The Returns to Training in a Low Income Labor Market: 
Evidence from a Field Experiment and Structural Model

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Motivation

- transition into the labor market marks a key stage in the life cycle
- scarring literature $\Rightarrow$ transition dynamics have persistent impacts
- transition process is shaped by three factors:
  - labor supply: skills of workers
  - labor demand from firms
  - labor market: efficiency of worker-firm matches
This Paper

- experimentally varying worker skills and matching process
- shed light on $L^S$, matching and $L^D$ sides of the labor market
- $L^S$ and matching:
  - RF: SR impacts on employment, earnings outcomes during transition
  - SF: dynamics and steady state impacts on lifetime earnings
- $L^D$:
  - SF: firm productivity
  - RF: employment/displacement impacts and competition effects
This Paper

- context: Uganda

- use an RCT to measure causal impacts on workers of experimentally varying process of entry into the labor market:
  - on-the-job-training
  - provision of sector-specific vocational training
  - matching:
    - matching firms to skilled workers (have received vocational training)
    - matching firms to workers that are willing to work and be trained
Research Questions 1

- how do the impacts on workers of these alternative training/matching routes compare?

- **key outcomes**: verified skills, employment, wages, hours, productivity

- what we learn:
  - comparison of training routes: vocational versus on-the-job
  - LM search costs: finding skilled workers, workers willing to work
Research Questions 2

- so far, followed workers for three years since baseline
- what are the steady **state impacts** of these training/matching routes on workers?
- structurally estimate a job ladder model of worker search: dynamics
- **key mechanisms**: search effort, job offers, wage offer distribution and reservation wages
- feed into IRR calculations of alternative transition routes into the LM
Research Questions 3

- what are the labor demand side responses?
- extend structural model to estimate productivity of firms matched to
- parallel experiment on firm side to measure displacement and competition effects
Related Literature: Training

- WB invested $9bn in 93 skills programs 2002-12, $100mn per project [Blattman and Ralston 2015]


- **middle-income** settings: mixed evidence of returns to such training
  - **zero/low**: Kluve et al. 2014, Groh et al. 2015, McKenzie et al. 2015, 2016

- our study: extension into **low-income** country setting
Further Innovations

- most studies **combine** vocational and on-the-job training [JTPA in US, YTS in UK]

- **long run** experimental study:
  - Card *et al.* [2015] meta-analysis of 200+ ALMPs, 10% in LICs

- **methodological** innovations:
  - combine RF and SF approaches
  - joint analysis of worker and firm behavior
Context: Firms

- urban labor markets throughout Uganda
- panel data: 1714 workers tracked from baseline and two follow-ups
- matched to nationally representative sample of SMEs
  - \( L \in [1, 15], \bar{L} = 3 \), operating in eight sectors:
    - welding, motor mechanics, construction,..., hairdressing
- [Table 1: The Demand for Skills, Mincerian Returns to Skills]
<table>
<thead>
<tr>
<th>Sector</th>
<th>Share of firms in sector</th>
<th>% workers skilled in sector</th>
<th>Coefficient and SE from worker wage regressions [USD]</th>
<th>Coefficient and SE from worker log(wage) regressions [USD]</th>
<th>% workers skilled in sector</th>
<th>Coefficient and SE from worker wage regressions [USD]</th>
<th>Coefficient and SE from worker log(wage) regressions [USD]</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Sectors</td>
<td></td>
<td>74.4%</td>
<td>30.8***</td>
<td>1.38***</td>
<td>31.1%</td>
<td>17.9***</td>
<td>.521***</td>
</tr>
<tr>
<td>Motor-mechanics</td>
<td>9.12%</td>
<td>69.6%</td>
<td>31.6***</td>
<td>1.01***</td>
<td>24.2%</td>
<td>17.2*</td>
<td>.303**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5.92)</td>
<td>(.086)</td>
<td>(3.33)</td>
<td>(9.81)</td>
<td>(.154)</td>
<td>(.104)</td>
</tr>
<tr>
<td>Plumbing</td>
<td>2.14%</td>
<td>80.4%</td>
<td>38.7***</td>
<td>2.35***</td>
<td>49.1%</td>
<td>64.0***</td>
<td>.722**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(45.9)</td>
<td>(3.90)</td>
<td>(9.81)</td>
<td>(19.9)</td>
<td>(2.84)</td>
<td>(.164)</td>
</tr>
<tr>
<td>Catering</td>
<td>4.18%</td>
<td>80.0%</td>
<td>-19.9</td>
<td>.638**</td>
<td>40.2%</td>
<td>28.2**</td>
<td>.332***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.54)</td>
<td>(.284)</td>
<td>(12.2)</td>
<td>(12.2)</td>
<td>(.109)</td>
<td>(.109)</td>
</tr>
<tr>
<td>Tailoring</td>
<td>10.8%</td>
<td>64.6%</td>
<td>50.9***</td>
<td>2.14***</td>
<td>41.6%</td>
<td>19.4*</td>
<td>.923***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(10.9)</td>
<td>(.240)</td>
<td>(10.6)</td>
<td>(10.6)</td>
<td>(.184)</td>
<td>(.184)</td>
</tr>
<tr>
<td>Hairdressing</td>
<td>35.8%</td>
<td>73.9%</td>
<td>33.4***</td>
<td>1.35***</td>
<td>29.2%</td>
<td>23.8***</td>
<td>.444***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(10.3)</td>
<td>(.136)</td>
<td>(6.26)</td>
<td>(6.26)</td>
<td>(.069)</td>
<td>(.069)</td>
</tr>
<tr>
<td>Construction</td>
<td>3.98%</td>
<td>81.85%</td>
<td>18.9</td>
<td>.378</td>
<td>28.8%</td>
<td>12.1</td>
<td>.292*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(.321)</td>
<td>(.591)</td>
<td>(9.86)</td>
<td>(9.86)</td>
<td>(.171)</td>
<td>(.171)</td>
</tr>
<tr>
<td>Electrical wiring</td>
<td>4.22%</td>
<td>83.3%</td>
<td>64.0***</td>
<td>1.55***</td>
<td>41.9%</td>
<td>28.7***</td>
<td>.489**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(12.9)</td>
<td>(.417)</td>
<td>(7.99)</td>
<td>(7.99)</td>
<td>(1.19)</td>
<td>(1.19)</td>
</tr>
<tr>
<td>Welding</td>
<td>9.87%</td>
<td>77.7%</td>
<td>44.7***</td>
<td>1.26***</td>
<td>24.9%</td>
<td>36.3***</td>
<td>.382***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(9.55)</td>
<td>(.207)</td>
<td>(6.73)</td>
<td>(6.73)</td>
<td>(.085)</td>
<td>(.085)</td>
</tr>
</tbody>
</table>
Context: Workers

