Selection Committee
National Bureau of Economic Research
Cambridge, MA

Re: Application for NBER Workshop on Development Economics and Networks for Early-Career Researchers

Dear Professor Breza, Professor Chandrasekhar, and Dr. Viviano,

My name is Jiayue Zhang. I am a Postdoctoral Scholar at the University of Chicago, Energy and Environment Lab, and hold a PhD in Economics from Brown University. I would appreciate the opportunity to present my paper and discuss the frontiers of empirical network research at the workshop. The paper that I hope to present is titled "Won't You Hire Your Neighbor? Experimental Evidence on Small Firm Labor Consolidation," co-authored with Morgan Hardy (NYU Abu Dhabi) and Jamie McCasland (UC Merced).

The project experimentally creates candidate labor-sharing links between 1,429 micro-enterprise owners in Aburi, Ghana, randomly matching them into 710 dyadic pairs and subsidizing 361 of those pairs to work for one another for up to 30 days. We find that the subsidy activates the assigned edge at a high rate and durably raises each owner's network degree. The activated ties are used for production input and information sharing, but do not lead to complete firm consolidation. Despite no detectable average effect on pair output, the tie functions as an income-smoothing mechanism among pairs with at least one male owner, with female-only pairs forming ties at the same rate but not using them to smooth income.

I am applying to this workshop because my paper sits squarely at the intersection of development economics and network analysis, and because the questions I most want feedback on are methodological ones specific to the networks literature: how to credibly interpret a full-sample, fuzzy-matched network built from experimentally-seeded and organically-formed edges together, and how to test whether an owner's baseline position in that ambient network moderates their response to a randomly assigned tie. A workshop with exactly this combination of substantive and methodological focus is the ideal venue to sharpen the paper.

My faculty recommender is Andrew Foster, George and Nancy Parker Professor of Economics at Brown University, who can be reached at afoster@brown.edu. Thank you for your consideration.

Sincerely,

Jiayue Zhang
University of Chicago

Jiayue Zhang

Website: jzhangg.github.io
Email: zhangjiayue@uchicago.edu

ACADEMIC APPOINTMENTS

Postdoctoral Scholar, Energy and Environment Lab, University of Chicago, *2026 to present*

EDUCATION

Ph.D. in Economics, Brown University, *2026*
Completed courseworks: Microeconomics I & II, Macroeconomics I & II, Econometric Methods, Industrial Organization, Topics in Macro and Monetary Economics, Urbanization, Economic Development I & II, Behavioral Finance
M.Sc. Finance, The Chinese University of Hong Kong Business School , *2020*
B.A. Economics and Finance (Hon.), University of Hong Kong , *2015*

WORKING PAPERS

"Returns to Capital for Whom? Experimental Evidence from Small Firm Owners and Workers in Ghana", with Morgan Hardy and Jamie McCasland, *revise and resubmit at **American Economic Journal: Applied Economics***

"Credit and Demand for Green Energy: Evidence from Small Firms in Kenya", with Yunyu Shu and Wycliffe Oluoch

"Informed Climate Adaptation: Input and Output Subsidies for Shaded Cocoa", with Yunyu Shu

WORKS IN PROGRESS

"Less is More; Worse is Better", with Ming Li, Yunyu Shu, and Jia Xiang

"Information, Insurance, and the Shadow Price of (No) Adaptation", with Bo-Yeon Jang

"Beyond Informality: The Importance of Residential-Based Businesses", with Morgan Hardy, Gisella Kagy and Monica Lambon-Quayefio

"Won't You Hire Your Neighbors", with Morgan Hardy, and Jamie McCasland

CONFERENCE PRESENTATIONS AND INVITED TALKS

2026: PEDL Early-Career Researchers Workshop; The Sustainable Energy Transitions Initiative (SETI) Pre-WCERE Conference Workshop; United Nations University World Institute for Development Economics Research (UNU-WIDER) Workshop; New England Experimental Economics Workshop; PEDL 15th Anniversary Conference; 8th Japanese Association for Development Economics (JADE) Conference; New York University

2025: MIT-Brown Development Workshop; Association of Environmental and Resource Economists 2025 Summer Conference; LSE Environment Camp; AEA CSQIEP Mentoring Conference; Political Economy of Climate & Environment Conference; Advances with Field Experiments (AFE) Conference; Haverford College; University of Rhode Island; Beijing Normal University[†]

2024 : NBER Development Economics†; IGC/Yale EGC Firms, Trade, and Development Conference; IPA Northwestern Methods & Measurement Conference; Berkeley/Sloan Summer School in Environmental and Energy Economics; Firms, Labor Markets and Development Workshop; Webinar Series in Finance and Development (WEFIDEV); New York University Abu Dhabi

2023: PEDL Young Scholars Matchmaking Workshop; Nature-based Climate Solutions and Biodiversity Conservation; Princeton Research Program in Development Economics; Pacific Conference for Development Economics (PacDev)†

2021: Oberlin College Danforth-Lewis Speakers Series

2018: ECB-FRB-FRBNY Conference

2017: FIW Research Conference; HKMA-BIS Conference; Central Bank of Brazil Annual Seminar

* Scheduled † By co-author

GRANTS

2025 - 2026: Private Enterprise Development in Low Income Countries (PEDL) Scale-up Grant (*Green Energy Adoption*) (£33,700)

PEDL Scale-up Grant (*Cocoa Trading and Adaptation*) (£27,788)

International Growth Centre (IGC) Small Projects Facility (*Cocoa Trading and Adaptation*) (£19,880)

2024 - 2025: IGC Small Research Grant (*Green Energy Adoption*) (£29,920)

Orlando Bravo Center for Economic Research PDBF Research Fund (*Green Energy Adoption*) ($10,000)

2023 - 2024: IGC Small Research Grant (*Farmers' Climate Change Adaptation*) (£39,623)

PEDL Exploratory Research Grant (*Green Energy Adoption*) (£39,989)

Population Studies and Training Center Summer Research Grant ($1,200)

2022 - 2023: PEDL Exploratory Research Grant (*Farmers' Climate Change Adaptation*) (£39,777)

Orlando Bravo Center for Economic Research PDBF Research Fund (*Farmers' Climate Change Adaptation*) ($7,760)

2021 - 2022: Brown University Travel Grants ($1,700)

Watson Institute Graduate Program in Development Summer Funding ($1,500)

SCHOLARSHIPS, HONORS AND AWARDS

2025 - 2026: Merit Dissertation Fellowship, Brown University

2023 - 2024: Stephen R. Ehrlich Fellowship, Brown University

2022 - 2023: Stephen Robert Graduate Fellowship, Global Mobility Fellowship, Brown University

2021 - 2022: Manning Graduate Fellowship, Brown University

2020 - 2021: Doris I. Eccleston 1925 Fellowship, Brown University

2018 - 2020: CUHK Distinguished Academic Performance Scholarship for Graduates (1st Place), CUHK Distinguished Academic Performance Scholarship for New Students, CUHK Business School Admission Scholarship

