

Job Search and Hiring with Limited Information about Workseekers' Skills[†]

By ELIANA CARRANZA, ROBERT GARLICK, KATE ORKIN, AND NEIL RANKIN*

We assess South African workseekers' skills and disseminate the assessment results to explore how limited information affects firm and workseeker behavior. Giving workseekers assessment results that they can credibly share with firms increases workseekers' employment and earnings and better aligns their skills, beliefs and search strategies. Giving workseekers assessment results that they cannot easily share with firms has similar effects on beliefs and search, but smaller effects on employment and earnings. Giving assessment results only to firms shifts interview decisions. These findings show that getting credible skill information to the right agents can improve outcomes in the labor market. (JEL J22, J23, J24, J31, J41, J64, O15)

Workseekers make job search decisions and firms make hiring decisions using potentially limited information about workseekers' skills. Limited information for firms can lead to hiring poorly matched workers and to wedges between wage offers and productivity (Altonji and Pierret 2001; Arcidiacono, Bayer, and Hizmo 2010; Farber and Gibbons 1996; Kahn and Lange 2014). These hiring distortions can reduce both employment and average wages conditional on employment (Aigner

*Carranza: World Bank (email: ecarranza@worldbank.org); Garlick: Duke University (email: robert.garlick@duke.edu); Orkin: University of Oxford (email: kate.orkin@bsg.ox.ac.uk); Rankin: University of Stellenbosch (email: neilrankin@sun.ac.za). Esther Duflo was the coeditor for this article. We are grateful for helpful comments from the editor, anonymous referees, Martin Abel, Peter Arcidiacono, Vittorio Bassi, Paolo Belli, Emily Breza, Rulof Burger, Stefano Caria, Jishnu Das, Giacomo di Giorgi, Taryn Dinkelman, Rebecca Dizon-Ross, Stefan Dercon, Erica Field, Gary Fields, Simon Franklin, Doug Gollin, Marek Hanusch, Rachel Heath, Lukas Hensel, Clement Imbert, Lisa Kahn, Julien Labonne, Clare Leaver, David McKenzie, Melanie Morten, Simon Quinn, Imran Rasul, Duncan Thomas, Gabriel Ulyssea, Ian Walker, Chris Woodruff; and seminar participants at the Barcelona Summer Forum, Berkeley, BREAD Fall Meetings, Duke, Georgia, Harvard/MIT, NBER Summer Institute, Notre Dame, NYU, Oxford, SoLE conference, UIUC, and the World Bank. We appreciate exceptional research assistance from Wim Louw, Wendy Trott, Shelby Carvalho, Allegra Cockburn, Goodwill Mpofu, Emmanuel Bakirdjian, and Nilmini Herath in South Africa; and Lukas Hensel, Svetlana Pimkina, Laurel Wheeler, Brynde Kreft, Stephanie Palla, Rachel Sayers, Gabriel Cunha, and Jenn Kades at our institutions. Thanks to staff at the Harambee Youth Employment Accelerator, the Abdul Latif Jameel Latif Poverty Action Lab Africa Office, and our institutions. The project is conducted in collaboration with the World Bank Jobs Group (<https://www.worldbank.org/en/topic/jobsanddevelopment>) and Africa Gender Innovation Lab (<https://www.worldbank.org/en/programs/africa-gender-innovation-lab>), and received funding from the National Science Foundation (1824413), Private Enterprise Development in Low Income Countries (3024 and 4728), W. E. Upjohn Institute for Employment Research, and the UKRI GCRF Accelerating Achievement for Africa's Adolescents Hub. This study has been approved by the University of Cape Town Commerce Faculty Ethics in Research Committee, the Duke Institutional Review Board for the Protection of Human Subjects in Non-medical Research (D0368) and the Oxford Department of Economics Research Ethics Committee (ECONCIA15-055). This study is preregistered at <https://doi.org/10.1257/rct.1631-8.0> (Carranza et al. 2020). The authors' views do not necessarily represent the views of the World Bank or the governments of the countries they represent.

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and Cain 1977; Pallais 2014). Limited information for workseekers can lead them to search for jobs that poorly match their skills or withdraw from search entirely (Belot, Kircher, and Muller 2019; Conlon et al. 2018). These search distortions can also lead to lower employment and lower wages conditional on employment. When both sides of the market receive credible information on workseekers' skills or past performance, these workseekers' labor market outcomes can improve (Abebe et al. 2021; Abel, Burger, and Piraino 2020; Bassi and Nansamba 2020; Pallais 2014). These information problems may be particularly important in settings where hiring is less formal and education provides less information about skills (Pritchett 2013). Limited information may exacerbate other frictions in developing country labor markets, such as high search and migration costs (Abebe, Caria, and Ortiz-Ospina 2020; Bryan, Choudhury, and Mobarak 2014; Franklin 2017).

We study how providing additional information about workseekers' skills affects job search, hiring, and workseekers' labor market outcomes. We run a series of field experiments that manipulate firms' and workseekers' information about workseekers' skills. We provide evidence that *both* firms *and* workseekers adjust their behavior when they acquire new information about workseekers' skills, suggesting they both face limited information. Their responses lead to substantial improvements in workseekers' outcomes in the labor market. The magnitude of effects suggests such information frictions may be an important target of government policy. The finding that both firms and workseekers respond to information is important both conceptually and for the design of information-provision products and policies. Many existing policies provide information directly to only one side of the market and may have different returns depending on whether this information can be shared with the other side of the market. For example, workseeker skill assessments offered in job search assistance programs can help workseekers to change job search strategies. But their returns may be different if the workseekers can also credibly share the assessment results with prospective employers. Most existing papers study only one side of the market or study simultaneous information revelation to both workseekers and firms.

We study firms' and workseekers' responses to learning workseekers' results on standardized skill assessments. The assessments measure nonspecialist skills such as communication, numeracy, and grit and draw on existing tools used by job placement agencies and large firms. The 6,891 assessed workseekers are drawn from a population where limited information may be important. They are unemployed or underemployed black youths in urban South Africa with limited postsecondary education, work experience, and access to referral networks. This population faces statistical discrimination in this labor market and has limited information about labor market prospects (Banerjee and Sequeira 2020; Malindi 2017; Pugatch 2018).

We demonstrate the consequences of limited information about workseekers' skills in this labor market in three steps. First, we show that giving workseekers their results from these assessments and enabling them to easily and credibly share the results with firms improves the workseekers' labor market outcomes. To show this, we randomly select some workseekers for a "public" certification intervention. We give them electronic and physical certificates describing the assessments and showing their results. The certificates show their names and national identity numbers and are branded by the widely known agency that conducts the assessments and the World Bank. We compare these workseekers to a control group of workseekers

who receive no certificates and do not learn their results. In the three to four months following certification, publicly certified workseekers shift their beliefs about their skills closer to their assessment results, target their search toward jobs that they think value their skills, and use certificates in job applications. Their employment rate increases by 17 percent (5 percentage points), weekly earnings increase by 34 percent, and hourly wages increase by 20 percent relative to the control group. The rise in earnings reflects both higher employment and higher earnings conditional on employment.

Second, we show that these labor market effects are smaller when workseekers cannot easily and credibly share assessment results with firms. To show this, we randomly select some assessed workseekers for a “private” certification intervention. This intervention gives them one physical certificate that shows their assessment results and describes the assessments, but deliberately excludes features designed to make the public certificate credible to firms: branding and the workseekers’ identifying information. Private and public certification have very similar effects on workseekers’ beliefs about their skills and how they target job search based on their skills. But private certification has no effect on employment and raises earnings by less than public certification. The relative outcomes in the private certification and control groups suggest but do not prove that workseeker responses to additional information contribute to improved labor market outcomes. The relative outcomes in the public and private certification groups suggests an important role for firm responses to additional information and highlight the importance of getting credible information to firms as well as workseekers. A small share of workseekers also use private certificates in job applications, but this does not appear to explain the positive earnings effects of private certification.¹

Third, we show that directly giving firms information about workseekers’ skills changes their behavior. To show this, we run an audit/correspondence experiment that manipulates firms’ information without scope for changes in workseeker behavior. We submit applications to real job vacancies using real resumes from workseekers in our sample. We submit multiple applications per vacancy, randomizing whether applications include public certificates. When only one application sent to a vacancy includes a certificate, that application is 11 percent more likely to get an interview than the applications without certificates. But this benefit vanishes as the vacancy gets more applications with certificates. This pattern is consistent with firms acting on information from skill certification, although their actions may depend on the scale of certification.

These three experiments demonstrate our main finding: additional information about workseekers’ skills improves labor market outcomes, but it matters who gets this information and how credibly and easily it can be shared. In addition, we present four secondary findings about the role of limited information in this labor market. These findings rely on heterogeneity analysis and smaller experiments and we interpret them as suggestive rather than conclusive. First, learning specific assessment

¹ The positive earnings effect of private certification is driven by workseekers who do *not* use the certificates in job applications. This suggests that the private effect on earnings is not primarily driven by information transmission to firms, consistent with the unbranded, unidentified design of the private certificates. However, we cannot rule out some role for information transmission to firms.

results is important, not just learning that workseekers have been assessed. The certification effects are not driven, for example, by firms using workseekers' decisions to get assessed as a signal for tenacity or proactivity, or by firms basing hiring decisions purely on the certificates' branding. Second, the certification effects are more consistent with horizontal than vertical differentiation of workseekers: certification helps firms identify which workseekers are suited for different jobs more than it helps firms identify a subset of workseekers suited for all jobs.² This may occur because, in this context, preferences for different skills vary across firms and relative performance in different assessments varies across workseekers. Third, certification has larger effects on the labor market outcomes of workseekers who lack other ways to communicate their skills to employers, like work experience and university education. Fourth, although we do not directly observe if certified workseekers become employed at the expense of workseekers outside our sample, most of our results are consistent with economic mechanisms in which certification can increase total employment.

Our main contribution is to study workseeker and firm responses to additional information about workseekers' skills, highlighting the importance of information that is easily and credibly shared. This extends existing work documenting labor market patterns consistent with either firms alone or workseekers alone facing limited information, in both developed and developing economies.³ We build on this work by showing that *both* firms and workseekers in the same labor market respond to new information about workseekers' skills. Our work is most similar to studies that provide information to both firms and workseekers about skill assessment results (Abebe et al. 2021; Bassi and Nansamba 2020; Groh et al. 2015) or evaluations from workseekers' past employers (Abel, Burger, and Piraino 2020; Pallais 2014). We build on this work by experimentally varying which agents receive the information and how credibly and easily it can be shared.⁴

Understanding how different agents respond to information is important for designing mechanisms that private actors or governments can use to address limited information. Separate firm-facing and workseeker-facing mechanisms are common, but their effects may depend on the information available to the other side of the market. For example, on the workseeker side, some job search assistance programs offer skill assessments to workseekers (McCall, Smith, and Wunsch 2016). This can inform workseekers and improve their search targeting. But if firms do not learn

²This finding is consistent with recent work on information frictions in matching models with multidimensional skills (Fredriksson, Hensvik, and Skans 2018; Guvenen et al. 2020; Lise and Postel-Vinay 2020).

³Altonji and Pierret (2001); Arcidiacono, Bayer, and Hizmo (2010); Farber and Gibbons (1996); and Kahn and Lange (2014) show that wages align more closely with skills as tenure increases, consistent with firms' facing limited information about skills at the time of hiring. Wage and retention patterns for workers hired through referrals are also consistent with limited information (Ioannides and Loury 2004; Heath 2018) and some researchers find that workers have better labor market outcomes when they have formal educational qualifications, conditional on measured skills (Alfonsi et al. 2017; MacLeod et al. 2017). Workseekers can have systematically inaccurate beliefs about their labor market prospects (Spinnewijn 2015) and their job search decisions can change when they learn more about their prospects (Ahn, Dizon-Ross, and Feigenberg 2019; Altmann et al. 2018; Banerjee and Sequeira 2020; Belot, Kircher, and Muller 2018), although these papers do not specifically examine limited information about workseekers' skills.