- oversubscription design used for intervention
- targeted to poorest/disadvantaged youth
  - not the kinds of individual that can self-finance VT or OTJ training
- many job training programs target youth [Card et al. 2011, Attanasio et al. 2012]
- [Table 2: C-group Worker Characteristics and Labor Market Outcomes]
### Table 2: Baseline Balance on Labor Market Outcomes

Means, robust standard errors from OLS regressions in parentheses  
P-value on t-test of equality of means with control group in brackets  
P-value on F-tests in braces

<table>
<thead>
<tr>
<th></th>
<th>Number of workers</th>
<th>Currently working</th>
<th>Has worked in the last month</th>
<th>Total earnings in the last month [USD]</th>
<th>F-test of joint significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(7)</td>
<td>(8)</td>
</tr>
<tr>
<td>T1: Control</td>
<td>451</td>
<td>.381 (.049)</td>
<td>.401 (.048)</td>
<td>5.11 (1.27)</td>
<td></td>
</tr>
<tr>
<td>T2: On-the-job Training</td>
<td>283</td>
<td>.369 (.035)</td>
<td>.387 (.035)</td>
<td>6.44 (.955)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.955 ({.979} [.985] [.239])</td>
</tr>
<tr>
<td>T3: Vocational Training</td>
<td>390</td>
<td>.358 (.032)</td>
<td>.389 (.032)</td>
<td>7.29* (.831)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.831 ({.763} [.990] [.063])</td>
</tr>
<tr>
<td>T4: Vocational Training + Match</td>
<td>307</td>
<td>.320 (.033)</td>
<td>.360 (.034)</td>
<td>5.25 (.954)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.954 ({.316} [.747] [.758])</td>
</tr>
<tr>
<td>T5: Match</td>
<td>283</td>
<td>.364 (.033)</td>
<td>.367 (.034)</td>
<td>5.58 (.996)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.996 ({.707} [.386] [.713])</td>
</tr>
</tbody>
</table>

F-test of joint significance:  
{.882} {.908} {.379}
2. Design

[Figure 1: Summary of Experimental Design]
Figure 1: Experimental Design

1714 Workers

- Training
  - T3: Vocational Training (390)
  - T4: Vocational Training + Match (307)
  - T5: Match (283)
  - T2: On-the-job Training (283)
  - T1: Control (451)

- No training

T3-T4: Search Cost of Finding Trained Workers
T3-T2: Vocational versus on-the-job Training
T3-T1: Training
T4-T5: Search Cost of Finding Trained Worker
T5-T2: Wage subsidy
T5-T1: Search Cost of Finding a Willing Worker
Training in VTIs

- 6 months training: sector specific skills

- In T3 and T4, BRAC covered trainees cost of training, accommodation, food and transportation to VTIs

- Total cost: $470 per trainee split as,
  - VTI ($400) + worker's out-of-pocket costs ($70)

- Each VTI received 50% of the total one week after training began, remaining 50% 4 months later (for trainees still enrolled)
  - VTIs incentivized to retain trainees, not to find them jobs
  - Solve drop out problem associated with many training programs in low-income settings [Blattman and Ralston 2015]
**OTJ Training [T2]**

- firm paid 120K UGX/month = $50 (for 6 mnths) to hire an untrained worker

- **inflexible wage subsidy with designated split: 30K to owner, 90K to worker**
  - subsidy rate for unskilled workers (subsidy/average wage): 69% [de Mel et al. 2010, SR=50%]
  - untrained worker has to be hired from a matched list [as in T4]

- wage subsidy lasted 6 months, conditional on the trainee remaining in the firm

- BRAC monitored use of wage subsidies

- [Figure 2: Timeline]
Figure 2: Timeline

- Trainees applications, baseline survey: Jun - Sept 12
- Vocational Training (6 months) VTI survey: Jan-Jul 13
- Matching and OTJ-interventions, Process survey: Jul-Aug 13
- First follow-up survey of trainees: Jul 13-Feb 14
- Second follow-up: 12 months since end of Training/24 months since baseline
- Third follow-up survey of trainees: 24 months since end of Training/36 months since baseline
- Third follow-up: 36 months since end of Training/48 months since baseline
Timing of Treatments