TEACHING

2025:	Teaching Assistant, Brown University, *Behavioral Finance* by Professor Rafael La Porta
2024:	Lab Instructor, Brown University, *Honors Tutorial for Economics Majors*
2023:	Guest Lecturer, New York University Abu Dhabi, *Research Design, Fieldwork, and Data Analysis for Development Economics*
	Guest Lecturer, University of Ghana, *Empirical Methods in Applied Economics*
2021:	Teaching Assistant, Brown University, *Inequality of Income, Wealth, and Health in the United States* by Professor David Weil

RESEARCH EXPERIENCE AND OTHER EMPLOYMENT

2025:	Research Assistant for Matthew Pecenco and Bobby Pakzad-Hurson, Brown University
2018 - 2020:	Manager (Offshore Renminbi Policy), Hong Kong Monetary Authority
2015 - 2018:	Assistant Economist (Financial Markets), Hong Kong Monetary Authority

JOURNAL REFEREE

American Economic Review, Management Science, Journal of Development Economics, Journal of Environmental Economics and Management, The European Journal of Finance, Utilities Policy

SKILLS

Computer: Stata, Python, R, Earth Engine, ArcGIS, QGIS, LaTeX, SurveyCTO

Language: English, Cantonese, Mandarin Chinese (native)

Motivation Statement

NBER Workshop on Development Economics and Networks for Early-Career Researchers

Jiayue Zhang
University of Chicago

My research studies how small firms in low-income labor markets grow, focusing on the labor-market frictions and interfirm relationships that keep most firms at single-person scale. The paper I submit for this workshop, "Won't You Hire Your Neighbor?," tests directly whether small firms grow by absorbing neighboring firms' labor, a question that sits at the center of both the "missing middle" literature on firm growth and the literature on interfirm networks as informal substitutes for missing labor, credit, and insurance markets.

What draws me to this workshop specifically is that my paper's central methodological contribution is a networks one: rather than observing an existing network and instrumenting for tie strength or exposure, we randomly create the tie itself by pairing 1,429 firm owners in Aburi, Ghana into 710 dyads and subsidizing use of that specific edge for six weeks. This lets us cleanly separate two questions the conventional networks data usually cannot: whether a tie forms at all, and what economic function it ends up serving once it exists. Our main finding is that these are empirically distinct. The subsidized tie forms at equal rates for pairs of any gender composition, feeds into and durably reshapes the town's broader (independently observed) labor-sharing network, and yet is used as an income-insurance device only in pairs with at least one male owner. I want to bring this finding, and the identification strategy behind it, to a room of researchers working at the frontier of empirical network methods.

Beyond feedback on this paper, I am eager to engage with the broader agenda represented at this workshop, particularly works using randomized or quasi-experimental variation to identify network formation and diffusion in developing-country settings. This will be instrumental as I continue building a research program on firm-to-firm relationships for small enterprises in low and middle income contexts.

Won't You Hire Your Neighbor? Experimental Evidence on Small Labor Firm Consolidation *

Work in Progress for 2026 NBER Workshop on Network and Development Consideration.

Please do not cite or circulate.

Morgan Hardy
NYU Abu Dhabi

Jamie McCasland
UC Merced

Jiayue Zhang
University of Chicago

September 2026

Abstract

Can firms run by "innate entrepreneurs" grow by absorbing labor from neighboring "necessity entrepreneurs" through the inter-firm labor network that connects small firms in a low-income-country labor market? We test this by randomly incentivizing a candidate network tie among 1,429 micro-enterprise owners in Aburi, Ghana. They are randomly matched into 710 same-product-category pairs, and 361 of them are offered a daily wage subsidy equivalent to about a day's average baseline profit for either partner to work for the other for up to 30 days over a six-week window. The subsidy activates the assigned tie at a high rate (45.5 percent of treated pairs) and raises each owner's labor-network degree by 14–15 percentage points during the program against a near-zero control mean; a full-sample, fuzzy-matched labor network shows aggregate density rising over the same window and partially reverting once the subsidy ends. The new tie does not dissolve either firm, i.e., almost none of the partner's firm close during treatment. But it becomes a durable channel for production- and information-sharing including tools, skills, outsourcing, and customer-referral connections. None of this network growth raises average pair-level net sales, gross profits, or profits. Yet the null conceals a gendered pattern in how the tie gets used. Among pairs with at least one male owner, treatment lowers the standard deviation of pair profits, an effect absent among female-only pairs.

*We are grateful to Charles Sefenu, owner of Data Pivot Ghana, and his excellent enumeration team for their invaluable assistance with fieldwork. We thank Jonathan Atta-Aidoo, Mercy Darkwah, Poorvi Goel, Angela Orozco, and Yunyu Shu for excellent research assistance. We gratefully acknowledge funding from New York University Abu Dhabi and The World Bank. Fieldwork received ethics approval from the New York University-Abu Dhabi Research Ethics Committee (protocol HRPP-2022-101). This research was registered with the AEA RCT registry (AEARCTR-0010163). All errors are our own.

1 Introduction

Most firms in low-income countries (LICs) never grow past single-person scale, and the literature explaining this "missing middle" has mostly looked inward at the firm itself (Hsieh and Olken, 2014), e.g., owners lack the capital to expand or the management practices to run a larger operation (De Mel et al., 2008a; McKenzie, 2021). When evaluating the constraints from the outside, firms are limited not just by what they can afford to buy, but by whom they can hire (De Mel et al., 2008b; Hardy and McCasland, 2023), and that reallocating labor across firm boundaries can raise output even while holding capital fixed (Hardy et al., 2024). That kind of reallocation, though, presupposes a willing counterparty on the other side of the hire, and a separate literature suggests LIC labor markets contain exactly this asymmetry: some owners are "innate entrepreneurs" with real growth ambitions, while others run a business only because no wage job is available, and would take one if it existed (Karaivanov and Yindok, 2022; Schoar, 2010). Put together, these two strands of literature point to a specific growth channel that has not been directly tested: an innate entrepreneur growing her own firm by hiring a neighboring necessity entrepreneur's labor outright.

Firm consolidation non-binary, but spans across a spectrum of aspects. Classic theory of the firm already treats the boundary between two production units as something firms choose task by task and input by input, not as a single binary merge-or-don't decision (Coase, 1937; Grossman and Hart, 1986). Recent evidence from LICs is consistent with firms operating along this spectrum, where small firms can achieve scale by sharing capital with neighboring firms (Bassi et al., 2022), by relying on worker-owned capital (Hardy et al., 2026), and by organizing production in ways that make a cluster of nominally separate firms look, functionally, like employees of one another (Bassi et al., 2023). Labor is the one input largely missing from this picture. Whether a labor sharing tie is used to fully merge the two firms, to share inputs while both remain open, or simply to pool income risk is, to our knowledge, an open empirical question that an experimentally created network tie is well suited to answer, in the spirit of interventions that randomize monitoring relationships (Breza and Chandrasekhar, 2019) or information seeding (Banerjee et al., 2013) onto network structure.