⁴Abel, Burger, and Piraino (2020) reveal reference letters to both sides of the market and only to firms, but do not measure workseeker belief updating or search targeting. Related work by Banerjee and Chiplunkar (2020) studies the implications of university placement officers having limited information about workseekers' preferences over job types.

these assessment results, then firms' hiring choices and wage offers will remain distorted and workseekers' improved search will have limited returns. On the firm side, skill assessments are sometimes used to inform firm hiring decisions (Autor and Scarborough 2008; Hoffman, Kahn, and Li 2018). But if workseekers have limited information, they might not apply for jobs that match their skills, leaving firms to assess and select from a suboptimal pool of applicants. Alonso (2018) shows theoretically that giving better information to only firms or only workseekers in labor market matching can reduce welfare when they cannot or will not share that information with the other side of the market.

Second, this paper complements work on the aggregate implications of limited information in the labor market. Canonical models show that search and matching frictions facing individual workseekers and firms can generate aggregate unemployment (Mortensen and Pissarides 1999). Our findings offer an experimental foundation for general equilibrium models that show how either firms' or workseekers' limited information about match productivity can distort aggregate employment (Jovanovic 1979; Gonzalez and Shi 2010). In particular, our findings complement work by Donovan, Lu, and Schoellman (2018), who show that models with limited information about workseekers' skills can explain aggregate labor market dynamics in developing countries. We borrow the language of the search and matching literature, referring to distortions in workseeker and/or firm behavior due to limited information as "information frictions."

Third, our findings on information frictions are relevant to the design of active labor market programs (ALMPs). We show that a skill assessment and certification intervention, delivered during recruitment for an ALMP, can substantially and cheaply improve participants' employment and earnings. The employment effect is almost three times larger than the mean effect size of the active labor market programs reviewed by Card, Kluve, and Weber (2017). The average earnings gain in the first three months after treatment is 5.6 times the average variable cost of adding this certification intervention onto an existing assessment program and 2.3 times the average variable cost of assessment and certification.⁵ Skill assessment and certification may enhance the value of ALMPs to participating workseekers even when other mechanisms for learning about workseekers' skills exist. Importantly, certification is available to first-time workseekers, unlike reference letters or performance evaluations from past employers (Abel, Burger, and Piraino 2020; Pallais 2014). Assessment results can be certified to multiple employers, while workplace performance at one employer may be imperfectly observed by other employers (Kahn 2013). Certification can help workseekers excluded from referral networks or firms who receive referrals based on factors poorly aligned with workseekers' skills (Beaman and Magruder 2012; Beaman, Keleher, and Magruder 2018; Chandrasekhar, Morten, and Peter 2020).

We describe the economic environment in Section I: a simple conceptual framework, the context, the sample, and the skill assessments. In Section II, we describe the public skill certification experiment and the treatment effects on workseekers' labor

⁵In a similar spirit, several papers show that making low-cost changes to ALMPs so they provide more information to firms and/or workseekers improves their effectiveness (Abel, Burger, and Piraino 2020; Belot, Kircher, and Muller 2018; Wheeler et al. 2019).

market outcomes. In Section III, we analyze the roles of firm- and workseeker-side limited information. In Section IV, we discuss secondary results about what workseekers and firms learn from certification, what this implies for the effects of certification on different types of workseekers, and what this might imply for certification at a larger scale. We conclude in Section V and discuss questions around markets for assessment-based certification.

I. Economic Environment

A. Conceptual Framework

In this section, we sketch a simple conceptual framework with two goals. First, the framework illustrates how either workseeker- or firm-side limited information can lower two labor market outcomes: the employment rate and the mean wage conditional on employment. Hence, observing that employment and/or wages rise when both firms and workseekers have access to more information does not show which side(s) of the market responds to information. Second, the framework illustrates the mechanisms that link limited information to distortions in firm and workseeker behavior and hence to lower wages and employment. This guides our empirical tests of these mechanisms.

Consider a stylized economy consisting of infinitely many type W_1 and W_2 workseekers and type J_1 and J_2 jobs. Workseekers may choose not to search, to search for type 1 jobs, or to search for type 2 jobs. Searching for either type of job incurs fixed cost $C > 0$. A type i workseeker searching for type j jobs meets a firm offering such a job with probability P_{ij} . Conditional on meeting, the match produces output with pecuniary value V_{ij} net of any screening cost the firm incurs during hiring and pays wage $W_{ij} \leq V_{ij}$. The workseeker receives utility $P_{ij} \cdot U(W_{ij}) - C$ if she searches and zero otherwise, implying that she has a reservation wage $\underline{W}_i(C, P)$.⁶ There will be some labor force nonparticipation if search costs are high relative to the expected utility of working and some unemployment if the meeting probability P_{ij} is less than one for some (i, j) .

We make some additional simplifying assumptions for this discussion, but none of the results in the framework depend on these additional assumptions. First, we assume fraction p of all workseekers and all jobs are type 1. Second, we assume that type i workseekers are better at searching for type i jobs, produce the most output in type i jobs, and earn the highest wages in type i jobs, and similarly for type j workseekers and type j jobs. Under these assumptions, if type i workseekers choose to search, they will choose to search for type i jobs rather than type j jobs, and vice versa.

Either firms or workseekers can have limited information about workseekers' skills in this environment. First, we consider the case where only firms observe workseekers' types with error. This can occur if attributes observable to firms, like educational qualifications or past work experience, provide limited information about skills. Workseekers search for the "right" types of jobs but firms do not know

⁶For simplicity, we assume that firms post and commit to wages before workseekers make search decisions. This implies that all workseekers who choose to search for type j jobs will accept them if offered.

the type of the workseekers they meet. If type j firms believe that fraction q of the workseekers they meet are type j , then the expected output from each hire is $q \cdot V_{jj} + (1 - q) \cdot V_{ij}$. If firms' utility is a concave function of their output, then they will offer a wage lower than $q \cdot W_{jj} + (1 - q) \cdot W_{ij}$. Concavity can arise from firms' production technology or from uninsured risks from bad hires. Possible uninsured risks include lost customers or damaged equipment from hiring the "wrong" workseekers or severance pay and dispute resolution costs when firing workseekers. This reduces mean wages conditional on employment and, if offered wages for some vacancies are below the reservation wage or a legal minimum wage, reduces the employment rate. If firms have access to screening technology, they may observe workseekers' types more accurately and be able to pay workers a larger share of the match output. But the cost of the screening technology presumably reduces net match output, so the value available to pay in wages remains lower than in a world with perfect information. Aigner and Cain (1977) and Pallais (2014) prove results of this flavor formally.

Second, we consider the case where only workseekers observe their types with error. This can occur if, for example, workseekers receive limited information about their own type from education or work experience or if they have little education or work experience. In this case, each workseeker chooses whether and where to search based on her perceived type. If a type i workseeker "incorrectly" searches for a type $j \neq i$ job, she is less likely to meet a firm and, conditional on meeting a firm, will produce less and earn a lower wage. This reduces mean wages conditional on employment by generating some mismatches between workseeker and job types. This can also reduce the employment rate through two mechanisms: workseekers who search for the wrong type of jobs are less likely to meet firms, and mismatches between workseeker and job types may not generate enough output to offer wages above the reservation wage or minimum wage. The former mechanism can occur if, for example, firms offering different types of jobs hire using different channels, like posting formal adverts versus hiring walk-ins. The latter mechanism can occur if, for example, search costs and hence reservation wages are high or there is a legal minimum wage. Belot, Kircher, and Muller (2019) and Falk, Huffman, and Sunde (2006) prove results of this flavor formally.

This simple framework shows that observing a rise in employment and/or wages when both firms and workseekers acquire more information does not show which side(s) of the market faces limited information. This highlights the importance of studying both firm and workseeker responses to new information. Depending on the structure of the model, limited information on both sides of the market might interact to generate larger distortions or partly offset each other.⁷ We focus on the static case for simplicity, but recognize that the effect of limited information may differ in a dynamic framework with learning by firms or workseekers (Conlon et al. 2018; Lange 2007).

⁷ We do not explore interaction effects in detail in this paper. They are not identified by our experimental design without strong assumptions, because we do not directly cross-randomize the information available to firms and workseekers. They are also difficult to characterize theoretically because they depend on second-order beliefs, which we do not observe. For example, firms' return to investing in screening technology depends on their own uncertainty about workseekers' skills and their beliefs about the workseekers' own uncertainty about their own skills and what this implies for their search decisions.

The framework allows either horizontal or vertical differentiation of workseekers. We define horizontal differentiation as type i workseekers being more productive than type j workseekers in type i jobs and vice versa. We define vertical differentiation as type i workseekers being more productive than type j workseekers in all jobs. In both cases, either firm- or workseeker-side limited information can lower the employment rate and the mean wage conditional on employment. With horizontal differentiation, limited information on either side of the market can lower wages conditional on employment for all types of workseekers. With vertical differentiation, firm-side limited information can lower wages for type i workseekers mistaken for type j workseekers and raise wages for type j workseekers if they are mistaken for type i workseekers.

B. Context

We work in the metropolitan area of Johannesburg, South Africa's commercial and industrial hub. Johannesburg's labor market has four salient features for our study. First, information frictions are likely, as there are few sources of information on workseekers' skills. Many young workseekers have no work experience several years after completing education, limiting the scope to learn about or signal their skills through experience (Ingle and Mlatsheni 2017). Grades and grade progression in most primary and secondary schools are weakly correlated with independently measured skills (Lam, Ardington, and Leibbrandt 2011; Taylor et al. 2011). Workseekers who have completed secondary school typically report their grades in the nationally standardized graduation exam in job applications. But examination grades weakly predict performance in postsecondary education and firms report in interviews that the grades convey limited information about skills (Schöer et al. 2010).⁸ This limits the scope for firms and workseekers to learn about workseekers' skills from their educational attainment. Certification can thus provide both firms and workseekers with additional information on workseekers' skills.

Second, "wrong" hires are costly to firms. Firing a worker requires a complex and lengthy process and can be challenged by even temporary employees in courts and specialized dispute resolution bodies.⁹ Probationary work is permitted but regulated and probation periods cannot exceed three months (Bhorat and Cheadle 2009). Firms report challenges understanding labor regulation, contributing to the perceived cost of separations.¹⁰ Consistent with these factors, giving firms free consulting on labor regulation increases hiring (Bertrand and Crépon 2019).

Third, reservation and legal minimum wages exist. Minimum wage compliance in the formal sector is high (Bhorat et al. 2016; International Labour Organization 2016). Commuting costs are high and likely to raise reservation wages (Kerr 2017). The nearly universal state pension system gives workseekers in multigeneration

⁸The limited information content of education qualifications is consistent with the large role of referrals in hiring: more than one-half of all firms report that referrals are their preferred recruitment mechanism (Schöer, Rankin, and Roberts 2014).

⁹Small firms report an average of two dispute resolution cases in the previous year, requiring an average of 11 days of staff time per case (Rankin, Darroll, and Corrigan 2012).

¹⁰Only 18 percent of small- and medium-sized enterprise owners know the conditions that made a contract valid or rules governing severance pay (Bertrand and Crépon 2019).

households access to nonlabor market income, increasing reservation wages (Abel 2019).

Fourth, employment rates are low. In our study period, unemployment in Johannesburg was 28 percent for the working-age population, 51 percent for ages 15–24, and 32 percent for ages 25–34 (Statistics South Africa 2016b).¹¹ Low employment in the presence of information frictions, costs from “wrong” hires, and reservation or minimum wages are consistent with our conceptual framework. Particularly low employment for youths is also consistent with information frictions, as youths have less of the search and work experience that could reveal their types. Many other factors can contribute to low employment rates; we merely argue that a role for information frictions is plausible.