- workers are observationally equivalent at point of application to VTI
- we present ITT estimates based on random assignment to each treatment at point of application
- VT offered 6 months earlier than OTJ-T and matching treatments
  - ensures workers make transition into labor market at same time
  - selective non-compliance by worker ability
- selection into OTJ-T and match treatments also depends on firm’s willingness to accept trainee
  - no such supply-side selection for vocational training
  - SM informative of productivity of firms employed at
- [Table A3: Firm Interest and Take-Up]
Table A3: Firm Interest and Worker Take-Up of Treatments

<table>
<thead>
<tr>
<th>Sample of Workers:</th>
<th>Vocational Training</th>
<th>On-the-Job Training</th>
<th>Matching</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Workers Offered Training</td>
<td>% Workers Who Took Up Training</td>
<td>% Workers Offered Treatment (as firm interested)</td>
</tr>
<tr>
<td>T3: Vocational Training</td>
<td>96.4</td>
<td>76.9</td>
<td>-</td>
</tr>
<tr>
<td>T4: Vocational Training + Match</td>
<td>95.8</td>
<td>85.4</td>
<td>-</td>
</tr>
<tr>
<td>T2: On-the-job Training</td>
<td>-</td>
<td>-</td>
<td>39.1</td>
</tr>
<tr>
<td>T5: Match</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Balance and Attrition

- **randomize individuals** to treatment within strata [region (C, N, E, W), gender, education]
- balance on characteristics and labor market outcomes
- 14% attrition rate by 36-month follow-up
- to correct for selective attrition:
  - weight ITT estimates using IPW
  - conditional Lee bounds [Lee 2009]
Estimation

- observe worker $i$ in treatment group $d$ in strata $s$ in survey wave $t = 0, 1, 2$
- estimate the following ANCOVA specification in survey waves $t = 1, 2$:

$$y_{ist} = \sum_j \beta_j T_i + \gamma y_{i0} + \delta x_{i0} + \lambda_s + \vartheta_{t=2} + u_{ist}$$

- worker $i$’s assigned treatment $T_i$ ($j$ treatments)
- coefficient of interest $\beta_j$: ITT estimates (averaged over $t = 1, 2$)
- $\lambda_s$: strata fixed effects
- $\vartheta_{t=2} = 1$ if observation is in wave $t = 2$
- randomization at worker level ($i$): robust standard errors
Spillovers: Size of Labor Markets

- market (sector-region combination): 156 employed workers, 40 firms (initial firm census)
- we matched an average of 8 workers per market (or 5% of total workers) in the matching interventions
- workers are geographically and sectorally mobile

implications:
  - do not expect C-group to be contaminated by treated workers in the same labor market → SUTVA holds
  - but might be spillover effects onto workers not in our evaluation sample [GE effects]

later exploit parallel experiment: examine displacement effects within firms that hire a treated worker
4. Results: RF Impacts on Skills and Employment
Skills Test

- map productivity impacts to **measurable skills**

- has not been done often in training literature \([\text{Ibarran et al. 2014, Berniell and de la Mata 2016}]\)

- conducted a (neutral) skills test on workers (incl. \(C\)), administered at second follow-up
# MOTOR-MECHANICS

## 1. Multiple-choice

**Question:** What are you advised to do when servicing the engine by changing oil?

- A. Top up lubricating oil
- B. Replace oil filter
- C. Overhand engine
- D. Overhand cylinder head

**Correct Answer:** B

## 2. Multiple-choice

**Question:** What immediate remedy can you give to a vehicle with a problem of excessive tyre wear in the center more than other parts?

- A. Increase tyre pressure
- B. Reduce tyre pressure
- C. Inflate pressure
- D. Remove the vehicle tire

**Correct Answer:** B

## 3. Multiple-choice

**Question:** If a customer reports to you that his/her vehicle changing system works at lower rate, how can you help him?

- A. Replacing the changing system
- B. Adjusting the alternator tension
- C. Replacing alternator housing
- D. Renewing wire insulator

**Correct Answer:** B

## 4. Multiple-choice

**Question:** Which of the following sets of systems or components call for mechanical adjustment during general vehicle service?

- A. Tyres, cooling system, master cylinder
- B. Brake shoes, alternator, and valve clearance
- C. Distributor, radiator, propeller shaft
- D. Tank, crankshaft, Turbo charger

**Correct Answer:** B

## 5. Multiple-choice

**Question:** What solution would you give a customer with a vehicle engine producing blue smoke?

- A. Top up lubricant
- B. Time the engine
- C. Replace piston rings
- D. Remove carbon deposits

**Correct Answer:** C

## 6. Matching

**Question:** What should you do to stop the following vehicle troubles?

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Battery over charging</td>
<td>A. Leaking fuel tank</td>
</tr>
<tr>
<td>2</td>
<td>Engine over heating</td>
<td>B. Renew regulator</td>
</tr>
<tr>
<td>3</td>
<td>Lubricant leakage</td>
<td>C. Reduce oil to the correct level</td>
</tr>
<tr>
<td>4</td>
<td>Smoke in exhaust</td>
<td>D. Renew piston rings</td>
</tr>
<tr>
<td>5</td>
<td>Engine fails to start</td>
<td>E. Charge the battery</td>
</tr>
</tbody>
</table>