We test this directly in Aburi, Ghana, by randomly matching 1,429 micro-enterprise owners into 710 same-product-category pairs and offering 361 of these pairs a daily wage subsidy (20 GHC, roughly a day's average baseline profit) for either partner to work for the other, for up to 30 days over a six-week window. Take-up is substantial with 45.5 percent of treated pairs participate and each owner's labor-network degree increasing by 14–15 percentage points during the program and 17–20 points afterward, against a near-zero control mean. A full-sample,

fuzzy-matched network built independently of the randomized pairs shows aggregate density rising over the same window and partially reverting once the subsidy ends. Consolidation, however, stays incomplete: treated pairs are no more likely to see one partner's firm close.

Instead, the tie becomes a durable channel for production- and information-sharing including tools, skills, outsourcing, customer referrals, which remains elevated through our final follow-up in May 2023, without raising average pair-level net sales, gross profits, or profits. This null conceals a gendered pattern in how the tie gets used: among pairs with at least one male owner, treatment reduces the volatility of pair profits by roughly 160 GHC, about 20% of the control mean, an effect entirely absent among female-only pairs. Randomly assigning a single labor-sharing tie can facilitate growth of an inter-firm labor sharing network, but whether that network is used to consolidate, to share production inputs, or to pool income risk depends on both the tie's persistence and the identity of who is on either end of it. This indicates a distinction between network *formation* and network *function* that speaks directly to Bassi et al. (2022) and Cai and Szeidl (2018), the closest experimental precedents for inter-firm collective scale.

2 Research Design and Intervention

The experiment was conducted in Aburi, Ghana. In June 2022, a comprehensive listing exercise mapped 43 separate enumeration zones, capturing mobile and home-based firms alongside permanent structures. This initial framework enumerated 1,600 distinct business owners managing 1,710 active enterprises. Appendix Figure A1 plots the enumeration area in Ghana and sample coverage. The filtering mechanisms, attrition, and final compliance criteria underlying our target experimental cohort are tracked comprehensively in Appendix Table A1. The final experimental sample consists of 1,429 firm owners who held active mobile money accounts, gave informed consent, and had a sufficient pool of potential matches within their identical product categories. Baseline structural attributes of this sample are summarized in Table 1.

Firms were randomly matched into pairs within product strata, resulting in 361 treated pairs (722 firms), 349 control pairs (698 firms), and 9 dropped remainder control firms. Firm distribution across product categories is shown in Figure A2. The balance test shows that treatment is statistically balanced across main pair-level characteristics except for the pair-level sum of owner hours spent in a typical week in baseline (Appendix Table A2).

The intervention provided treated pairs with a 20 GHC/day wage subsidy for up to 30 days across a 6-week time frame (August 22nd to September 30th, 2022). Crucially, the subsidy was symmetric: on any given active program day, either partner could take on the role of the "worker"

Table 1: Experiment Sample Firm-level Statistics

	Mean	Median	10th Percentile	90th Percentile	99th Percentile	N
Owner Characteristics						
Female	0.78	1	0	1	1	1429
Age	43.21	42	28	60	77	1428
Years of education	9.73	9	6	15	19	1425
Married	0.50	1	0	1	1	1429
% income from primary business	97.51	100	100	100	100	1399
Primary Business Characteristics						
Formal	0.44	0	0	1	1	1429
Has loan	0.09	0	0	0	1	1429
Assets (GHC)	8843.53	3200	470	20800	105300	1427
Sales (GHC)	2267.00	1100	300	5000	20000	1424
Profits (GHC)	605.76	400	100	1300	4000	1422
Wagebill (GHC)	133.11	0	0	400	2000	1426
Num. workers	0.50	0	0	2	6	1426
Has worker	0.26	0	0	1	1	1426
Owner hours	52.36	54	25	77	98	1429

Notes: This table shows the summary statistics of key owner and business characteristics at the individual level in the baseline in May 2022. Formal equals one if the firm is registered with any central or local government agency. Sales, profits and wagebills are measured at the monthly level. Has worker equals one if the firm has at least one worker providing positive hours of work at the firm in May 2022. Owner hours measures the number of hours that the owner worked at the firm in a typical week in May 2022.

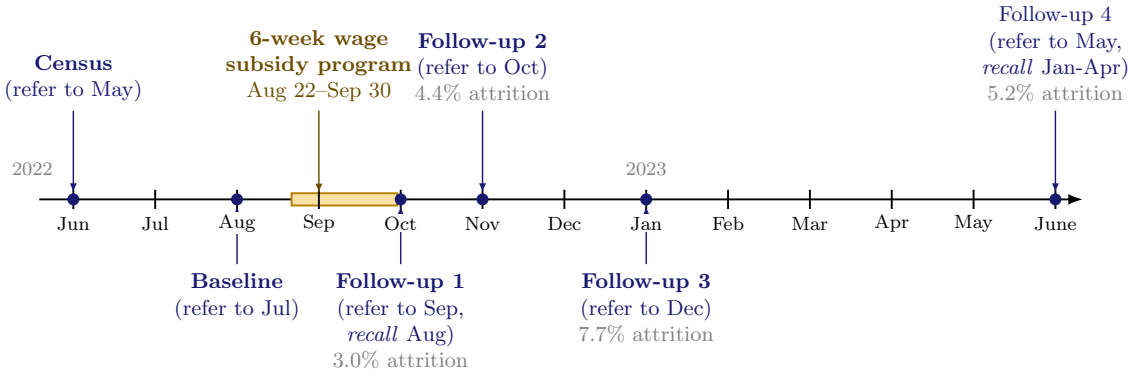
or the "boss." Split roles required sign-up by Friday of the preceding week. The research team enforced adherence via random spot checks, yielding an infraction rate of just 1.8%.

Data collection spanned a baseline survey in early August 2022 and four follow-up survey rounds: October 2022 (covering the active intervention period, August and September of 2022, 3.0% attrition), December 2022 (covering the immediate preceding month, November 2022, 4.4% attrition), January 2023 (covering December 2022, 7.7% attrition), and June 2023 (covering a retrospective panel of selected outcomes from January to April, 2023, as well as the immediate preceding month, May 2023, 5.2% attrition). Figure 1 summarizes the timeline of data collection and intervention activities.

Diagnostic evaluations of tracking rate confirm that survey round attrition remains symmetrically distributed and fully balanced on pair treatment status across all waves (Appendix Table A3). Treatment effects are estimated at the pair-level using an intent-to-treat (ITT) specification controlling for baseline outcomes, baseline imbalanced labor hours, strata, and survey-round fixed effects, with standard errors clustered at the dyadic pair level.

