted a bid?	99	0.0310
At least one of the owners has an Americo-Liberian name	0	.
Have you responded to a tender or submitted a bid in the past 6 months?	67	0.0438
Number of tenders submitted in the past six months	55	0.0107
Number of contracts won through tenders in the past six months	78	0.0553
Do you import?	0	.
Have you ever had a contracts for the government?	0	.
Have you ever had a contracts for an NGO?	10	0.0487
Have you ever had a contracts for an international client?	46	0.0378
How often do you use the Internet for business purposes?	194	0.122

This table presents the results of the LASSO procedure developped in section 5.3.2. The LASSO estimation predicts what variables, interacted with treatment, best explain the heterogeneity if the effect observed. The first column shows the number of times each variable was kept out of the 200 LASSO estimations. The second column shows the average coefficient of each variables, accross LASSO procedures.

TABLE A.9: BASELINE CORRELATION BETWEEN FIRM CHARACTERISTICS AND INTERNET-BASED DEMAND SHOCK

	Total # of employees	# of tenders bid on	# of tenders won	# of contracts won w/o tender	Ability to access tenders easily (1-10)
	(1)	(2)	(3)	(4)	(5)
Online Demand Shock	-0.05	0.01	0.00	0.00	0.01
	(0.10)	(0.01)	(0.00)	(0.01)	(0.02)
Constant	11.96***	0.64***	0.20***	0.52***	6.90***
	(1.70)	(0.06)	(0.03)	(0.05)	(0.18)
Observations	582	582	580	582	285

Standard errors are in parentheses and are robust. This table shows the correlation between the share of tenders published online in the week before the encouragement and baseline characteristics.

TABLE A.10: HOW THE EFFECT ON TRAINING TAKE-UP VARIES WITH INTERNET AND ONLINE DEMAND SHOCKS

	Training Take-up
	(1)
Assignment to Treatment	0.11***
	(0.03)
Voucher + Encouragement	0.02
× Online Demand	(0.01)
Voucher + Encouragement	-0.01
× Internet	(0.05)
Voucher + Encouragement	
× Online Demand	
× Internet	0.00
	(0.01)
Controls	YES
Control Mean	0.01
Observations	1077

This table presents the results from estimating Equation (10). It shows the heterogeneity of treatment effect with respect to Internet access at baseline and the internet-based demand shock on take up of both types of training.Standard errors are in parentheses and are robust. Controls include employment, counties of operation, gender of the owner, sectors, languages used for business, geographical zone, the number of submitted bids, total number of tenders published in the sector, share of different types of tenders in the sector (tenders from local or international orgnizations, local or international governments, local or international private firms, local or international NGOs. All controls are measured at baseline.

TABLE A.11: HOW THE EFFECT OF WINNING-CONTRACTS TRAINING VARIES WITH INTERNET ACCESS AND OVERALL DEMAND SHOCKS

	# of tenders bid on	Total # of contracts	# of tenders won	# of contracts won w/o tender	Won long-lasting contract
	(1)	(2)	(3)	(4)	(5)
Voucher + Encouragement for Training	-0.30	-0.43**	-0.01	-0.41**	-0.06
	(0.22)	(0.21)	(0.08)	(0.18)	(0.07)
Voucher + Encouragement × Total Demand	0.02	0.05*	-0.01	0.05**	0.00
	(0.03)	(0.02)	(0.01)	(0.02)	(0.01)
Voucher + Encouragement × Internet	0.01	0.51	-0.11	0.61**	0.13
	(0.38)	(0.32)	(0.17)	(0.26)	(0.11)
Voucher + Encouragement × Total Demand × Internet	0.04	-0.02	0.03**	-0.05*	0.01
	(0.04)	(0.03)	(0.02)	(0.03)	(0.01)
Controls	YES	YES	YES	YES	YES
Control Mean	0.35	0.48	0.15	0.33	0.23
Observations	710	711	712	711	712
Computed ATE (Internet, +ve Demand)	0.28	0.35	0.13	0.22	0.14

This table shows results from estimating Equation (10). It presents the heterogeneity of treatment effect with rspect to Internet access at baseline and the online demand shock. Standard errors are in parentheses and are robust. Controls include employment, counties of operation, gender of the owner, sectors, languages used for business, geographical zone, the number of submitted bids, total number of tenders published in the sector from the predicted date of training, share of different types of tenders in the sector (tenders from local or international organizations, local or international governments, local or international private firms, local or international NGOs. All controls are measured before baseline. Columns (1) refers to the number of bids submitted for tenders. Columns (2) to (4) refer to the number of contracts won overall, through a tender process and without a tender process. Column (5) refers to whether firms won long term contracts i.e. contracts longer than six months.