**Correct Answer:** 1B, 2A, 3C, 4D, 5E

## 7. Order

**Question:** When changing engine oil, in which order should you perform the following steps?

- A. Drain oil through drain plug
- B. Remove oil filter cup
- C. Run engine to check leaks
- D. Fill new oil through filler cup to level
- E. Remove oil filter
- F. Warm up the engine

**Correct Answer:** B, E, A, D, F, C
### Table 3: Skills

OLS regression coefficients, IPW estimates, robust standard errors in parentheses

Lee [2009] Bounds in brackets

<table>
<thead>
<tr>
<th>Skills Test</th>
<th>Report No Skills</th>
<th>All</th>
<th>45th Quantile</th>
<th>75th Quantile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>T2: On-the-job Training</td>
<td>-.112**</td>
<td>3.21</td>
<td>2.26</td>
<td>3.37</td>
</tr>
<tr>
<td></td>
<td>(.044)</td>
<td>(2.15)</td>
<td>(2.20)</td>
<td>(3.94)</td>
</tr>
<tr>
<td></td>
<td>[-.095 ; -.078]</td>
<td>[1.46 ; 3.23]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3: Vocational Training</td>
<td>-.314***</td>
<td>8.14***</td>
<td>14.5***</td>
<td>8.77***</td>
</tr>
<tr>
<td></td>
<td>(.036)</td>
<td>(1.90)</td>
<td>(1.46)</td>
<td>(2.08)</td>
</tr>
<tr>
<td></td>
<td>[-.303 ; -.259]</td>
<td>[5.93 ; 11.2]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T4: Vocational Training + Match</td>
<td>-.323***</td>
<td>7.95***</td>
<td>12.8***</td>
<td>7.99***</td>
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<tr>
<td></td>
<td>(.037)</td>
<td>(2.15)</td>
<td>(1.42)</td>
<td>(2.67)</td>
</tr>
<tr>
<td></td>
<td>[-.283 ; -.264]</td>
<td>[7.88 ; 9.89]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T5: Match</td>
<td>-.004</td>
<td>1.49</td>
<td>.399</td>
<td>-.543</td>
</tr>
<tr>
<td></td>
<td>(.045)</td>
<td>(2.17)</td>
<td>(1.80)</td>
<td>(2.57)</td>
</tr>
<tr>
<td></td>
<td>[-.049 ; -.003]</td>
<td>[2.65 ; 3.61]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean (SD) Outcome in Control Group

|                          | .443             | 29.2 (23.5) |

Control for Baseline Value

|                          | No              | No            | No            | No            |

P-values on tests of equality:

|                          | .000***         | .023**        | .000***       | .185          |

OTJ Training = Vocational Training

|                          | .780            | .931          | .373          | .776          |

Vocational Training = Vocational Training + Match

|                          | 1,174           | 1,174         | 1,174         | 1,174         |

N. of observations
<table>
<thead>
<tr>
<th></th>
<th>Has done any paid work in the last month</th>
<th>Has done any wage employment in the last month</th>
<th>Employed at firm they were matched to</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T2: On-the-job Training</strong></td>
<td>.079*** (.030) [0.075 ; 0.093]</td>
<td>.071** (.028) [0.047 ; 0.067]</td>
<td>.159*** (.017) [0.149 ; 0.150]</td>
</tr>
<tr>
<td><strong>T3: Vocational Training</strong></td>
<td>.095*** (.027) [0.077 ; 0.123]</td>
<td>.058** (.025) [0.042 ; 0.092]</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>T4: Vocational Training + Match</strong></td>
<td>.083*** (.029) [0.085 ; 0.112]</td>
<td>.066** (.028) [0.053 ; 0.085]</td>
<td>.005 (.005) [0.003 ; 0.003]</td>
</tr>
<tr>
<td><strong>T5: Match</strong></td>
<td>.053* (.029) [0.040 ; 0.063]</td>
<td>.025 (.026) [0.010 ; 0.027]</td>
<td>.005 (.004) [0.003 ; 0.004]</td>
</tr>
<tr>
<td><strong>Mean Outcome in Control Group</strong></td>
<td>.396</td>
<td>.260</td>
<td>0</td>
</tr>
<tr>
<td><strong>Control for Baseline Value</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>P-values on tests of equality:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTJ Training = Vocational Training</td>
<td>.606</td>
<td>.642</td>
<td>N/A</td>
</tr>
<tr>
<td>Vocational Training = Vocational Training + Match</td>
<td>.692</td>
<td>.771</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>N. of observations</strong></td>
<td>2,683</td>
<td>2,683</td>
<td>2,245</td>
</tr>
</tbody>
</table>
## Table 5: Total Effect Impacts on Employment

OLS regression coefficients, IPW estimates, robust standard errors in parentheses
Lee [2009] Bounds in brackets