In every survey round we also elicit a worker roster from each firm owner, which enabled us to construct a full labor network through name matching of all recorded workers and sampled owners. For each individual providing positive hours of labor at the firm in the reference month, owners report the worker's first name, last name, and popular name, along with gender, age, the year-month they first started working for the owner, and their wage and hours worked for the

Figure 1: Timeline of Data Collection and Intervention Activities



Notes: This figure illustrates the timeline of data collection activities and intervention.

owner in the reference month. We use these rosters, independent of random pair assignment, to construct a full-sample labor-sharing network through a person-level matching exercise that checks whether the same named individual (i) appears in the worker rosters reported by two or more different owners, which we code as a labor-sharing edge between those two firms, or (ii) is themselves one of the sampled firm owners, which we code as a direct edge between the worker's own firm and the firm reporting them as a worker. Because names are self-reported, and spelling, nickname use, and completeness of the last name vary across respondents, matches are necessarily fuzzy. We code two roster entries as the same individual if at least two of the three name fields (first, last, popular name) match and the reported age is roughly consistent. This rule is deliberately permissive, and a planned robustness check will re-construct the network under more stringent matching criteria to test the sensitivity of the degree and density results to the matching threshold.

3 Preliminary Results

We document a substantial but temporary effect on firm consolidation, despite long-term expansion of information networks. All analysis below are conducted at the pair level, while controlling for strata fixed effects and round fixed effects (if multiple rounds included).

3.1 Program Take-Up and Predictors

We document a high rate of take-up of the intervention. The take-up rate of the program at the pair level is 45.5 percentage points on the extensive margin ($p < 0.01$), as shown in Table 2. Treated pairs on average take up around ten out of the thirty days offered, unconditional on take-up. Conditional on taking up at least one day of the program, the average days taken up is

21 days, and about one third of the pairs are able to make full use of the subsidy to jointly take up all thirty days offered. As a result, the treated pairs on average receive 205 Ghana cedis over August and September 2022.

Table 2: Subsidy Program Take-Up

	(1) Program Take-up	(2) Total Days Taken-up
	During (Aug, Sep 2022)	
Treated	0.455***	10.26***
	(0.0253)	(0.645)
Observations	1378	1378
Mean (Control)	0.00	0.00

Notes: This table reports the ITT effects of assignment of wage subsidy on first-stage binary take-up and and take-up intensity. Regression includes strata fixed effects, round fixed effects, and imbalanced baseline variables. Standard errors are clustered at the pair level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Baseline network characteristics of owners in a pair predict program take-up. Paired owners who know of each other take up more days of the program, and are more likely to split the days offered (Columns (2) to (4), Table 3). Pairs that locate within a shorter distance are also more likely to take up. When paired firms have more uneven labor input (measured by number of individuals involved in firm production, i.e., firm size), the pair is more likely to take up and take up the program more intensively.

3.2 Consolidation and Spillovers to Firm Networks

We then examine whether the intervention induced complete firm consolidation where necessity entrepreneurs close down their business to work for another. As shown in Table 4, there is *no* detectable short-run or long-run effect on the total number of active firms within treated pairs, whether measured by positive sales, owner hours, or total hours. This indicates that, despite the high rate of take-up where one of the firm owners works at their partner firm, those taking up as "workers" do not completely shut down their own business during the program intervention nor post subsidy period. We do not detect full absorption of the partner firms.

While full consolidation does not occur, treated pairs substantially increase both production- and information-sharing along the assigned edge. Table 5 reports impacts on self-reported and roster-identified labor sharing within the pair, across three windows: during the active program, immediately after subsidy ended (Oct–Dec 2022), and over the full post-period (Oct 2022–May 2023).[1] Labor sharing is measured by (a) direct owner-to-owner hiring within the pair, and (b)

[1]We are in the process of cleaning name-match data for the May 2023 round. The analysis will then cover panel C for roster identified labor sharing.

Table 3: Predictors of Program Take-Up

	Unconditional		Conditional on Takeup	
	(1)	(2)	(3)	(4)
	Take-up	Total Take-up Days	Total Take-up Days	Gini Takeup Direction
Knew each other	0.0344	1.542*	1.463*	-0.0917***
	(0.0359)	(0.926)	(0.860)	(0.0331)
Both female	0.0376	2.376	4.131*	-0.185*
	(0.0810)	(1.979)	(2.263)	(0.0973)
Gini firm size	0.323*	11.50**	7.048*	0.0135
	(0.187)	(5.061)	(4.039)	(0.162)
Pair has worker	-0.142	-3.959	-0.975	-0.0267
	(0.0894)	(2.416)	(1.938)	(0.0844)
Distance	-0.0910***	-1.770**	-0.215	-0.0449
	(0.0308)	(0.735)	(0.786)	(0.0319)
Observations	336	336	167	167
Mean (all)	0.49	10.26	20.99	0.43

Notes: This table demonstrates how baseline characteristics are correlated with intervention take-up rate and intensity, for treated pairs. Knew each other equals one if any of the pair owners reported knowing their paired partner in the baseline. Gini firm size is the Gini coefficient (between 0 and 1) of firm sizes (measured by number of individuals providing positive labor hours to the firm). Pair has worker equals one if at least one firm within the pair has a worker. Distance is the straight-line distance between the firms' GPS locations of a pair, in kilometers. Columns (3) and (4) are conditional on pair taking up at least one day of the program. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: (No) Impact on Complete Firm Consolidation

	(1)	(2)	(3)
	Sales > 0	Owner Hours > 0	Any Hours > 0
	Panel A: During (Aug, Sep 2022)		
Treated	-0.00776	-0.0154	-0.0106
	(0.0229)	(0.0228)	(0.0228)
Observations	1378	1378	1378
Mean (Control)	1.89	1.90	1.90
	Panel B: After (Oct 2022 - May 2023)		
Treated	0.0292	0.0195	0.0139
	(0.0194)	(0.0196)	(0.0175)
Observations	4699	4699	2007
Mean (Control)	1.82	1.83	1.85

Notes: This table reports the ITT effects of assignment of wage subsidy on pair-level consolidation. Outcomes in each column equals 0, 1, or 2, indicating the number of firms within a pair that has positive sales (Column (1)), positive owner hours (Column (2)), and positive hours by owners or workers (Column (3)). Regression includes strata fixed effects, round fixed effects, and imbalanced baseline variables. Standard errors are clustered at the pair level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

full labor sharing including hiring the within-pair partner owner and hiring the same worker(s) between the paired owners. Treatment effects are large and highly significant during the program (10–15 percentage points on a near-zero control mean) and remain statistically significant — albeit smaller in magnitude — after removing subsidy, indicating the intervention leaves a lasting

mark on within-pair labor relationships rather than dissolving once the subsidy ends.