C. Sample Recruitment and Data Collection

We recruit a sample of 6,891 young, active workseekers from low-income backgrounds with limited work experience. Workseekers in our sample have limited access to traditional ways to learn about their skills and communicate their skills to prospective employers: university education, work experience, or access to referral networks. We recruit only active workseekers, so we do not examine the relationship between information frictions and labor market participation decisions. This is a sample from a policy- and theory-relevant population likely to face information frictions, rather than a population-representative sample.

To recruit the sample, we work with the Harambee Youth Employment Accelerator,¹² a social enterprise that assesses the skills of inexperienced workseekers and matches them to employers looking for entry-level workseekers, among other activities aimed at addressing a mismatch of demand and supply in the South African youth labor market. Harambee recruits candidates through radio and social media advertising and door-to-door recruitment in low-income neighborhoods. Interested candidates register online and complete a phone-based screening questionnaire.¹³ Eligible candidates are invited to two days of standardized skill assessments. Some candidates are invited to further job readiness training based on their assessment results and residential location, but only 0.2 percent of candidates in our sample get jobs through this training. Our sample consists of all candidates who arrive at Harambee for the second of these two testing days, on 84 operational days.

We conduct three surveys to measure workseekers’ labor market outcomes, job search, and beliefs about their skills and the labor market. The baseline is a self-administered questionnaire that candidates complete on desktop computers at Harambee under supervision. This is administered after candidates have done skills assessments but before they receive information about their results. We collect endline

¹¹ Throughout the paper, we use Statistics South Africa’s definition of an employed person as someone who did any income-generating activity, for at least one hour, during the reference week. Unemployment rates exclude those in full-time education or not in the labor force.

¹² <https://harambee.co.za/>.

¹³ Candidates are eligible to work with Harambee if they are aged 18–29, have legal permission to work in South Africa, have completed secondary school, have at most 12 months of formal work experience, have no criminal record, and are from disadvantaged backgrounds. This information is self-reported but checked against administrative data for some candidates.

data in a 25-minute phone survey three to four months after treatment.¹⁴ The phone survey response rate is 96 percent, leaving an endline sample of 6,609 respondents. The response rate is balanced across treatment groups (online Appendix Table D.6) and unrelated to most baseline covariates (online Appendix Table D.7). We also conduct a short text message survey two to three days after treatment. Respondents receive mobile phone airtime payments for answering the text message and phone surveys. The data and questionnaires are available at Carranza et al. (2022).

D. Job Search and Employment in the Sample

This section describes relevant patterns around labor market outcomes and job search in our sample. We report summary statistics for key baseline and endline variables for the 6,891 workseekers in online Appendix Tables D.1 and D.2. Respondents are 99 percent Black African, 62 percent female, and on average 24 years old; 17 percent have a university degree or diploma, 21 percent have some other postsecondary certificate, and 99 percent have completed secondary school. Malindi (2017) shows that young, black workseekers with relatively low levels of education face discrimination in this labor market, with wage dynamics consistent with information frictions and statistical discrimination.

Of the sample, 38 percent worked in the week before the baseline and 70 percent had ever worked, but only 9 percent had ever held a long-term job. Conditional on working, mean weekly earnings in the week before the baseline was 565 South African rand (US\$94 in purchasing power parity [PPP] terms), slightly below the minimum wage for a full-time worker in most sectors. Wage work was eight times more common than self-employment. Most work was relatively short-term, with median and mean tenures of two and seven months respectively.

Of the sample, 97 percent searched for work in the week before the baseline. In that week, they spent on average 17 hours and 242 South African rand (US\$40 PPP) searching. The relatively high search costs suggest that welfare gains for workseekers are possible from improved search targeting. Workseekers submitted on average 10 applications in the preceding month and received 1.2 offers. The job search and application process is somewhat formal: 38 percent of the candidates employed at endline reported that they submitted written applications for their current job and 47 percent reported that they had a formal interview.

Unsurprisingly, this sample is positively selected on search behavior and negatively selected on labor market outcomes. We establish this by comparing our sample to people from the same city with the same distribution of age, education, gender, and race using South Africa's nationally representative Quarterly Labour Force Survey (Statistics South Africa 2016a, 2017). Our sample has roughly the same employment rate but earns only 25 percent as much, potentially reflecting both lower hours and lower hourly wages, and is roughly twice as likely to be searching for work.

¹⁴ See Garlick, Orkin, and Quinn (2020) for an experimental validation of labor market data from phone surveys in this setting.

E. Assessments

We conduct six assessments with workseekers: communication, concept formation (similar to a Raven's test), focus, grit, numeracy, and planning. Firms have demonstrated interest in the results of these assessments, though they obviously also use other information in hiring decisions. Client firms have paid Harambee to screen roughly 160,000 prospective workers using these assessments. Online Appendix A describes each assessment in detail, their psychometric properties, and how some Harambee client firms use them in hiring.

Each assessment session is led by two or three industrial psychologists, who manage a team of facilitators. Assessments are conducted in English and are self-administered on desktop computers. Online Appendix Table D.1 shows standardized scores on the assessments. There is a fairly even spread of candidates over the distribution and little evidence of ceiling effects.

Online Appendix Table A.2 shows the correlation matrix between different skills. We interpret candidates with different assessment results as different worker types, in the language of the conceptual framework. Scores are weakly correlated across assessments, with pairwise correlations between 0.05 and 0.51. Hence, the assessments horizontally differentiate candidates based on their relative skills rather than only ranking or vertically differentiating them in a single dimension of skills.

Candidates have inaccurate beliefs about their own types, suggesting a role for workseeker-side information frictions. We ask candidates in which tercile they believe they ranked for each of the communication, concept formation, and numeracy assessments, after taking the assessments but before any candidates learn their results. Only 8 percent of candidates answer correctly for all three assessments and 29 percent of candidates answer incorrectly for all three assessments. Overconfidence is more common than underconfidence: 22 percent of candidates overestimate their tercile on all three assessments and 1 percent underestimate their tercile for all three assessments (online Appendix Table D.1).

Workseeker "types" in our data are multidimensional and ordinal within each dimension, rather than the simple case of binary types discussed in the conceptual framework. This means that workseekers may have inaccurate beliefs because they imperfectly observe the population distribution of skills, even if they perfectly observe their own skills.

II. Labor Market Effects of Skill Certification

A. Intervention

Our first certification intervention gives candidates information about their assessment results that they can easily and credibly share with prospective employers. The effects of this intervention may reflect changes in firm- or workseeker-side behavior. In either case, the framework predicts that certified workseekers will have higher employment and higher earnings conditional on employment.

Candidates receive a certificate describing the assessments and their performance (Figure 1). They receive 20 color copies printed on high-quality paper and an email version. Each certificate briefly describes Harambee and its placement and

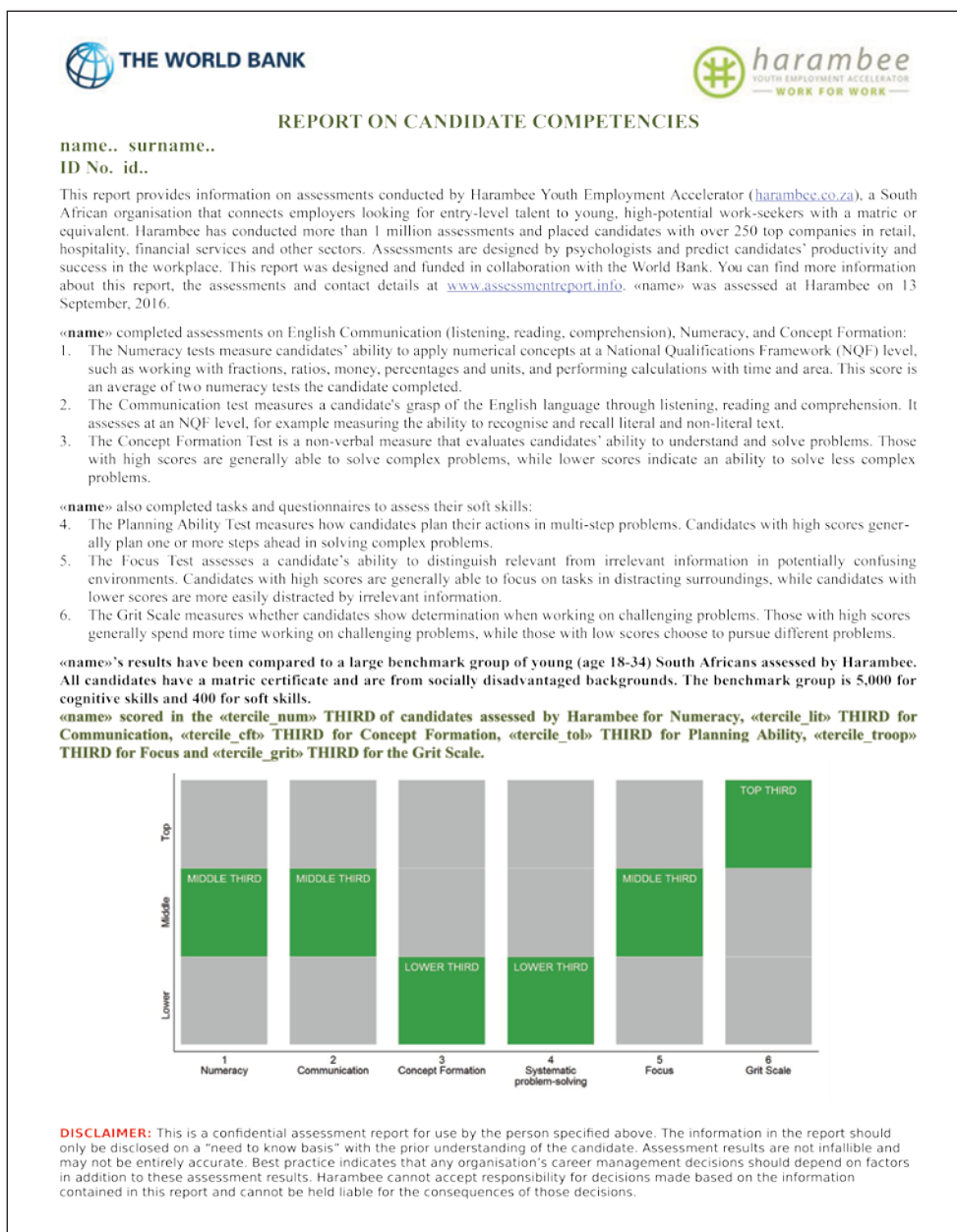


FIGURE 1. SAMPLE PUBLIC CERTIFICATE

Notes: This figure shows an example of the certificates given to candidates in the certification treatment. Each certificate shows some information about the assessments, the candidate's assessment results, the candidate's name and national identity number, and the logo of the World Bank and the implementing agency. Each workseeker received 20 printed certificates, an email copy of the certificate, and guidelines on how to request more certificates.

assessment work. To provide credibility to the assessments and results, the certificate is branded with the World Bank and Harambee logos. Harambee is a widely recognized brand in South African marketing surveys (Mackay 2014).

The certificate describes the skills measured by each assessment. The certificate directs the reader to a website¹⁵ www.assessmentreport.info for more information on Harambee and the assessments. The website shows sample questions for each assessment and describes how psychologists have designed and evaluated the assessments. For each skill, the certificate shows the tercile in which the candidate ranked on each assessment, compared to other candidates assessed by Harambee.¹⁶ The candidates assessed by Harambee are described as South African high school graduates aged 18–34 from disadvantaged backgrounds. To link candidates with certificates, each certificate shows the candidate's name and national identity number. National identity numbers are typically shown on resumes and school transcripts in South Africa.

Each candidate receives their certificates during a group briefing with a psychologist. The psychologist explains what each assessment measures and how to interpret the results on the certificate. They explain that workseekers can, but do not have to, attach the certificate to future job applications and that they can request more certificates from Harambee. To ensure briefings were standardized, the research team and Harambee psychologists jointly developed a briefing script and PowerPoint presentation. Research assistants monitored each briefing to ensure psychologists used the script.