<table>
<thead>
<tr>
<th></th>
<th>Number of hours worked in wage employment in the last week</th>
<th>Number of months worked in the last year</th>
<th>Hourly wage rate [USD]</th>
<th>Total earnings in the last month [USD]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>T2: On-the-job Training</td>
<td>2.97</td>
<td>.557*</td>
<td>.060*</td>
<td>7.49**</td>
</tr>
<tr>
<td></td>
<td>(1.84)</td>
<td>(.299)</td>
<td>(.032)</td>
<td>(3.56)</td>
</tr>
<tr>
<td></td>
<td>[.122 ; 2.50]</td>
<td>[.468 ; .681]</td>
<td>[.001 ; .055]</td>
<td>[1.32 ; 9.00]</td>
</tr>
<tr>
<td>T3: Vocational Training</td>
<td>3.07*</td>
<td>.944***</td>
<td>.042*</td>
<td>10.2***</td>
</tr>
<tr>
<td></td>
<td>(1.77)</td>
<td>(.269)</td>
<td>(.022)</td>
<td>(3.15)</td>
</tr>
<tr>
<td></td>
<td>[.666 ; 4.47]</td>
<td>[.696 ; 1.30]</td>
<td>[.004 ; .058]</td>
<td>[5.68 ; 12.1]</td>
</tr>
<tr>
<td>T4: Vocational Training + Match</td>
<td>4.61**</td>
<td>.600**</td>
<td>.034*</td>
<td>9.28***</td>
</tr>
<tr>
<td></td>
<td>(1.95)</td>
<td>(.299)</td>
<td>(.020)</td>
<td>(3.44)</td>
</tr>
<tr>
<td></td>
<td>[2.95 ; 5.90]</td>
<td>[.616 ; .989]</td>
<td>[.002 ; .040]</td>
<td>[7.43 ; 11.0]</td>
</tr>
<tr>
<td>T5: Match</td>
<td>.770</td>
<td>.551*</td>
<td>-.013</td>
<td>1.91</td>
</tr>
<tr>
<td></td>
<td>(1.83)</td>
<td>(.299)</td>
<td>(.019)</td>
<td>(3.16)</td>
</tr>
<tr>
<td></td>
<td>[.120 ; 1.64]</td>
<td>[.249 ; .568]</td>
<td>[-.009 ; -.008]</td>
<td>[-.784 ; 1.88]</td>
</tr>
</tbody>
</table>

Mean Outcome in Control Group
16.4                                      3.90                         .110                         30.8
Control for Baseline Value
Yes                                       No                           Yes                         Yes

P-values on tests of equality:
OTJ Training = Vocational Training
.960                                      .210                         .544                         .477
Vocational Training = Vocational Training + Match
.460                                      .270                         .714                         .799

N. of observations
2,581                                      2,683                         2,556                         2,574
Productivity and Composition Effects

- overall treatment impact on earnings combines:
  - employment effect: $\Delta \text{prob(employed)}$
  - composition effect: $\Delta \text{composition of those employed (EM)}$
  - productivity effect: $\Delta \text{earnings of those employed}$

- follow Attanasio et al. [2011] in estimating **bounds** for the treatment effect on productivity

- [Fig A3, Table A7: Productivity Bounds]
Productivity Bounds, By Treatment and Gender

Panel A: All Workers
Panel B: Women
Panel C: Men
Underlying Market Failure

- with such high returns from training, why do workers not self-invest in their HK?

- credit constraints likely bind in this sample
  - total cost: $470 per trainee split as VTI ($400) + out-of-pocket costs ($70)
  - also prevents workers paying for OTJ (even though no binding min. wage)

- worker beliefs (imperfect information)?
  - individuals are imperfectly informed about returns to skills in low-income labor markets [Jensen 2009, Kaufmann 2014]
  - [later results from SM]
External Validity

- we have documented large impacts of training relative to studies in middle- and high-income countries: why?
  - low-income setting [Card et al. 2015]
  - worker selection into evaluation sample
  - treatment intensity
  - VTI quality (interacting with imperfect information of workers)
5. Structural Model of Job Search
Value Added of a Structural Model

- pinpoint mechanisms driving steady state employment impacts:
  - search/likelihood of job offers
  - distribution of offered and accepted wages
  - productivity of firms employed at

- **dynamic impacts** of training routes differ

- input estimated SS impacts into IRR calculations
Auxiliary Assumptions

- standard job ladder model of worker search
- homogenous and risk neutral workers (apart from training/employment status)
- workers are in steady state two by October 2014 (over a year since end of VT)
- firms do not make wage offers to $u$ workers that would be refused
Job Ladder Model of Job Search

- risk neutral workers
- workers can be either trained \((t = 1)\) or untrained \((t = 0)\)
- at the beginning of each period, a worker can be either employed or unemployed
Value Functions

- value function for an unemployed worker is:

\[
V^n(t) = -\phi(c) + \beta[\hat{\lambda}_0(c, t)\max \left\{ \int V(w, t)d\hat{F}(w|t), V^n(t) \right\} + (1 - \hat{\lambda}_0(c, t))V^n(t)]
\]

value function for an employed worker with wage \( w \) is:

\[
V(w, t) = w - \phi(c) + \beta[\delta V^n(t) + \hat{\lambda}_1(c, t)\max \left\{ \int V(w, t)d\hat{F}(w|t), V(w, t) \right\} + (1 - \delta - \hat{\lambda}_1(c, t))V(w, t)]
\]

(2)
Treatments and Job Search

- training can affect worker behavior through two mechanisms:
  - the probabilities of receiving a job offer: \((\lambda_0(c, t), \lambda_1(c, t))\)
  - the distribution of offered wages \((F(w|t))\)

- through these mechanisms training impacts endogenous choices:
  - search effort \((c)\)
  - whether to accept or reject wage offers (reservation wage)