Table 5: Impact on Labor Consolidation

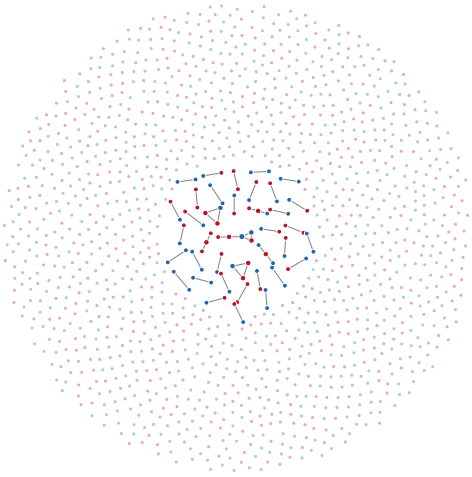
	Self-Reported Labor Sharing		Roster Identified Labor Sharing	
	(1)	(2)	(3)	(4)
	Pair Owner	Pair Any	Pair Owner	Pair Any
	Panel A: During (Aug, Sep 2022)			
Treated	0.307***	0.313***	0.147***	0.147***
	(0.0242)	(0.0244)	(0.0181)	(0.0181)
Observations	1292	1292	1344	1344
Mean (Control)	0.01	0.01	0.00	0.00
	Panel B: Immediate After (Oct, Dec 2022)			
Treated	0.0498***	0.0498***	0.178***	0.178***
	(0.00931)	(0.00931)	(0.0210)	(0.0210)
Observations	1296	1296	1298	1298
Mean (Control)	0.00	0.00	0.00	0.00
	Panel C: After (Oct 2022 - May 2023)			
Treated	0.0167***	0.0169***		
	(0.00489)	(0.00489)		
Observations	4156	4156		
Mean (Control)	0.00	0.00		

Notes: This table reports the ITT effects of assignment of wage subsidy on pair-level labor consolidation. Outcomes are dummies for pair-level labor sharing, either self-reported by an owner or identified via roster/name-matching of the full firm network. Regression includes strata fixed effects, round fixed effects, and imbalanced baseline variables. Standard errors are clustered at the pair level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

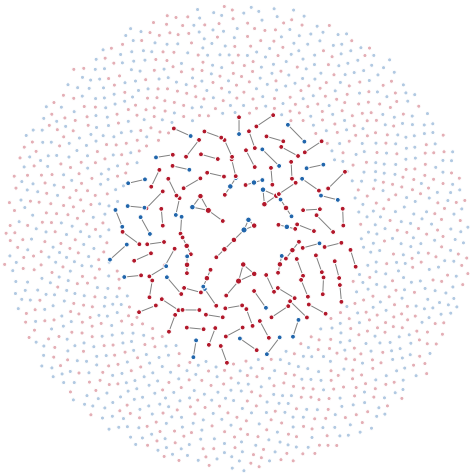
Crucially, the new edge does not stay isolated to the randomly assigned dyads. A fuzzy-matched labor-sharing network built by name-matching self-reported ties across the *entire* 1,429-owner sample (not just within randomized pairs) shows that aggregate network density visibly rises during the program period and only partially reverts in the two post-program snapshots we observe (October and December 2022; Figure 2). Substantively, this means the subsidized edge is feeding into, and potentially reshaping, the pre-existing informal network of the town rather than existing as an isolated experimental artifact, which is itself the kind of diffusion pattern the network-diffusion literature looks for following a localized shock (Banerjee et al., 2013). It also means our pair-level estimates likely understate the program's total effect on network structure, since owners connected to (but not randomized into) a treated pair may pick up new links of their own — a standard concern for interference across units sharing a common underlying network (Cai and Szeidl, 2018), and one that motivates our next step of testing whether an owner's *baseline* position in this ambient network (e.g., baseline degree) moderates their own take-up and network-formation response, in the spirit of Breza and Chandrasekhar (2019). The overall pattern is consistent with the intervention seeding durable interfirm relationships rather than producing a purely mechanical, program-duration response (Bassi et al., 2022).

Figure 2: Labor Sharing Network among Sampled Owners

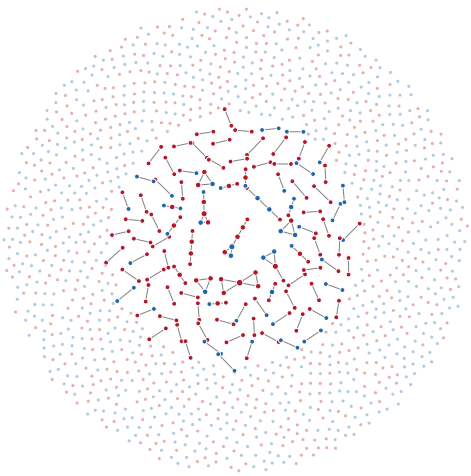
(a) Before (May, Jul 2022)



(b) During (Aug, Sep 2022)



(c) After (Oct, Dec 2022)



Notes: This figure plots the owner-level labor-sharing network for the full 1,429-owner sample, built from worker rosters collected each round (worker name, gender, age, wage, and hours reported by each firm owner) and linked via the person-matching procedure: an edge is drawn between two owners' firms when a rostered worker's name (agreeing on at least two of first, last, and popular name, with roughly consistent age) reappears in another owner's roster, or when a rostered worker is identified as one of the sample's own 1,429 firm owners. Each panel is a separate cross-section: before the program (May, Jul 2022), during (Aug, Sep 2022), and immediately after (Oct, Dec 2022). Faded outer points are owners with no reported connection in that period.

Besides direct and indirect labor consolidation, the intervention also alters the paired firms' operational relationships across capital, information, and risk sharing. Table 6 shows that owners in the treated pairs are more likely to share tools and equipment, discuss industry-specific and general management skills, outsource and refer customers during the program, and tool sharing,

industry-skill sharing, general-skill sharing, and customer referrals remain significantly elevated through May 2023.

Table 6: Impact on Capital and Information Sharing Networks

	(1) Share tool	(2) Industry skill	(3) General skill	(4) Outsource	(5) Refer Customer
	Panel A: During (Aug, Sep 2022)				
Treated	0.178***	0.171***	0.160***	0.0378***	0.0566***
	(0.0200)	(0.0187)	(0.0186)	(0.0111)	(0.0148)
Observations	1292	1292	1292	1292	1292
Mean (Control)	0.00	0.00	0.00	0.01	0.02
	Panel B: After (Oct 2022 - May 2023)				
Treated	0.0117**	0.0109***	0.0120***	0.00456	0.0153***
	(0.00508)	(0.00280)	(0.00272)	(0.00359)	(0.00587)
Observations	4156	4156	4156	4156	4156
Mean (Control)	0.00	0.00	0.00	0.00	0.01

Notes: This table reports the ITT effects of assignment of wage subsidy on pair-level sharing of information. Outcomes are dummy variables indicating sharing of the corresponding information reported by any firm owner within a pair. Share tool equals one if any owner reports using partner's tools or equipment, or letting the partner use their tools or equipment. Industry/General skill equals one if any owner reports discussing industry-specific/general management skills with their partner. Outsourcing equals one if any owner reports outsourcing jobs to the partner, or receiving an outsourced job from the partner. Refer customer equals one if any owner reports referring customers to their partner. Regression includes strata fixed effects, round fixed effects, and imbalanced baseline variables. Standard errors are clustered at the pair level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

3.3 Firm Performance and Revenue Impacts

While our intervention induced production-side consolidation during the program period, this does not lead to increases in the joint firm output in the full sample. On average, the pooled sample analysis reveals no statistically significant impacts on pair-level output net of program subsidy, i.e., net sales, net gross profits, and net total profits (Table 7), or unadjusted pair-level sum of sales, gross profits and total profits (Appendix Table A4) from a social planner's perspective. Instead, when evaluating output from the firm owners' perspective, adding (instead of subtracting) the program subsidy to firm gross profits, we do find the intervention increases pair gross profits including program subsidy Table A5.