B. Experimental Design

We randomly divide our workseeker sample into a public certification group, a control group, and other groups discussed in the next section of the paper. We randomize treatment by assessment date to reduce risks of spillovers between treated and control workseekers, assigning 2,247 workseekers assessed over 27 days to certification and 2,274 workseekers assessed over a different 27 days to the control group. Treated and control workseekers differ in only one way: treated workseekers receive the certification intervention described above, while control workseekers receive no information about their assessment results and no certificate to enable them to share results with firms. Control workseekers received the same experience at Harambee as all workseekers before the experiment and were not told that workseekers assessed on other days received certificates, so it is unlikely that workseekers assigned to the control group were discouraged or inferred anything about the assessment results from not getting certificates. All treated and control workseekers receive roughly one hour of job search counseling before the assessments on how to create an email address and how to prepare and dress for an interview. They also receive an email with a CV template, interview tips, and job search tips.¹⁷ This differs from the design in Abebe et al. (2021), where treated workseekers receive

¹⁵ www.assessmentreport.info.

¹⁶ In piloting, both workseekers and firms found certificates with only rankings easier to interpret than certificates with only cardinal scores or both rankings and cardinal scores.

¹⁷ Harambee invites some workseekers for further training and job search assistance. These invitations depend partly on their assessment results and may only be issued months after assessment. By the endline survey, only 1.4 percent of our sample are invited for further interaction with Harambee and only 0.17 percent receive a job offer through their further interaction with Harambee. These outcomes are uncorrelated with treatment status and all our results are robust to dropping these workseekers.

both skill certification and job search counseling while control workseekers receive neither.

We estimate treatment effects using models of the form

$$(1) \quad Y_{id} = \mathbf{T}_d \cdot \Delta + \mathbf{X}_{id} \cdot \Gamma + S_d + \epsilon_{id},$$

where Y_{id} is the outcome for workseeker i assessed on date d , \mathbf{T}_d is a vector of treatment assignments, and \mathbf{X}_{id} is a vector of prespecified baseline covariates; S_d is a block fixed effect, to account for the fact that we randomly assign days to treatment groups within blocks of six-to-ten sequential days. We use heteroskedasticity-robust standard errors clustered by assessment date, the unit of treatment assignment. All labor market and job search measures use seven-day recall periods, except where we specify otherwise. We apply an inverse hyperbolic sine transformation to right-skewed variables such as earnings; the distributions of these variables in our sample allow us to interpret these treatment effects as percentage changes. We assign zeros to job characteristics for nonworking respondents (e.g., earnings, hours) and to search measures for nonsearching respondents (e.g., number of applications submitted) to avoid sample selection. We thus analyze treatment effects on realized outcomes, rather than latent outcomes that may be nonzero for the nonemployed or nonsearching. We also estimate quantile treatment effects on selected labor market outcomes, which allows us to examine on the distribution of outcomes for employed candidates.

The estimating equations and variable definitions are prespecified. All outcomes whose treatment effects are reported in tables/figures are prespecified except where we indicate otherwise, although not all outcomes discussed in the text are prespecified. Our estimates of key treatment effects are robust to omitting the prespecified covariates (online Appendix Table D.8) and to including the covariates that are unbalanced at baseline (online Appendix Table D.9). Our inferences about key treatment effects are robust to several adjustments for multiple testing: estimating q -values that control the false discovery rate across related outcomes, combining related outcomes into indices, and estimating q -values across indices following Anderson (2008) and Benjamini, Krieger, and Yekutieli (2006).

C. Certification Improves Labor Market Outcomes

The first main effect of certification is to increase employment. Current employment rises by 5.2 percentage points from a control group mean of 30.9 percentage points (Table 1, column 1). We also ask about employment in each calendar month between treatment and endline and show in online Appendix Table D.12 that certification increases employment in every month between treatment and follow-up.

Certification increases average weekly hours worked, coded as zero for nonemployed candidates, by 20 percent (column 2). The treatment effect on hours may reflect two effects: an extensive margin effect if treatment increases the employment rate and an intensive margin effect if treatment increases the hours that employed candidates work. We adapt a decomposition proposed by Attanasio, Kugler, and Meghir (2011) to identify these two effects (details in online Appendix C). We define the extensive margin effect as the treatment effect

TABLE 1—TREATMENT EFFECTS ON LABOR MARKET OUTCOMES

	Employed (1)	Hours ^c (2)	Earnings ^c (3)	Hourly wage ^c (4)	Written contract (5)
Treatment	0.052 (0.012)	0.201 (0.052)	0.337 (0.074)	0.197 (0.039)	0.020 (0.010)
Mean outcome	0.309	8.848	159.291	9.840	0.120
Mean outcome for employed		28.847	518.291	32.283	0.392
Number of observations	6,607	6,598	6,589	6,574	6,575
Number of clusters	84	84	84	84	84

Notes: Coefficients are from regressing each outcome on a vector of treatment assignments, randomization block fixed effects, and prespecified baseline covariates (measured skills, self-reported skills, education, age, gender, employment, discount rate, risk aversion). Heteroskedasticity-robust standard errors shown in parentheses, clustering by treatment date. Mean outcomes are for the control group. All outcomes use a seven-day recall period. Outcomes marked with ^c use the inverse hyperbolic sine transformation for the treatment effects but the control group means are reported in levels. All monetary figures are reported in South Africa rands. 1 rand \approx US\$0.167 in PPP terms. The sample sizes differ across columns due to item nonresponse, mostly from respondents reporting that they don't know the answer.

on employment multiplied by mean hours worked for employed control group candidates. Intuitively, this is the rise in hours we would see if treatment increased employment but the marginally and inframarginally employed treated candidates worked the same average hours as the inframarginally employed untreated candidates. We define the intensive margin effect as the difference between the total treatment effect on hours and the extensive margin effect on hours. Intuitively, this is the treatment effect on hours due to changes in hours worked conditional on employment. We find that the entire effect on hours is explained by the extensive margin effect (Table 2, column 1). This shows that treated candidates do not work longer hours conditional on employment, but are simply more likely to be employed.

The second main effect of certification is to increase earnings. Weekly earnings increase by 34 percent (Table 1, column 3). The extensive margin effect and intensive margin effects account for respectively 27 and 7 percentage points of the 34 percent increase in earnings (Table 2, column 2). Hourly wages, calculated by dividing earnings by hours, also increase by 20 percent (Table 1, column 4). The extensive and intensive margin effects account for respectively 14 and 6 percentage points of the 20 percent increase in wages (Table 2, column 3). These results show that treatment increases earnings mainly by increasing employment, but also increases earnings conditional on employment.

These results are consistent with the conceptual framework: more information about workseeker skills (i.e., types) increases the latent value net of screening costs of some workseeker-job matches, leading to higher employment and mean earnings conditional on employment. However, these results do not pin down the relative contributions of lower screening costs and higher match quality without either data on firm screening activities or stronger assumptions. Treatment also increases another common proxy for match quality: it increases average tenure at endline by 0.1 months (standard error 0.04 months). However, the three-to-four-month period between baseline and endline is too short to infer a strong relationship between match quality and tenure.

TABLE 2—TREATMENT EFFECTS ON LABOR MARKET OUTCOMES AT EXTENSIVE AND INTENSIVE MARGINS

	Hours ^c (1)	Earnings ^c (2)	Hourly wage ^c (3)	Written contract (4)
Total effect	0.201 (0.052)	0.337 (0.073)	0.197 (0.039)	0.020 (0.010)
Extensive margin	0.188 (0.042)	0.269 (0.059)	0.141 (0.031)	0.020 (0.005)
Intensive margin	0.013 (0.020)	0.069 (0.040)	0.056 (0.027)	−0.000 (0.008)
Treatment effect conditional on employment	0.037 (0.058)	0.194 (0.113)	0.158 (0.078)	−0.001 (0.024)

Notes: This table reports decompositions of treatment effects on job characteristics into extensive and intensive margin effects. The extensive margin effects are the treatment effects on job characteristics due to the treatment effect on employment, evaluated at the mean job characteristics for the control group. The intensive margin effects are the differences between the treatment effects and extensive margin effects, which must be due to changes in job characteristics for the employed candidates in the treatment group. The conditional effect is the implied mean change in job characteristics per employed treatment group candidate. Treatment group employment is 36 percent, so the conditional effects on all outcomes are roughly three times larger than the corresponding intensive margin effect. Heteroskedasticity-robust standard errors are shown in parentheses, clustering by treatment date. All outcomes use a seven-day recall period. Outcomes marked with ^c use the inverse hyperbolic sine transformation.

These results allow us to reject a special case of the framework where more information increases only job-finding rates but not the value of firm-worker matches net of screening costs. In this special case, treatment would not increase earnings conditional on employment. This special case does not match the positive treatment effects we find on earnings and wages conditional on employment, nor does it match the quantile treatment effects on earnings shown in Figure 2. In this special case, the quantile treatment effects would be large and positive from the 66 to 71 percentiles where the marginally employed workseekers went from zero to positive but low earnings, and zero for all other percentiles. Instead, we see positive quantile treatment effects from the 66 percentile upward, although they are not statistically significantly different from zero above the 93 percentile.

Finally, certification shifts the types of employment. Certification increases the probability of having a written contract, Statistics South Africa's definition of a formal job, by 2 percentage points (Table 1, column 5). This effect is entirely explained by the higher employment rate (Table 2, column 4). Furthermore, 4 percentage points of the 5.2 percentage point increase in employment are in wage employment, and only 1.2 percentage points are in self-employment. The wage employment and formality results show that certification is particularly effective at getting workers into more formal jobs, which are more likely to use formal hiring processes where certificates can play a role.

The effects on employment and earnings are substantial and easily exceed the cost of the program. The employment effect is almost three times larger than the mean standardized short-run effect size of active labor market programs reviewed by Card, Kluve, and Weber (2017), larger than the effect of an intervention that helped similar South African workseekers get reference letters from past employers (Abel, Burger, and Piraino 2020), and similar to the effect of a program that

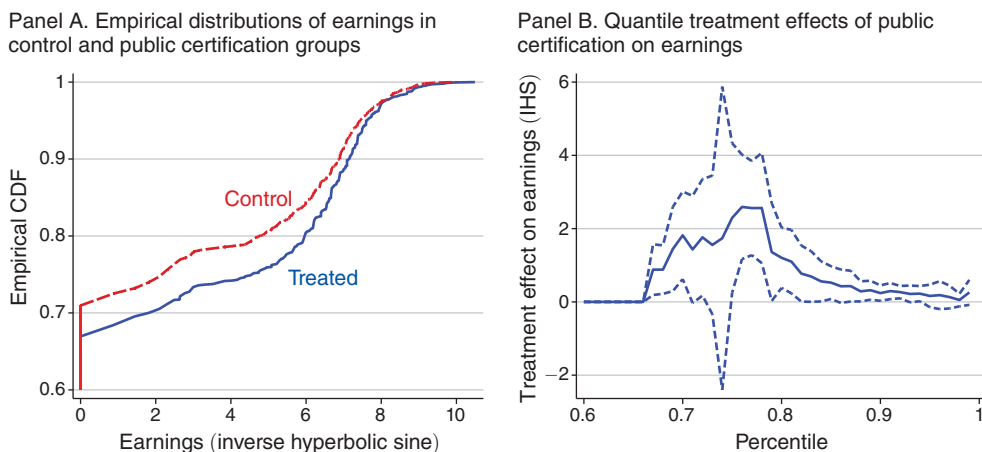


FIGURE 2. QUANTILE TREATMENT EFFECTS ON EARNINGS

Notes: Panel A shows the empirical distributions of earnings in the control and public certification groups. Earnings are the inverse hyperbolic sine transformation of earnings in South African rand, with 1 rand \approx US\$0.167 in PPP terms. Earnings are coded as zero for candidates who are not working. The vertical axis in panel A is truncated below at the 60 percentile because earnings below that value are zero. Panel B shows the quantile treatment effects of public certification. These are unconditional quantile treatment effects, estimated without controlling for any covariates or stratum fixed effects. The 95 percent pointwise confidence intervals allow heteroskedasticity and clustering by treatment date. The confidence intervals exclude zero at all percentiles except 73–74, 86, and 93–99.

subsidized firms to hire South African workseekers from similar backgrounds (Levinsohn et al. 2013). The average earnings gain in the first three months after treatment is 778 South African rand (US\$130 PPP)—5.6 times the average variable cost of adding certification onto an existing assessment program alone and 2.3 times the average variable cost of assessment and certification (details in online Appendix B). The average weekly earnings gain is equal to 17 percent of the weekly adult poverty line in South Africa (details in online Appendix D.2).