- matching could impact workers through the same mechanisms

- [Table 6: Worker Beliefs and Search]
### Table 6: Worker Beliefs and Job Search

OLS regression coefficients, robust standard errors in parentheses

Lee [2009] Bounds in brackets

<table>
<thead>
<tr>
<th>Job Offer Probability</th>
<th>Offered Wages</th>
<th>Search Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Expected probability of finding a job in the next 6 months (0 to 10 scale)</td>
<td>Minimum expected monthly earnings [USD]</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>T2: On-the-job Training</td>
<td>0.617***</td>
<td>-0.687</td>
</tr>
<tr>
<td></td>
<td>(0.154)</td>
<td>(3.26)</td>
</tr>
<tr>
<td></td>
<td>[0.388 ; 0.571]</td>
<td>[-8.75 ; 5.99]</td>
</tr>
<tr>
<td>T3: Vocational Training</td>
<td>1.78***</td>
<td>22.6***</td>
</tr>
<tr>
<td></td>
<td>(0.142)</td>
<td>(3.95)</td>
</tr>
<tr>
<td></td>
<td>[1.69 ; 2.07]</td>
<td>[2.00 ; 37.1]</td>
</tr>
<tr>
<td>T4: Vocational Training + Match</td>
<td>1.72***</td>
<td>14.3***</td>
</tr>
<tr>
<td></td>
<td>(0.152)</td>
<td>(3.46)</td>
</tr>
<tr>
<td></td>
<td>[1.75 ; 1.96]</td>
<td>[2.27 ; 30.3]</td>
</tr>
<tr>
<td>T5: Match</td>
<td>-0.118</td>
<td>1.07</td>
</tr>
<tr>
<td></td>
<td>(0.144)</td>
<td>(3.33)</td>
</tr>
<tr>
<td></td>
<td>[-0.250 ; -0.116]</td>
<td>[1.55 ; 1.52]</td>
</tr>
<tr>
<td>Mean Outcome in Control Group</td>
<td>4.01</td>
<td>43.5</td>
</tr>
<tr>
<td>Control for Baseline Value</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>P-values on tests of equality:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTJ Training = Vocational Training</td>
<td>0.000***</td>
<td>0.000***</td>
</tr>
<tr>
<td>Vocational Training = Vocational Training + Match</td>
<td>0.719</td>
<td>0.044**</td>
</tr>
<tr>
<td>N. of observations</td>
<td>2,581</td>
<td>1,964</td>
</tr>
</tbody>
</table>
Two Simplifications

- ignore search effort, so $c = \phi(c) = 0$
- workers have correct beliefs: $\hat{\lambda}_i(t) = \lambda_i(t)$ and $\hat{F}(w|t) = F(w|t) \ i \in \{0, 1\}$
- implication: $\lambda_i(t)$ combines worker’s search effort and other firm’s search effort $\to$ job offers
Accepted Versus Offered Wage Distributions

- cross sectional distribution of job values/accepted offers among employed, $G(.)$, differs from the offer sampling distribution $F(.)$

- $G(.)$ is readily observed in the data; $F(.)$ is not

- given $u$ in SS, we can derive SS relationship between $F(w)$ and $G(w)$:

$$\frac{F(w) - G(w)}{(1 - F(w))G(w)} = \frac{\lambda_1}{\delta} = \kappa_1$$  \hspace{1cm} (3)

- $G$ FOSD $F$ unless if no J-J transitions $\Rightarrow \lambda_1 = 0$ and $F(w) = G(w)$

- $\kappa_1$ measures intensity of interfirm competition
  - no. outside offers received before being laid off
7. Structural Model Estimation

[Figure 3: Worker Timeline]

[Table 8: Spell Descriptives]

[Table 9: Estimates of the Job Ladder Model]

[Figure 4: G and F Distributions]
Data: Job Spells Format

- construct history of employment status $e_i \in \{0,1\}$ from $t_0$ (August 2013: matching/OTJ interventions) to $T$ (June-Sep 15)
- spell durations $d_i$ (left censored at $t_0$, right censored at $T$)
- transition indicators between spells: $\tau_{JU_i}$, $\tau_{JJ_i}$, $\tau_{UJ_i}$
- wage: $w_i$ (one per employment spell)
- assume SS has been reached in October 2014
- estimate based on maximum of two spells since then to get SS transitions
Figure 3: Worker Spells Data

Spell 1: unemployment duration $d_i$
- Start of record $t_0 = \text{Aug 2013}$
- Start of unemployment spell at date $t$
- Unemployed at reference date Oct 2014
- Exits unemployment at date $t + d_i$
- Transition $\tau_{Uji}$ recorded

Spell 2: employment, value $w_{0i}$
- End of record $T = \text{Aug 2015}$

Spell 1: employment duration $d_i$, value $w_{1i}$ (left censored)
- Start of record $t_0 = \text{Aug 2013}$
- Employed at reference date Oct 2014
- Job spell ends at date $t_0 + d_i$, type of transition $\tau_{JKi}$ recorded

Spell 2: job or unemployment
- End of record $T = \text{Aug 2015}$
Estimation

- follow two-step procedure in Bontemps et al. [2000]

- **step 1**: $G(.)$ estimated non-parametrically from CDF of observed wages for those employed

- **step 2**: substitute $G(.)$ into $L(x_i)$ using relationship between $G(.)$ and $F(.)$
  - $\lambda_0, \lambda_1, \delta$ are estimated, asymptotic se’s calculated