3.4 Gendered Network Insurance Function

Networks of small, geographically proximate producers are the setting in which informal risk-sharing has traditionally been documented (Fafchamps and Lund, 2003). The muted average performance effect above conceals a striking heterogeneity in whether the newly created edge is put to this insurance use, visible only once we move from the mean to the variance of pair

Table 7: Pair Outcomes Net of Program Subsidy Payments

	(1) Net Sales (win)	(2) Net Gross Profits (win)	(3) Net Profits (win)
	Panel A: During (Aug, Sep 2022)		
Treated	297.1	-65.54	-64.78
	(396.3)	(74.97)	(68.57)
Observations	1378	1378	1378
Mean (Control)	4882.65	1243.89	1095.52
	Panel B: After (Oct 2022 - May 2023)		
Treated	-196.9	-40.08	-43.72
	(309.7)	(59.67)	(55.86)
Observations	4699	4698	4699
Mean (Control)	5767.62	1381.40	1251.26

Notes: This table reports the ITT effects of assignment of wage subsidy on pair-level output (adjusted by amount of program subsidy) in the full sample. Top 1% of firm-level sales, gross profits, and profits are winsorized. Net sales equals the sum of sales of firms in a pair minus program subsidy received by the pair. Net gross profits equals the sum of profits and wagebills of firms in a pair minus program subsidy received by the pair. Net profits equals the sum of profits of firms in a pair minus program subsidy received by the pair. Regression includes strata fixed effects, round fixed effects, and imbalanced baseline variables. Standard errors are clustered at the pair level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

income. Figure 3 reports the impact of treatment on the within-pair standard deviation of net sales, gross profits, and profits over the full post-period (Aug 2022–May 2023), interacted with an indicator for whether the pair is female-only.

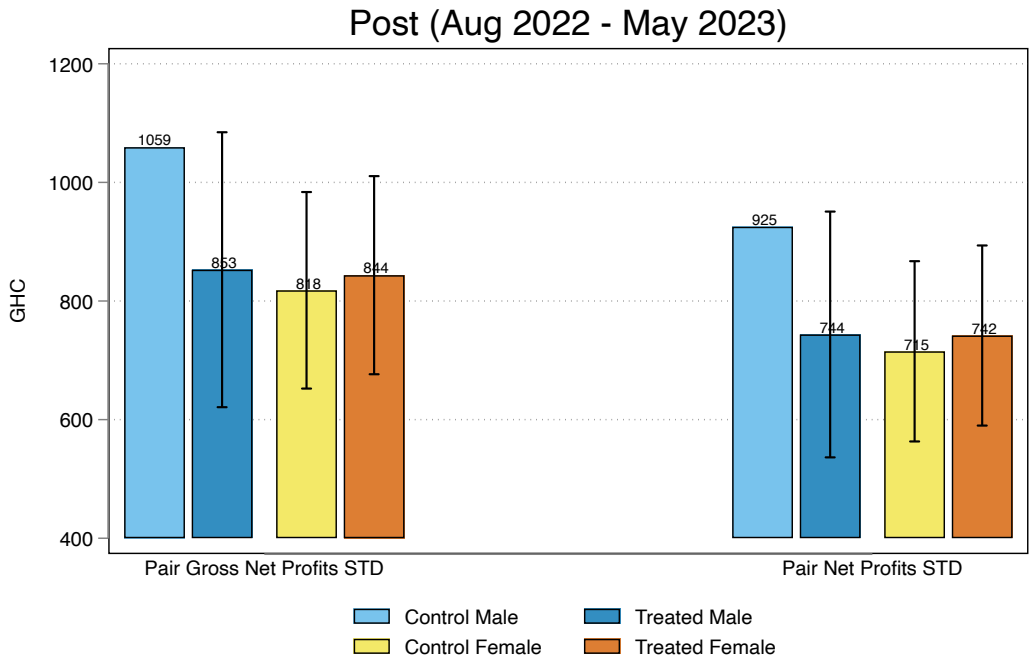
Among pairs with at least one male owner (the omitted category), treatment reduces the volatility of both pair net gross profits and net profits on the order of 20% of the male-inclusive control mean (Figure 3). The interaction with the female-only indicator is positive and significant for both outcomes, essentially offsetting the base effect such that there is no detectable treatment effect on pair output volatility among female-only pairs. In other words, the same edge that forms with equal frequency regardless of gender composition is used as an income-smoothing device only in pairs with at least one male owner. This is potentially driven by gendered heterogeneity in outsourcing and customer referrals. Table A3 in the appendix shows the same qualitative pattern for the underlying labor-sharing margins.

Taken together, we show in this section that network *formation* in this setting is gender-neutral, but network *function* is not. The owner tie is equally likely to be established regardless of who is on either end of it, but only some ties get used for income smoothing.

4 Discussion and Next Steps

Randomly matching a labor-sharing edge between two small firms, and subsidizing its use for six weeks, helps grow an inter-firm labor network along several dimensions that outlast the subsidy

Figure 3: Heterogeneous Treatment Effect on Pair Output Volatility by Gender Composition



Notes: This figure plots standard deviation of pair gross net profits and net profits over the post-period (Aug 2022–May 2023), by treatment status and pair gender composition. Monetary values are in GHC. Bars show control group means for pairs with at least one male partner (Control Male) plus the corresponding estimated treatment effect; whiskers show 95% confidence interval.

itself: activated edges raise owner-level network degree, feed measurably into the town's broader fuzzy-matched labor-sharing network, and leave production- and information-sharing margins elevated as far out as our May 2023 follow-up.

What the network is used for, however, is a different question from whether it exists, and here the results diverge sharply from a naive prediction that more connection means more output. Average revenue and profit impacts remain close to zero throughout, but network *function* turns out to be both real and unevenly distributed, where pairs with at least one male owner use the new tie to reduce the volatility of joint income, consistent with the network operating as an informal insurance arrangement of the kind documented in Fafchamps and Lund (2003), while female-only pairs despite forming the tie at the same rate show no such smoothing. This is a novel example of a setting in which a randomly assigned network link is taken up equally regardless of the identity of its endpoints, but is put to economically different use depending on that identity, which speaks directly to an open question in the networks literature about whether treating link *formation* as the object of interest (as in much of the diffusion literature, e.g. Banerjee et al., 2013) can be separated from treating link *use* as the object of interest.

References

Banerjee, A., Chandrasekhar, A. G., Duflo, E., and Jackson, M. O. (2013). The diffusion of microfinance. *Science*, 341(6144):1236498.

Bassi, V., Lee, J. H., Peter, A., Porzio, T., Sen, R., and Tugume, E. (2023). Self-employment within the firm. Technical report, National Bureau of Economic Research.

Bassi, V., Muoio, R., Porzio, T., Sen, R., and Tugume, E. (2022). Achieving scale collectively. *Econometrica*, 90(6):2937–2978.

Breza, E. and Chandrasekhar, A. G. (2019). Social networks, reputation, and commitment: Evidence from a savings monitors experiment. *Econometrica*, 87(1):175–216.