III. How Do Different Agents Respond to Certification?

Certification may increase employment and earnings by providing information to firms, to workseekers, or to both sides of the market. This distinction matters for modeling information frictions and designing government or market-based remedies to limited information. In this section, we show that both sides of the market change behavior in response to new information and explore how these changes relate to the labor market effects of additional information. Our argument proceeds in three steps. First, we show that public certification changes workseekers' beliefs and search behavior in multiple ways. These changes don't conclusively show whether firms, workseekers, or both face limited information, motivating the second and third steps of the argument. Second, we discuss another arm of our workseeker experiment that reveals information to workseekers without helping them share the information with firms. The results of the different experimental arms show that both firms and workseekers face limited information and suggest but do not prove

that both firms' and workseekers' behavioral changes upon receiving new information contribute to improved labor market outcomes. Third, we discuss an audit-style experiment that reveals information only to firms. The results of this experiment are consistent with firm-side limited information.

A. Public Certification Changes Job Search and Beliefs

We document three patterns in the effects of certification on workseekers' beliefs and job search behavior and then interpret these patterns. First, certification shifts workseekers' beliefs about their skills closer to their measured skills. We ask candidates if they think they scored in the top, middle, or bottom third on each of the six assessments, compared to other candidates assessed by Harambee. Certification increases the fraction of assessments where candidates' self-assessments match their measured results from 0.39 to 0.55 (Table 3, column 1).¹⁸ In contrast, certification has no effect on candidates' self-esteem (column 2). This shows that their updated beliefs about the skills do not lead to more general updating about their self-worth.¹⁹

Second, certification changes the types of jobs that candidates target. We ask candidates if the types of jobs they are applying for most value communication, concept formation, or numeracy. Certification increases the fraction of candidates searching for jobs that most value the assessment in which they scored strictly highest from 0.16 to 0.21 (column 3).²⁰

Third, candidates use certificates in job applications (columns 4–7). Seventy percent of candidates use the certificates with at least one job application between treatment and endline, with an unconditional average of 6.7 applications sent with certificates per candidate.²¹ Applications with certificates generate an average of 0.43 interviews and 0.11 job offers over the three to four months from treatment to endline.

We interpret these patterns as evidence for limited information on both sides of the market. The first two patterns suggest a role for workseeker-side information frictions: candidates align their beliefs and job search more closely to their assessment results, potentially leading to better outcomes in the labor market. The third pattern suggests a role for firm-side information frictions: candidates use certificates with job applications, potentially making the applications more informative to employers, leading to more job interviews and offers. Jointly, these patterns lead candidates to expect 11 percent more offers in the next month, from a control group

¹⁸This question measures candidates' beliefs about their results in each assessment. These may differ from candidates' beliefs about their skills, if they believe the assessments are poor measures of their skills. Reassuringly, we obtain similar results when we measure candidates' beliefs about their skills in numeracy, communication, etc. rather than their results in these specific assessments. See online Appendix D for details.

¹⁹Certification also has no effect on the distribution of self-esteem (online Appendix Figure D.1) and has zero effects even for candidates who learn that they performed substantially worse or better on assessments than their baseline beliefs.

²⁰We ask candidates separately about the skill demand of the jobs they target and about their perceived skills in two different parts of the survey. We construct the measure of search targeting from these two questions. This may be less susceptible to experimenter demand effects than asking them directly if their job search aligns with their skills. The result is similar for the fraction of candidates searching for jobs that most value the assessment in which they *think* they scored highest. This search targeting measure is not prespecified.

²¹The 6.7 additional applications with certificates follows from the 1.682 unit effect on the inverse hyperbolic since of the number of applications in column 5, and the fact that control workseekers send zero applications with certificates.

TABLE 3—PUBLIC AND PRIVATE CERTIFICATION EFFECTS ON BELIEFS, SEARCH, AND LABOR MARKET OUTCOMES

	Skill belief accurate (1)	> median self-esteem (2)	Targeted search (3)		
Public certification	0.158 (0.008)	0.002 (0.013)	0.051 (0.010)		
Private certification	0.123 (0.008)	−0.002 (0.015)	0.047 (0.010)		
p: public = private	0.000	0.812	0.701		
Mean outcome	0.389	0.553	0.155		
Number of observations	6,607	6,609	6,609		
Number of clusters	84	84	84		
	Used report ^b (4)	Applications with report ^{b,c} (5)	Interviews with report ^b (6)	Offers with report ^b (7)	Expected offers ^{a,c} (8)
Public certification	0.699 (0.013)	1.682 (0.040)	0.432 (0.023)	0.112 (0.011)	0.106 (0.019)
Private certification	0.290 (0.012)	0.572 (0.033)	0.144 (0.017)	0.036 (0.008)	0.054 (0.023)
p: public = private	0.000	0.000	0.000	0.000	0.025
Mean outcome	0.000	0.000	0.000	0.000	4.198
Number of observations	6,609	6,598	6,597	6,597	6,531
Number of clusters	84	84	84	84	84
	Employed (9)	Hours ^c (10)	Earnings ^c (11)	Hourly wage ^c (12)	Written contract (13)
Public certification	0.052 (0.012)	0.201 (0.052)	0.337 (0.074)	0.197 (0.039)	0.020 (0.010)
Private certification	0.011 (0.012)	0.066 (0.048)	0.162 (0.078)	0.094 (0.046)	0.017 (0.009)
p: public = private	0.002	0.011	0.028	0.030	0.769
Mean outcome	0.309	8.848	159.291	9.840	0.120
Number of observations	6,607	6,598	6,589	6,574	6,575
Number of clusters	84	84	84	84	84

Notes: Coefficients are from regressing each outcome on a vector of treatment assignments, randomization block fixed effects, and prespecified baseline covariates (measured skills, self-reported skills, education, age, gender, employment, discount rate, risk aversion). Heteroskedasticity-robust standard errors shown in parentheses, clustering by treatment date. Mean outcomes are for the control group. Skill belief accurate is the share of the six assessments where the candidate's perceived tercile matches their actual tercile. Targeted search is an indicator equal to one if the candidate reports mainly applying for jobs that most value the skill in which the candidate scored highest. Above-median self-esteem is an indicator equal to one if the candidate's response on a shortened version of the Rosenberg (1965) self-esteem scale is above the sample median. All outcomes use a 7-day recall/forecast period unless marked with ^a (30-day recall/forecast period) or ^b (since treatment). All outcomes use a 7-day recall period. Outcomes marked with ^c use the inverse hyperbolic sine transformation for the treatment effects but the control group means are reported in levels. All monetary figures are reported in South African rands; 1 rand ≈ US\$0.167 in PPP terms. The sample sizes differ across columns due to item nonresponse, mostly from respondents reporting that they don't know the answer.

mean of 4.2 offers (column 8), and generate the improved outcomes in the labor market discussed in Section IIC.

Before proceeding to the next experiments, we note that certification does not change multiple prespecified measures of job search effort in the month before the endline survey: the probability of doing any search, number of applications

submitted, hours spent searching, and money spent on search (online Appendix Table D.12).²² There are two possible explanations for this pattern. First, certification may change how workseekers search—targeting different jobs and using certificates in applications—without changing their search effort. This is consistent with a special case of the conceptual framework where information frictions change how firms and workseekers match but do not change the share of workseekers who choose to search. Second, certification may temporarily change extensive or intensive margin search effort but the endline may occur too late to detect this change. Employment already rises in the first month after treatment (online Appendix Table D.12). This suggests that any changes in workseeker behavior that increase employment occur soon after treatment. The search effort questions use 7- or 30-day recall periods, which miss the period soon after treatment when candidates may have increased effort and found jobs. The questions on certificate use ask about the entire period between treatment and the endline survey, which will capture any short-term changes in search behavior.²³

B. Workseekers Respond to Information That Is Difficult to Credibly Share with Firms

In this section, we show that workseekers' beliefs and search behavior change when they get more information about their skills, even when this information cannot be easily and credibly shared with firms. The specific pattern of results suggests, but does not conclusively prove, that these workseeker-side changes contribute to improvements in labor market outcomes.

To show this, we implement a “private” certification intervention, distinct from the “public” certification intervention described above. Candidates assigned to the private certification intervention receive an unbranded, anonymous certificate with the assessment results rather than the branded, identifiable “public” certificate (Figure 3). The private treatment is designed to primarily provide information to the workseekers about their own skills.

Candidates in this group receive only one black-and-white, unbranded certificate, printed on low-quality paper, and do not receive an electronic version. Candidates receive a briefing from a psychologist about the assessment results. But this briefing does not encourage them to share the certificate with firms or suggest that this is possible, unlike the briefing for candidates in the public certification group. Candidates in the public certification, private certification, and control groups all receive the same one hour of job search counseling and email with job search advice. We assign 2,114 candidates assessed over 27 assessment days to private certification. We simultaneously randomize days to public certification, private certification, and control. The three groups are balanced on baseline characteristics (online Appendix Table D.3).

²² We also find no heterogeneity in the treatment effects of certification on employment by any measure of baseline search effort (applications, cost, time, or indices that combine these measures). This may reflect the relatively high baseline search activity in our sample, with 97 percent of the participants actively searching in the week before baseline.

²³ Consistent with this timing explanation, effects on all search effort measures are marginally larger for respondents with a shorter time between treatment and endline. This result is robust to instrumenting the treatment-to-endline time with the random order in which candidates were assigned to be surveyed.