- to increase precision:
  - combine C and T5 (match): Control
  - T2: OTJ-T
  - combine T3 and T4: VT
Table 7: Structural Estimates of the Job Ladder Model
Two-step estimation procedure in Bontemps, Robin and van den Berg [2000]

Panel A: Parameter Estimates
Standard error in parentheses

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Control</th>
<th>On-the-job Training</th>
<th>Vocational Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job destruction rate (monthly):</td>
<td>$\delta$</td>
<td>.0249 (.0022)</td>
<td>.0253 (.0034)</td>
</tr>
<tr>
<td>Arrival rate of job offers if UNEMPLOYED (monthly):</td>
<td>$\lambda_0$</td>
<td>.0104 (.0009)</td>
<td>.0118 (.0016)</td>
</tr>
<tr>
<td>Arrival rate of job offers if EMPLOYED (monthly):</td>
<td>$\lambda_1$</td>
<td>.0097 (.0034)</td>
<td>.0042 (.0032)</td>
</tr>
</tbody>
</table>
Table 7: Structural Estimates of the Job Ladder Model

Two-step estimation procedure in Bontemps, Robin and van den Berg [2000]

Panel A: Parameter Estimates
Standard error in parentheses

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>On-the-job Training</th>
<th>Vocational Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment Rate</td>
<td>( \bar{u} )</td>
<td>.7054</td>
<td>.6819</td>
</tr>
<tr>
<td>Interfirm competition for workers</td>
<td>( \kappa_1 )</td>
<td>.3896</td>
<td>.1660</td>
</tr>
</tbody>
</table>

OTJ workers still better off in terms of employment (lower \( u \)) than C-group

Relative to counterfactual, reduction in \( u \):
- OTJ: 2.35pp (3.3%)
- VT: 8.01pp (11.4%)

Large reductions in SS unemployment from supply-side interventions
### Table 7: Structural Estimates of the Job Ladder Model

Two-step estimation procedure in Bontemps, Robin and van den Berg [2000]

<table>
<thead>
<tr>
<th>Panel B: Function and Income Estimates</th>
<th>Control</th>
<th>On-the-job Training</th>
<th>Vocational Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average (sd) monthly OFFERED wage [USD]</td>
<td>$F(.)$</td>
<td>80.5 (86.4)</td>
<td>89.3 (89.9)</td>
</tr>
<tr>
<td>Average (sd) monthly ACCEPTED wage [USD]</td>
<td>$G(.)$</td>
<td>92.8 (96.6)</td>
<td>95.6 (94.4)</td>
</tr>
<tr>
<td>Treatment Effect Impact on Annual Income [USD]</td>
<td></td>
<td>36.9</td>
<td>122.4</td>
</tr>
<tr>
<td>% Impact:</td>
<td></td>
<td>11.3%</td>
<td>37.3%</td>
</tr>
</tbody>
</table>

% impacts on annual earnings far larger than % impacts on $\Delta u$ alone
Firms

- large difference in SS returns to trained workers: $122 versus $37
- can extend job ladder model to back out distribution of firm productivity that each group of workers matches to
- cannot use RF methods to estimate bounds on firm characteristics worker are matched to

- [Table 7, Panel C: Firm Productivity]
Table 7: Structural Estimates of the Job Ladder Model

Two-step estimation procedure in Bontemps, Robin and van den Berg [2000]

Panel A: Parameter Estimates

Panel C: Firm Productivity Distribution

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>On-the-job Training</th>
<th>Vocational Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average (sd) firm productivity</td>
<td>$P(.)$</td>
<td>645.2 (2152)</td>
<td>395.7 (1453)</td>
</tr>
<tr>
<td>% Impact:</td>
<td></td>
<td>-39%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Panel B: On-the-job Training vs Control

Panel C: On-the-job Training vs Vocational Training
Discussion

- comparing structural and reduced form impacts
- worker expectations
- IRR
Structural and RF Estimates

- recall Mincerian returns to VT: (+52%) [Table 1]
- RF earnings impacts: VT (33%), OTJ-T (24%) [Table 5]
  - ability/selection bias
- confirmed using Raven’s matrices IQ measure:
  - worker sample: mean (sd) 4.8 (2.3)
  - another sample of workers that self-financed VT: 5.1 (2.1)
- SF-SS earnings impacts: VT (37%), OTJ-T (11%) [Table 7]
  - why do impacts to OTJ-T vary so much across methods?
- [Figure 4: Dynamics]
Figure 4: Average Quarterly Earnings and Months Worked, by Treatment

Panel A: Average Quarterly Earnings

Panel B: Number of Months Worked in Quarter

Notes: Panel A shows for each quarter, the average earnings in the quarter for workers in the control or match group (T1 or T5), those assigned to on-the-job training (T2), and those assigned to receive vocational training (T3 and T4). For those assigned to on-the-job training, this includes the value of the wage subsidy given to them. Panel B shows for each quarter, the average number of months in the quarter that workers in each of these groups is in employment for. For workers assigned to on-the-job training, this includes employment at the firm they are originally matched to. All monetary variables are deflated and expressed in terms of August 2012 prices, using the monthly consumer price index published by the Uganda Bureau of Statistics. Deflated monetary amounts are then converted into August 2012 USD.
Worker Expectations