Cai, J. and Szeidl, A. (2018). Interfirm relationships and business performance. *The Quarterly journal of economics*, 133(3):1229–1282.

Coase, R. H. (1937). The nature of the firm. *Economica*, 4(16):386–405.

De Mel, S., McKenzie, D., and Woodruff, C. (2008a). Returns to capital in microenterprises: evidence from a field experiment. *The quarterly journal of Economics*, 123(4):1329–1372.

De Mel, S., McKenzie, D., and Woodruff, C. (2008b). Returns to Capital in Microenterprises: Evidence from a Field Experiment [*]. *Quarterly Journal of Economics*, 123(4):1329–1372.

Fafchamps, M. and Lund, S. (2003). Risk-sharing networks in rural philippines. *Journal of Development Economics*, 71(2):261–287.

Grossman, S. J. and Hart, O. D. (1986). The costs and benefits of ownership: A theory of vertical and lateral integration. *Journal of Political Economy*, 94(4):691–719.

Hardy, M., Kim, S., McCasland, J., Menzel, A., and Witte, M. (2024). Allocating labor across small firms: Experimental evidence on information constraints. *Journal of Development Economics*, 171:103345.

Hardy, M. and McCasland, J. (2023). Are small firms labor constrained? experimental evidence from ghana. *American Economic Journal: Applied Economics*, 15(2):253–284.

Hardy, M., McCasland, J., and Zhang, J. (2026). Returns to capital for whom? experimental evidence from small firm owners and workers in ghana. *Working Paper*.

Hsieh, C.-T. and Olken, B. A. (2014). The missing" missing middle". *Journal of Economic Perspectives*, 28(3):89–108.

Karaivanov, A. and Yindok, T. (2022). Involuntary entrepreneurship – evidence from thai urban data. *World Development*, 149:105706.

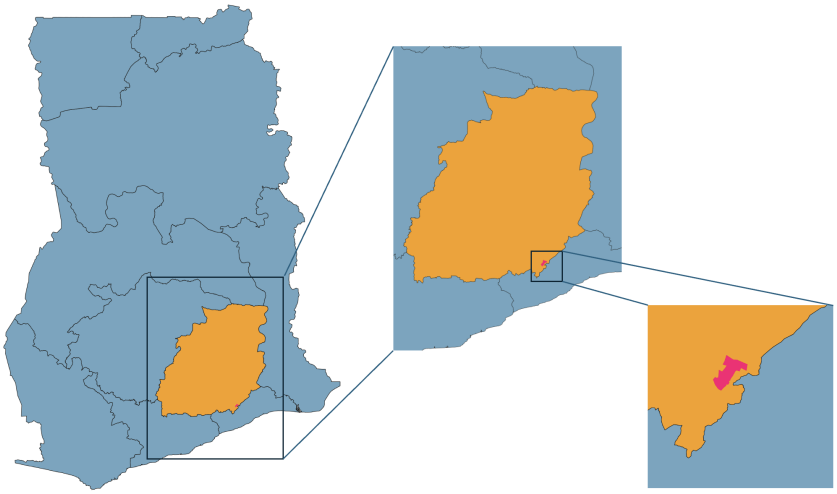
McKenzie, D. (2021). Small business training to improve management practices in developing countries: re-assessing the evidence for 'training doesn't work'. *Oxford Review of Economic Policy*, 37(2):276–301.

Schoar, A. (2010). The divide between subsistence and transformational entrepreneurship. In *Innovation Policy and the Economy*, pages 57–81. University of Chicago Press.