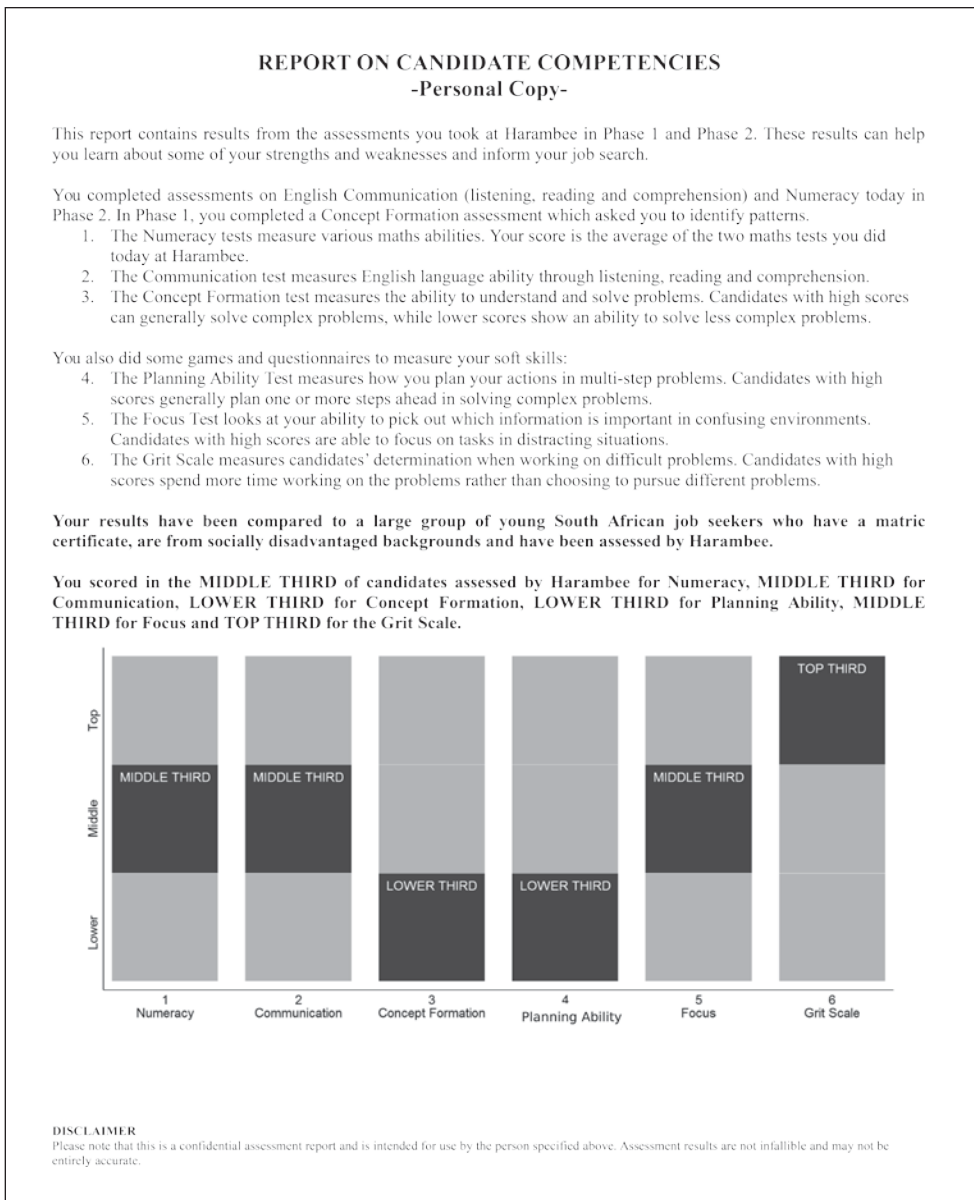


FIGURE 3. SAMPLE PRIVATE CERTIFICATE

Notes: This figure shows an example of the certificates given to candidates in the private treatment arm. The certificates contain the candidate's assessment results but no identifying information and no branding. Each candidate received one copy of this certificate.

The private and public certification interventions have similar effects on work-seekers' beliefs and search targeting. Private certification makes workseekers' beliefs about their own skills 12 percentage points more accurate and has no effect

on self-esteem (Table 3, columns 1 and 2).²⁴ Private certification increases search targeting by 5 percentage points, almost exactly the same magnitude as the public certification effect (column 3). Candidates in the private arm expect to receive 5 percent more offers than control candidates, significantly less than the 11 percent increase in expected offers in the public arm (column 8). This suggests that workseekers view the new information as useful, but less useful than when it is publicly certified and hence easy to credibly share with firms.

The private certification intervention has substantially smaller effects than public certification on candidates' outcomes in the labor market. Private certification effects on the probability of employment and hours worked are positive but small, not significantly different from zero, and statistically significantly smaller than the public certification effects (columns 9 and 10). Private certification increases earnings and hourly wages by respectively 16 and 9 percent but both effects are less than one-half the size of the public certification effects and are statistically significantly smaller (columns 11 and 12). The private certification effect on earnings is driven by workseekers who were not employed at baseline, so it reflects workseekers either getting or accepting higher-paying job offers, rather than using their new information to bargain up earnings at their current job. The intensive margin private certification effect on earnings of 0.103 inverse hyperbolic sine points is insignificantly larger than the equivalent public certification effect of 0.069 (online Appendix Table D.13). This is not explained by differential selection between the two groups into employment on skill, education, work experience, or demographics.

We interpret the average treatment effects of the public and private certification interventions as evidence that both firms and workseekers face limited information and that providing more information leads to quantitatively important improvements in labor market outcomes. These improvements may reflect both firm- and workseeker-side learning, which we view as the most plausible interpretation. However, they may instead reflect only firm-side or only workseeker-side learning, possibilities we now discuss in turn.

First, we consider the possibility that the improvements in labor market outcomes from both interventions are driven by only firm-side learning. This could occur if information from private certification "leaks" to firms, explaining the earnings gap between the private certification and control groups. Some information does indeed leak to firms: 29 percent of workseekers used private certificates in job applications, sending an average of 1.8 applications with certificates and getting an average of 0.04 job offers from these applications (Table 3, columns 4–7). However, information transmission to firms is limited: workseekers use public certificates in job applications four times more than private certificates and get offers from applications with public

²⁴The private certification effect on beliefs about skills is slightly smaller than the public certification effect. The former effect may be smaller because the public treatment conveys information differently (e.g., the branding makes it more credible to workseekers) or because the information is more likely to be retained (e.g., workseekers are more likely to keep copies of the public certificate or discuss it in recent job interviews). To separate these hypotheses, we measure workseekers' beliefs about their skills using a text message survey two to three days after treatment. The public and private effects in this survey are not different to each other, suggesting that workseekers' beliefs update in the same way straight after receiving the certificates and that the difference in the endline survey three to four months later is due to differential retention. See online Appendix D and Table D.10 for details.

certificates three times more often than from applications with private certificates.²⁵ Workseekers are also ten times more likely to include public certificates than private certificates with the applications they send us to participate in the audit study described in the next section. Even if information leaks to firms, it may have low credibility: private certificates do not have the candidate's name and identity number, so they cannot be linked to a particular candidate; have no branding from Harambee or the World Bank; do not explain that Harambee has used these assessments widely to place candidates with companies or that assessments predict workplace productivity; and do not link to a website. None of the 15 hiring managers interviewed during piloting reported that they would view the private certificates as credible. Furthermore, the positive earnings effect of private certification is driven entirely by workseekers who do *not* use the certificate with job applications. We interpret this result with caution, because it involves stratifying by a posttreatment outcome. But it suggests that some other mechanism helps to explain the earnings gap between the private certification and control groups, such as workseekers learning more about their skills and using this to target their job search.

Second, we consider the possibility that the improvements in labor market outcomes from both interventions are driven by only workseeker-side learning. This could occur if workseekers incorrectly believe that firms have limited information. Under this explanation, workseekers in the public certification group believe that firms are more likely to respond to job applications submitted with certificates, hence they change search behavior. This change in search behavior alone, rather than any responses by firms, would then explain the employment and earnings gaps between the public and private certification groups. This seems unlikely, as we observe no differences between these two groups' search targeting or search effort. In the next section, we further address this possibility by presenting an experiment that directly manipulates firms' information, without any scope for changes in workseeker behavior.

C. Firms Respond to Direct Information Provision

In this section, we show that revealing information only to firms, without allowing any potentially mediating behavior by workseekers, changes their responses to job applications. This is consistent with firms facing information frictions and the employment and earnings effects of certification being partly explained by firm-side responses.

We describe results from an audit-style study here, with more details on the experiment in online Appendix E. We invite a random sample of assessed candidates to send us a resume that we will forward to prospective employers on their behalf. We create a list of job vacancies by scraping online job advertisements. We eliminate scam vacancies and vacancies that require work experience or university education, where many candidates in our sample would be ineligible. We send

²⁵ We can't reject equality of the public and private certification effects on the offer-to-application ratio for applications with certificates. This might mean that firms view both certificates as equally credible, although we view this result with caution because the treatment effects on both ratios are very imprecisely estimated and selection into certificate use differs between the two groups.

resumes from four randomly chosen candidates to each vacancy, each from a different email address. We generate two outcome variables based on the email responses from firms. “Interview invitations” are invitations to interview with the firm. “Any responses” are similar to “callbacks” in other audit studies and include interview invitations and requests to provide more information by email or by visiting the firm in person.

We randomize each vacancy to receive either one or three resumes with public certificates attached. We also randomize which of the resumes are chosen to receive public certificates. This design motivates the estimating equation

$$(2) \quad Y_{rv} = \text{Certificate}_{rv} \cdot \beta_1 + \text{Certificate}_{rv} \cdot \text{HighIntensity}_v \cdot \beta_2 + \mathbf{V}_v \\ + \mathbf{X}_r \cdot \Gamma + \mathbf{E}_{rv} + \epsilon_{rv},$$

where Y_{rv} is the response to resume r sent to vacancy v , Certificate is an indicator equal to one if the application includes a public certificate, HighIntensity is an indicator equal to one if the vacancy receives three applications with certificates rather than one, \mathbf{V}_v is a vector of vacancy fixed effects that subsumes the main effect of HighIntensity , \mathbf{X}_r is a vector of prespecified resume covariates, and \mathbf{E}_{rv} is a vector of fixed effects for the email addresses used to submit the applications. We cluster standard errors by resume and vacancy.²⁶ We also estimate

$$(3) \quad Y_v = \text{HighIntensity}_v \cdot \alpha + \eta_v,$$

to explore the vacancy-level effects of getting more applications with certificates. We cannot condition on $(\mathbf{V}_v, \mathbf{X}_r, \mathbf{E}_{rv})$ in the vacancy-level regression but estimates of α are unchanged when we condition on vacancy-level averages of \mathbf{X}_r and sector-of-vacancy fixed effects.

The application-level effects of using a public certificate when other applications do not, captured by β_1 , are robustly positive. Applications with a public certificate are 1.6 percentage points more likely to get any response and 1 percentage point more likely to get an interview invitation (Table 4, panel A, columns 2 and 4). These are substantial effects, both equal to 11 percent of the control group means, although they are only statistically significant at the 10 percent level.

These results show that more informative applications lead to higher callback and interview invitation rates in a low-information environment. This suggests firms’ having limited information plays a role in the earnings and employment effects of public certification. Combining this result with the observed effects of the public and private certification on workseekers’ beliefs, search behavior, and outcomes in the labor market suggests that both firms and workseekers face limited information.

The vacancy-level effects shown in Table 4 panel B are more complex. Vacancies that get more applications with certificates, captured by α , make 2.3 percentage

²⁶Like most audit studies, we submit the same resume to multiple vacancies. Each resume includes a certificate for one-half of these vacancies. Audit studies generally cluster standard errors by resume (Neumark 2018). Abadie et al. (2017) recommend clustering by the unit at which treatment is assigned. We therefore cluster by both vacancy and resume. Results are very similar when clustering only by vacancy or only by resume.

TABLE 4—TREATMENT EFFECTS OF ADDITIONAL INFORMATION IN AUDIT STUDY

	(1)	(2)	(3)	(4)
<i>Panel A. Application-level analysis</i>				
Outcome	Any type of response		Interview invitation	
Certificate (β_1)	0.015 (0.009)	0.016 (0.009)	0.009 (0.004)	0.010 (0.006)
Certificate \times HighIntensity (β_2)	-0.027 (0.013)	-0.028 (0.014)	-0.016 (0.009)	-0.017 (0.010)
Mean outcome	0.130		0.087	
Vacancy fixed effects		\times		\times
Email address fixed effects		\times		\times
Workseeker covariates		\times		\times
<i>Panel B. Vacancy-level analysis</i>				
Outcome	Response mean	> 0 responses	Invitation mean	> 0 invitations
HighIntensity (α)	0.023 (0.020)	0.042 (0.026)	-0.001 (0.016)	0.021 (0.021)
Mean outcome	0.134	0.187	0.090	0.117

Notes: Analyses in panel A use each of the 3,992 applications as an observation. Analyses in panel B use each of the 998 vacancies as an observation. Applications are generated from 717 unique workseekers. Coefficients are from regressing each outcome on a vector of treatment assignments and, in panel A, columns 2 and 4, vacancy fixed effects, email address fixed effects, a vector of prespecified workseeker covariates (measured skills, education, age, gender, past employment, and the scan quality of documents they include in their application). The vacancy-level treatment variable HighIntensity is included in columns 1 and 3 but omitted in columns 2 and 4 because it is collinear with the vacancy fixed effects. Heteroskedasticity-robust standard errors shown in parentheses, clustered in panel A by resume and vacancy. The mean outcomes in panel A are for applications sent without public certificates to vacancies that receive only one application with a public certificate. The mean outcomes in panel B are for vacancies that receive only one application with a public certificate.

points more callbacks and are 4.2 percentage points more likely to make any callback, although the former effect is not statistically significant and the latter is barely so ($p = 0.099$). The effects on interview invitations are closer to zero.²⁷

The coefficient β_2 , the difference between the effect of being the only application with a public certificate sent to a vacancy and the effect of being one of multiple applications with public certificates sent to a vacancy, is negative. Applications that include a public certificate are 2.8 percentage points less likely to get a response and 1.7 percentage points less likely to get an interview invitation when they compete against other applications with certificates (Table 4, panel A, columns 2 and 4). Combining β_1 and β_2 shows that applications with certificates sent to high-intensity vacancies are 0.7–1.2 percentage points less likely to get callbacks and interviews than applications without certificates sent to low-intensity vacancies, although these effects are not statistically significant.