- can compare worker expectations of returns to training with estimated SS $G(\cdot)$ function (distribution of accepted wages)
- at baseline, workers expect returns to VT to be over 100%
- *overestimate* relative to steady state $G(\cdot)$ for those assigned to VT
  - those assigned to VT converge to $G(\cdot)$
  - those assigned to OTJ-T continue to *underestimate* true returns

- [Table 8: Expectations]
Table 8: **Expectations**

Columns 1 and 2: Means, standard deviations in parentheses  
All amounts in 2012 USD

<table>
<thead>
<tr>
<th></th>
<th>Measured at Baseline</th>
<th>Updated Expectations (Follow-up)</th>
<th>Steady State</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Expected earnings with current skill set (triangular distribution)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Workers (Baseline Interview)</td>
<td>60.2</td>
<td>129.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(53.2)</td>
<td>(184.8)</td>
<td></td>
</tr>
<tr>
<td>Expected earnings if receives VTI Training (triangular distribution)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2: On-the-job Training</td>
<td>2.20</td>
<td>95.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.33)</td>
<td>[4.08 ; 52.0]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[-9.59 ; 10.8]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected earnings (triangular distribution) [USD]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3 + T4: Vocational Training</td>
<td>33.0***</td>
<td>100.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.02)</td>
<td>[4.08 ; 52.0]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[-9.59 ; 10.8]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earnings for those assigned to VT (G(.))</td>
<td>62.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Outcome in Control Group</td>
<td>62.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control for Baseline Value</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-values on tests of equality:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTJ Training = Vocational Training</td>
<td>.000***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. of observations</td>
<td>1714</td>
<td>1714</td>
<td>1691</td>
</tr>
</tbody>
</table>
IRR

- IRR challenge versus capital/cash transfers in low-income settings [Blattman and Ralston 2015]

- vocational training cost: $470 per trainee split as VTI ($400) + out-of-pocket costs ($70)

- OTJ training cost: $50 \times 6 \text{ months} = $302 \text{ per trainee}

- SS earnings impact 3 times larger for vocational training: $122 \text{ versus } $37

- opportunity costs: foregone earnings while being trained

- [Table 9: IRR]

- [Figure 5: IRR Robustness]
## Table 9: Internal Rate of Return to Training

<table>
<thead>
<tr>
<th>Panel</th>
<th>On-the-job Training</th>
<th>Vocational Training</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A. External parameters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cost per individual at year 0 [USD]:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Training costs (for 6 months)</td>
<td>302</td>
<td>470</td>
</tr>
<tr>
<td>(ii) Program overheads costs</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>(iii) Foregone earnings (for 6 months)</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Social discount rate = 5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remaining expected productive life of beneficiaries</td>
<td>38 years</td>
<td>38 years</td>
</tr>
<tr>
<td><strong>Panel B. Estimated total earnings benefits</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 NPV change in total earnings year 1 and beyond-forever (from structural model)</td>
<td>621</td>
<td>2063</td>
</tr>
<tr>
<td>2 Benefits/cost ratio</td>
<td>1.74</td>
<td>3.93</td>
</tr>
<tr>
<td>Sensitivity to different discount rates/time horizons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social discount rate = 10%</td>
<td>1.00</td>
<td>2.27</td>
</tr>
<tr>
<td><strong>3 Internal Rate of Return (IRR)</strong></td>
<td>0.100</td>
<td>0.233</td>
</tr>
<tr>
<td><strong>Panel C. Women</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Internal Rate of Return (IRR)</td>
<td>0.136</td>
<td>0.216</td>
</tr>
<tr>
<td>Sensitivity to different expected remaining productive life of beneficiaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remaining expected productive life = 20 years</td>
<td>0.124</td>
<td>0.212</td>
</tr>
<tr>
<td>Remaining expected productive life = 10 years</td>
<td>0.063</td>
<td>0.172</td>
</tr>
<tr>
<td><strong>Panel D. Programme Costs for IRR to equate social discount rate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Total cost per individual at year 0 [USD]</td>
<td>615</td>
<td>1900</td>
</tr>
<tr>
<td>Sensitivity to different discount rates/time horizons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social discount rate = 10%</td>
<td>357</td>
<td>1185</td>
</tr>
</tbody>
</table>
Notes: This shows the internal rate of return (IRR) calculated, based on the structural model estimates among those assigned to on-the-job training (T2), and those assigned to receive vocational training (T3 and T4). The IRR estimates vary in when they assume the steady state is reached. This varies between assuming the steady state is reached in October 2014 (two years since the end of the period of vocational training) to assuming it is reached in February 2015.
Conclusions
Contributions 1

- extension of training evaluations into low-income country setting
- separating returns to vocational and on-the-job training
  - why such large impacts?: setting, workers, treatment intensity
- no evidence of some forms of worker-firm match frictions
- long term follow-ups allow us to study steady state impacts
Contributions 2

- use experimental variation to identify a structural model of worker search to pinpoint mechanisms:
  - $\lambda_0(OTJ)$ and $\lambda_1(OTJ)$ are low: VT workers move up the job ladder; OTJ-T do not

- important role of firm side heterogeneity in driving impacts:
  - productivity of firms employed at: VT (+13%), OTJ-T (−39%)

- IRR challenge met versus capital/cash transfers [Blattman and Ralston 2015]

- large reductions in unemployment rates: OTJ: 2.35pp (3.3%), VT: 8.01pp (11.4%)

- if no displacement $\Rightarrow$ more effective job creation than easing $L^d$ constraints on firm