The estimates of β_1 , β_2 , and α together show that firms respond to more information but that the response may depend on the scale of an information-provision

²⁷ Vacancies that get more applications with certificates are also significantly more likely to respond to only applications with certificates (5 and 4 percentage points for callbacks and interviews) and less likely to respond to only applications without certificates (2.4 and 0.8 percentage points). The former effect is significantly larger than the latter effect for both applications and interviews. These results show that firms, on average, do not prefer to diversify over applications with and without certificates and do not respond to multiple applications with certificates by becoming suspicious and discarding all of them.

program. A single application containing a public certificate is more likely to get a callback or interview ($\beta_1 > 0$) but this effect shrinks as more applications include public certificates ($\beta_2 \leq 0$), so that the vacancy-level effect of getting more applications with certificates is zero or positive but not statistically significant ($\alpha \geq 0$).

These results on callbacks and interview invitations are consistent with diminishing marginal returns to higher aggregate certificate use, a point we discuss in Section IVD. However, more informative applications may still be valuable in a higher-information environment for job *offers*, which we do not observe in the audit study. If firms use callbacks and interviews to get more information, then certificates may allow them to interview fewer candidates for each vacancy while still improving match quality and potentially increasing employment.²⁸

There are some caveats to the interpretation of the audit study results. This examines only one hiring method (online applications) and one stage of that process (interview invitations). These are standard limitations of correspondence-based audit studies. We randomly match workseekers to vacancies in the audit study. This omits any role for search targeting, which the public and private certification results suggest may be important. These caveats mean that we would need strong assumptions to use the audit results to quantify how much of the public certification effects on employment reflect firm-side responses. Despite these caveats, the audit study does provide additional evidence that firms face limited information.

IV. What Do Workseekers and Firms Learn from Skill Certification?

The preceding two sections show that skill certification provides information that improves workseekers' outcomes in the labor market. In this section, we explore what workseekers and firms learn from skill certification, what this implies for the effects of certification for different types of workseekers, and what this might imply for the effects of certification at scale. This section relies on smaller experiments and heterogeneity analysis of the main experiments, so we view these results as more suggestive than conclusive.

A. Assessment Results Matter, Not Just Being Assessed

The public certification and audit results above are consistent with three interpretations. First, our preferred interpretation is that firms and workseekers acquire information about workseekers' skills from the assessment results. Second, firms may acquire information about workseekers' tenacity or proactivity from their choice to get assessed, not their actual assessment results. Third, the assessment results may provide no useful information to firms but may be visually appealing or attention-grabbing because they are colorful, branded, and printed on high-quality paper. In this section, we discuss two smaller experiments whose results are consistent with the first but not the second or third interpretations. The first interpretation is also more consistent with the private certification results than the second or third interpretations.

²⁸ We do not find robust evidence that outcomes in the high-intensity vacancies depend on the relative skills of the three applications sent with certificates, although this comparison has very low power.

In the first additional experiment, we provide information that workseekers have been assessed without revealing their assessment results. We randomly assign 254 candidates from our workseeker sample, assessed over three days, to a “placebo” certification group. These candidates receive placebo certificates that are identical to the public certificates, including the branding and identifying information, except that the actual assessment results are omitted (online Appendix Figure F.1) and the psychologist’s briefing does not discuss the assessment results.

The placebo certification treatment has minimal effects on labor market outcomes (online Appendix Table F.1). It increases an index of labor market outcomes by 0.03 standard deviations. This is not significantly different from zero and is significantly smaller than the public certification effect of 0.12 standard deviations. This index is an inverse covariance-weighted average of the five labor market outcomes discussed in Section IIC: employment, hours, earnings, wages, and contract status. The placebo certification effects on the five individual outcomes are all smaller than the public certification effects and are on average only 26 percent as large. But we cannot reject equality of the public and placebo effects for some of the individual outcomes because the small size of the placebo sample leads to large standard errors.

The second additional experiment measures firms’ willingness to pay (WTP) for information on workseekers’ assessment results, conditional on knowing candidates have been assessed. We recruit 69 establishments located in commercial areas near the low-income residential areas in Johannesburg where most workseekers in our sample live and are likely to work.²⁹ We conduct a survey and WTP exercise with the person responsible for hiring decisions at each of these establishments. We show this person a secure online database containing assessment results, contact information, and selected resume-style information for our 6,891 candidates. This database allows users to filter and search for candidates with specific assessment results and obtain their contact information. See online Appendix Figures G.1 and G.2 for selected screenshots of the database. We use a Becker-DeGroot-Marschak mechanism to measure WTP for access to this database relative to a placebo database with candidates’ contact information and selected resume-style information, but no assessment results (Becker, Degroot, and Marschak 1964).³⁰

Firms’ WTP for access to the database with assessment results is substantial: 68 percent of firms report positive WTP and the unconditional mean WTP is 1,161 South African rand or US\$195 PPP (online Appendix Figure G.3). Mean WTP is 224 percent of the mean weekly earnings for employed candidates in our workseeker sample. This shows firms value information on specific assessment results, conditional on knowing candidates have been assessed.

²⁹ We recruit establishments by asking if they are willing to participate in a study on hiring and tell them we can provide some useful information on hiring. We restrict the sample to establishments that have hiring responsibilities, either single-establishment firms or branches of larger firms that hire independently. Most firms are in retail, have multiple entry-level workers, expect to hire entry-level workers in the next year, and take on average four weeks to fill a vacancy. See online Appendix Table G.1 for detailed summary statistics.

³⁰ We ask how much they are willing to pay for three months of database access, and then randomly offer them a discount between 0 and 100 percent of the normal price of 10,000 South African rand (US\$1,670 PPP). If their stated WTP is higher than the normal price minus the discount, we give them access to the database. If their stated WTP is below the normal price minus the discount, we give them access to a placebo database with candidates’ contact information and selected resume-style information but no skill assessment results. We explain the entire mechanism and run a practice round before the official round. See online Appendix G for more details on the experimental protocol.

Both the placebo experiment and WTP measurement are consistent with the first but not second or third interpretations above: information about assessment results is valuable, not just information about whether candidates have been assessed or any visual appeal of the certificates. This provides additional support for our preferred interpretation: public certification provides information about workseekers' types and either facilitates more productive firm-worker matches or lowers screening costs.

B. Horizontal versus Vertical Differentiation of Workseekers

Public certification provides more information about workseekers' types, allowing these types to be differentiated more accurately. Our conceptual framework distinguishes two types of workseeker differentiation. Under horizontal differentiation, type i workseekers are more productive than type j workseekers in type i jobs, and vice versa. Under vertical differentiation, type i workseekers are more productive than type j workseekers in both type i and j jobs. Under horizontal differentiation, additional information can help both types of workseekers by matching them with jobs where they are more productive. Under vertical differentiation, additional information can hurt type j workseekers by reducing their probability of being mistaken for more productive type i workseekers. Our experiments are not primarily designed to test vertical versus horizontal differentiation but we present some suggestive evidence on this distinction.

We observe two patterns in our data that are not consistent with at least some models of vertical differentiation. First, the public certification effects of employment are not robustly increasing in measured skill. To show this, we construct three indices that combine the six assessment results in different ways: the number of top terciles minus bottom terciles, the first principal component of the cardinal scores, and a weighted average of the cardinal scores with weights based on their associations with earnings.³¹ The first index weights all skills equally, the second gives more weight to skills that are highly correlated with each other, and the third gives more weight to skills with higher associations with earnings. For each index, we construct an indicator for above-median values of the index. We then include this indicator and its interactions with treatment assignments in equation (1). The interaction effects with public certification on employment are smaller than 2 percentage points and not significantly different from zero for all indices (online Appendix Table D.11, panel A).³²

Second, public certification does not increase the dispersion of earnings conditional on employment. To show this, we estimate the standard deviation, interquartile range, and interdecile range of earnings conditional on employment in the public certification and control groups. These estimates are respectively 0.03, 0.65, and

³¹ The weights equal the coefficients from regressing earnings on the cardinal scores using control group data. Results are similar for weighted averages based on the coefficients of regressions of control group earnings on polynomial or spline functions of the skills.

³² We see similarly little evidence of heterogeneous treatment effects by skill when we use continuous indices instead of binary indicators and when we use alternative model specifications: using nonlinear functions of skill indices that allow nonmonotonic relationships, using different single indices, or using machine learning methods to estimate heterogeneous treatment effects simultaneously across all individual scores.

0.42 inverse hyperbolic sine points lower in the public certification group than the control group. The latter two differences are substantial but none are close to statistically significant using a clustered nonparametric bootstrap test ($p = 0.87, 0.57$, and 0.41 respectively). This pattern is inconsistent with one form of vertical differentiation, where workers have a single index of skill, productivity is monotonically increasing in skill, skill is observed with classical measurement error, and workseekers are hired only if their imperfectly observed skill exceeds some threshold. In this model, public certification would increase the dispersion of earnings conditional on employment through two mechanisms. For inframarginal workers who are employed with or without certification, certification would steepen the earnings-skill gradient, raising the earnings dispersion. Marginal workers who are employed only with certification will be close to the bottom of the earnings distribution, hence raising the dispersion of earnings conditional on employment. Neither dispersion tests we report here nor the quantile treatment effects we report in Section IIC match the predictions of this model of vertical differentiation.

Why do we see little evidence of vertical differentiation in this setting? We document three mechanisms that can lead to more horizontal than vertical differentiation in this setting.

First, there is substantial heterogeneity in firms' relative demand for different skills.³³ We show this using an incentivized choice experiment with the sample of 69 establishments described in the previous subsection. We ask the person at each establishment responsible for hiring to rank profiles of seven hypothetical candidates and tell them we will use their ranking to match them with workseekers from the online database. Six of the profiles have middle terciles for five assessments, and a top tercile for one assessment. There is substantial variation in firms' relative ranking of profiles: the share of firms ranking each profile highest ranges from 6 to 33 percent. The seventh profile has middle terciles for all six assessments and has a one-year post-secondary education certificate, while the other six profiles have only completed secondary school. Only 9 percent of firms rank this profile first and 76 percent of firms rank this last, showing that firms value the assessed skills relative to an alternative signal of productivity in which workseekers might invest. We find similar results when we ask firms to rank profiles with visible versus concealed assessment results. See online Appendix G for more details on the experimental protocol and results.

Second, assessment results are weakly correlated across skills within candidates. Numeracy and concept formation are most highly correlated, with $\rho \approx 0.5$. But most other pairwise correlations are substantially lower, with $\rho < 0.1$ for several pairs of skills (online Appendix Table A.2). As a result, most candidates' certificates show substantial variation across skills. Online Appendix Table A.3 shows that 88 percent of the candidates have at least one top tercile but only 24 percent have four or more top terciles and only 2.3 percent have all top terciles; 76 percent of the candidates have at least one bottom tercile but only 12 percent have four or more bottom terciles and only 0.7 percent have all bottom terciles; 64 percent of candidates have both top and

³³ We also estimate earnings-skill gradients in the control group of workseekers and compare these across skills. These are relatively similar for all skills except communication, which has a slightly steeper gradient than the others. This is consistent with different types of firms valuing different skills. But we view this as weak evidence, because the estimated earnings-skill relationships condition on endogenous firm-worker matching.

bottom terciles. Other studies that measure multidimensional skills also find weak correlations across skills within candidates (Almlund et al. 2011; Poropat 2009).

Third, workseekers with different skills respond differently to public certification. To show this, we regress both search targeting and certificate use with job applications on the same treatment \times skill index interactions described earlier in this subsection. Workseekers with relatively high skills are more likely to use certificates in job applications. Workseekers with relatively low skills are more likely to engage in search targeting, although this difference is not statistically significant.

These three mechanisms show how public certification can facilitate horizontal more than vertical differentiation in this setting. Different firms demand different skills, different workseekers supply different combinations of skills, certification helps workseekers target jobs that value their skills, and certification helps firms hire workseekers whose skills better match the firms' demand. These patterns are consistent with models of multidimensional skill where information frictions can lead to poor matches between workseeker skills and firm requirements (Fredriksson, Hensvik, and Skans 2018; Guvenen et al. 2020; Lise and Postel-Vinay 2020).

However, our experiments are not primarily designed to test horizontal against vertical differentiation, so we view this as suggestive evidence that can motivate future work. Certification may facilitate vertical rather than horizontal differentiation when it is based on assessment of a single skill or when certificates show only a single summary measure of multiple skills, unlike our approach of measuring and reporting multiple weakly correlated skills. Certification may also facilitate vertical rather than horizontal differentiation when it covers a larger share of the workforce, whereas our sample excludes highly educated and highly experienced workseekers.

C. Certification Is More Effective When Other Information on Workseekers' Skills Is Limited

If certification changes labor market outcomes by providing information about workseekers' skills, then it should be most effective when there are limited alternative sources of information on workseekers' skills. These sources might include past work experience and postsecondary education, which allow workseekers and firms to learn about workseekers' productivity in specific tasks. We test this idea by augmenting equation (1) to include interactions between treatment and proxies for alternative sources of information. Public certification effects on employment are 2.7 percentage points smaller for candidates with post-secondary education (standard error 2.8 percentage points) and 4.3 percentage points smaller for candidates with prior work experience (standard error 3.2 percentage points) (online Appendix Table D.11, panel B). We also estimate the latent probability of being employed at endline as a single summary measure.³⁴ Candidates with above-median latent probabilities of employment have a 7.6 percentage point smaller public certification effect than candidates with below-median latent probabilities (standard error

³⁴We estimate the latent probabilities following Abadie, Chingos, and West (2018). We regress endline employment on baseline demographics, education, assessment results, beliefs about assessment results, employment, earnings, and search behavior in the control group. We use the predicted values from these regressions in all treatment groups as latent probabilities for employment, adjusting the predicted values in the control group using leave-one-out estimation to avoid overfitting.

2.8 percentage points). These results show that certification can substitute for traditional sources of information about workseekers' skills.³⁵ This is consistent with evidence that educational qualifications are more useful for members of groups facing statistical discrimination (Arcidiacono, Bayer, and Hizmo 2010).

D. Skill Certification at Different Scales

We show that skill certification at a relatively small scale increases employment and earnings for certified workseekers. In this section we discuss conditions under which effects may vary with the scale of skill certification. This provides a guide for thinking about potential scale effects, rather than a confident or quantitative argument about scale effects.³⁶

First, employment and earnings effects may depend on scale if certified workseekers displace noncertified workseekers. It is unlikely that our experimental results are due to displacement of noncertified workseekers *in the control group*. We certify only 2,247 workseekers in a metropolitan area with roughly 8 million people and 2 million employed workers (Statistics South Africa 2016b). The probability of certified and control group workseekers applying for the same jobs by chance is very small, and Harambee does not encourage recently assessed workseekers to apply to specific jobs or search for work in specific areas.

It is possible that certified workseekers displace noncertified workseekers who are not part of the experimental sample. We cannot directly test for this, but we can evaluate the mechanisms that might generate it. Displacement is less likely if certification improves match quality or reduces screening costs and hence increases the share of latent vacancies that are worth filling, as in our conceptual framework and general equilibrium models of information frictions (Jovanovic 1979; Gonzalez and Shi 2010). Displacement is more likely if firms value certification for some reason other than information (e.g., visual appeal) or if certification helps firms to identify a small set of universally demanded workseekers and compete for them.

Our results are more consistent with the match quality or screening costs mechanisms. We find that firms' demand for different skills is heterogeneous, firms value learning about workseekers' specific skill types, and the gains from certification are not limited to workseekers with specific skill profiles. All these patterns suggest that firms and workseekers use certification to learn about workseekers' skills and achieve some combination of better matches between workseekers' skills and firms' demand or equally good matches at lower screening cost. We also find that certification increases earnings and hourly wages conditional on employment, suggesting that certified workseekers are in matches that generate more value net of screening costs. We do find that the callback and interview premia to certification drop when

³⁵ This result is not explained by a correlation between workseekers' skills and their education and past employment. We regress employment on treatment assignments, a single index measure of skill from Section IVB, a measure of information about workseekers' skills from this section, and a full set of interactions. The interactions between public certification and the single index skill measure remain close to zero, while the interactions between public certification and the measure of information about workseekers' skills remain negative.

³⁶ There are few existing papers that study how the effects of specific active labor market policies change with scale. For job search assistance policies specifically, Crépon et al. (2013) and Lise, Seitz, and Smith (2004) find larger-scale policies generate negative spillovers on nonparticipants, while Blundell et al. (2004) find no spillovers on nonparticipants.

certified applicants compete against each other in the audit study. This is consistent with some certified workseekers displacing other certified workseekers from interviews. However, as discussed in Section IIIC, this does not necessarily imply that certified workseekers displace other certified workseekers from hiring. Certification may allow firms to call back and interview fewer candidates for each vacancy and still make better-matched hires. This suggests one specific way certification can reduce screening costs and is consistent with the finding by Algan, Crepon, and Glover (2020) that reducing firm-level screening costs can raise hiring.

Second, employment and earnings effects may depend on scale if the extent of limited information varies across the population of either firms or workseekers. Consider the case where the population is divided into fraction p of uninformed workseekers, who do not know their skills and cannot convey their skills to firms, and fraction $1 - p$ of informed workseekers, who know their skills and can convey this information to firms. Assessing and certifying the latter group will have limited returns. Our finding that certification has larger employment and earnings effects when there are limited alternative sources of information on workseekers' skills is consistent with this possibility. Our experiment does not identify the population shares of workseekers or firms facing information frictions. The share of relatively uninformed types may be higher in our sample than the population, as we study workseekers with poor baseline labor market outcomes. But Harambee's workseeker recruitment does not explicitly mention assessments or information frictions, so workseekers are unlikely to select into the sample specifically for assessment and certification.

Third, employment and earnings effects may depend on scale if certificate (non)use conveys information in general equilibrium. If, for example, all workseekers get assessed and certified but only use certificates when applying to vacancies where their match quality is high, then firms may infer that workseekers without certificates are poor matches for these vacancies. In another example, some firms may choose not to use assessments in hiring if assessments are costly and they believe they can infer workseekers' types by observing their interactions with other firms (Lockwood 1991). Our experiments cannot speak to these general equilibrium mechanisms. But adding either of these two mechanisms to our conceptual framework still predicts that any nonzero use of assessment and certification will raise employment and earnings relative to no assessment and certification.

Even if reducing information frictions has decreasing effects on employment and earnings at larger scales, it may still raise workseeker or firm welfare by reducing job search costs, vacancy posting costs, and the frequency of bad hires that lead to separations. This interpretation is consistent with models showing that firm- and workseeker-level search and matching frictions, including information frictions, can lower aggregate utility through multiple mechanisms, not just through unemployment (Donovan et al. 2018; Mortensen and Pissarides 1999; Poschke 2019).

V. Conclusion

We find that workseekers make different job search decisions, firms make different interview decisions, and workseekers experience higher employment and earnings when more information is available about workseekers' skills. Assessing

workseekers' skills and communicating the assessment results to both workseekers and firms increases assessed workseekers' employment by 17 percent (5 percentage points), earnings by 34 percent, and hourly wages by 20 percent. This shows that skill certification gets more workseekers into jobs and that these jobs pay more. When workseekers learn their assessment results but cannot easily and credibly share assessment results with firms, their labor market outcomes improve, but not by as much. This shows the importance of getting credible information to both sides of the market.

We study a context and sample where information frictions are likely: work experience is limited, education-skill relationships are relatively weak, hiring mistakes are costly, and reservation and minimum wages are relevant. However, none of these features are unique to young workseekers in South Africa. Formal education qualifications are weakly related to measured skills in many countries (Pritchett 2013). Many labor markets face more regulations governing hiring, firing, and probation than in South Africa (Botero et al. 2004). Hiring mistakes may be costly even when separations are unregulated, due to reposting and retraining costs. High rates of youth unemployment in many countries are consistent with information frictions, as youths have less job search and work experience that can reveal their skills to themselves or to firms (International Labour Organization 2017).

Our results suggest that, in similar contexts, providing information about workseekers' skills may be a valuable focus of government policy. Some existing job search assistance programs offer skill assessments to workseekers (McCall, Smith, and Wunsch 2016). Adding certification to these assessments might enhance their effectiveness at low cost. We find that adding certification to an existing assessment program generates earnings gains for workseekers that easily exceed the cost of both assessment and certification. Government involvement, through public-sector assessment programs or subsidies to private-sector assessments, is likely to be particularly important for credit-constrained workseekers (Abebe, Caria, and Ortiz-Ospina 2020). Better information about workseekers' skills could also come from more accurate assessments during formal education (MacLeod et al. 2017).

Our results suggest there may also be scope for market-based provision of information about workseekers' skills. We show that firms are willing to pay for access to a database with information on workseekers' skill assessment results and contact information. We also ask workseekers in our sample how much of a hypothetical job search subsidy they would be willing to spend on certification. They report 17 percent, compared to 24 percent on training and 27 percent on transport, suggesting the possibility of charging workseekers for assessment services. Some large firms already use in-house psychometric assessments in hiring (Autor and Scarborough 2008; Hoffman, Kahn, and Li 2018). Anecdotally, psychometric assessments seem rarer in small firms, perhaps because in-house assessment systems are unlikely to be cost-effective when hires are infrequent. There are some third-party providers of assessment services around the world, including Harambee, LinkedIn, and the Manpower Group. Our results show that providing more information through certification can be valuable even in a labor market where some firms already use assessments, suggesting scope to grow this market. There are important market design questions around third-party provision that might be addressed in future work, such as which side(s) of the market will pay for assessment services, how third-party

providers can establish reputations, how precisely or coarsely information should be reported, and under what conditions participants will opt into or out of assessment. This work might incorporate existing models of screening and signaling when both agents and principals have limited information, allowing possible interaction effects (Alonso 2018; Rosar and Schulte 2012).

Our results also motivate future work on the interaction between different information provision mechanisms. For example, we find that public certification is most effective for workseekers with less work experience and without university education. This suggests that skill assessment and certification can substitute for alternative sources of information about workseekers' skills. Future work could examine conditions under which skill assessment and certification are complements or substitutes for network referrals, reference letters, or outsourcing agencies.³⁷

Finally, our results show that certification allows some combination of higher match quality and lower screening costs for firms. Quantifying the relative importance of these mechanisms is difficult without direct data on firm recruitment practices and productivity. Future work could explore this further, by combining data on both earnings and productivity (as in Kahn and Lange 2014) with variation in firms' information about workseekers' skills.

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³⁷ We find one result consistent with certification enhancing the effectiveness of referrals, potentially by helping network links to target referrals or making their referrals more credible to employers. Public certification slightly increases the probability of securing a job through a formal application or interview after a referral. There is no large or significant treatment effect on the probability of securing a job in other ways we measure: by approaching an employer in person, dropping off an application, emailing an application, getting hired by a social contact directly, or working at an employment broker. However, this result is only marginally statistically significant once we account for multiple testing across the different ways of finding a job. Hence, we view this as a suggestion for future work, rather than a core result.

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