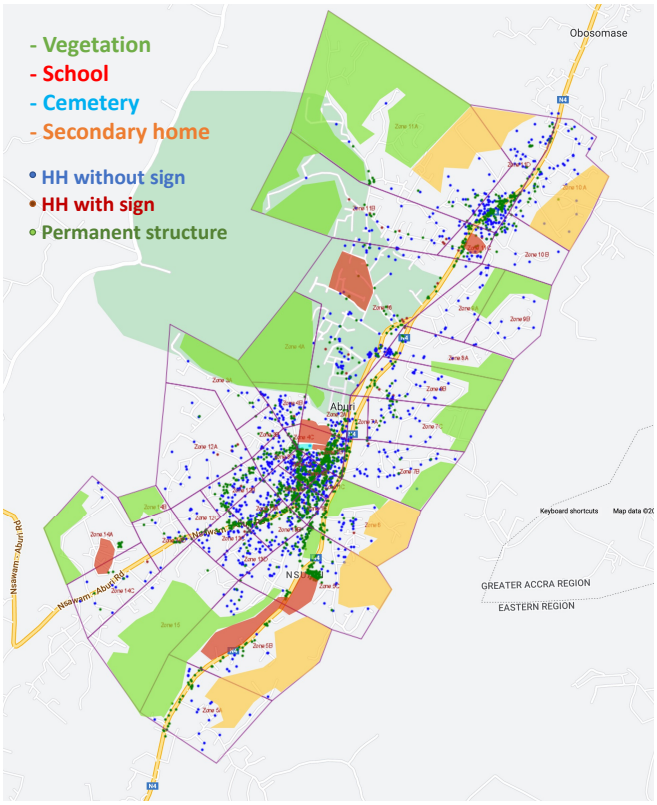
Appendix Exhibits

Figure A1: Enumeration Area and Sampling Frame

(a) Aburi in Eastern Region of Ghana

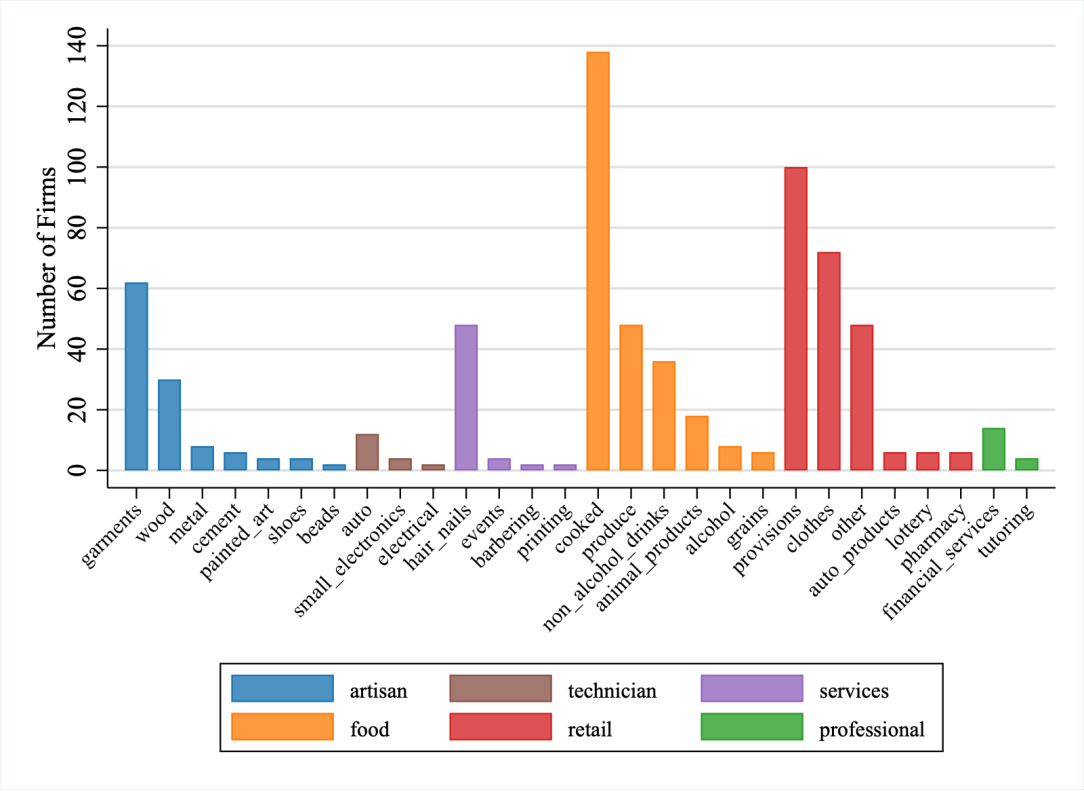


(b) Enumeration Area in Aburi and Firm Location



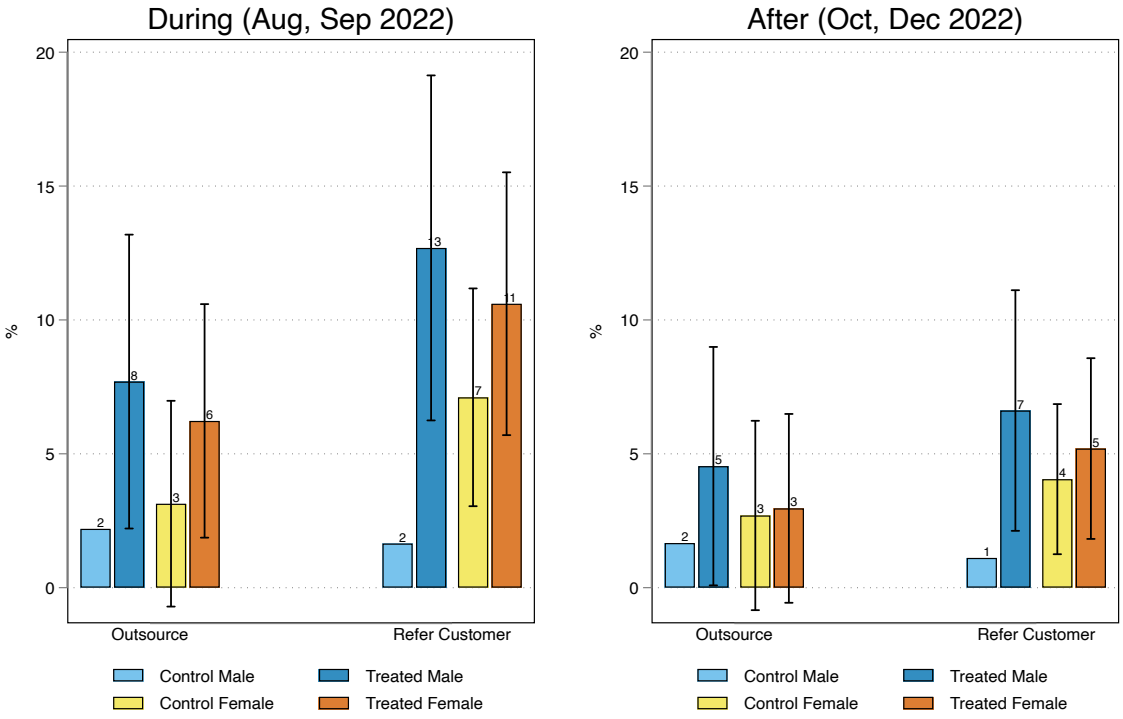
Notes: Panel (a) shows the relative location of Aburi in Eastern Region of Ghana. Panel (b) plots the enumeration areas where we conducted the firm census listing, which form the sampling frame in this study. It shows that firms are clustered in downtown and along major roadsides, while a non-trivial sample of firms also locate in residential areas.

Figure A2: Number of Firms across Sub-Industries



Notes: This figure plots the number of firms in each product category, by which the random assignment of intervention is stratified. Color indicates the broader industry classification.

Figure A3: Heterogeneous Treatment Effect on Pair Market Sharing



Notes: This figure plots the share of pairs reporting any outsourcing and customer referring during the program subsidy period (Aug, Sep 2022) and immediately after the program period (Oct, Dec 2022), by treatment status and pair gender composition. Bars show control group means for pairs with at least one male partner (Control Male) plus the corresponding estimated treatment effect; whiskers show 95% confidence interval.

Table A1: Sample Selection Framework

	All	Sampled			N
	mean	mean	diff	(diff=0) p-val	
Owner Characteristics					
Female	0.79	0.78	-0.00	(0.87)	1600
Age	43.47	43.21	-0.50	(0.27)	1597
Years of education	9.67	9.73	0.12	(0.42)	1594
Married	0.51	0.50	-0.00	(0.84)	1600
% income from primary business	97.51	97.51	-0.01	(0.99)	1564
Primary Business Characteristics					
Formal	0.43	0.44	0.01	(0.53)	1600
Has loan	0.09	0.09	0.00	(0.77)	1599
Assets (GHC)	8811.19	8843.53	61.21	(0.92)	1598
Sales (GHC)	2268.03	2267.00	-1.94	(0.99)	1593
Profits (GHC)	604.75	605.76	1.91	(0.94)	1592
Wagebill (GHC)	132.18	133.11	1.75	(0.90)	1596
Num. workers	0.50	0.50	0.01	(0.80)	1596
Has worker	0.26	0.26	0.00	(0.79)	1596
Owner hours	52.27	52.36	0.18	(0.81)	1599
F-test of joint sig. (p-value)				(1.00)	

Notes: This table reports the characteristics of the census population and experiment sample in the baseline in May 2022. Formal equals one if the firm is registered with any central or local government agency. Sales, profits and wagebills are measured at the monthly level. Has worker equals one if the firm has at least one worker providing positive hours of work at the firm in May 2022. Owner hours measures the number of hours that the owner worked at the firm in a typical week in May 2022.

Table A2: Dyadic Randomization Baseline Balance Table

	All	Control	Treated		N
	mean	mean	diff (Control)	(diff=0) p-val	
Pair Num. Female Owner	1.57	1.58	0.02	(0.59)	710
Pair Hours	104.73	102.72	3.91*	(0.06)	710
Pair Sales (win)	4345.47	4425.03	-272.86	(0.36)	705
Pair Gross Profits (win)	1499.91	1499.92	-83.81	(0.38)	700
Pair Profits (win)	1185.00	1181.12	-29.04	(0.66)	703
Pair Firm Size	3.01	3.02	-0.07	(0.57)	707
Pair Wagebill (win)	305.25	307.23	-31.47	(0.51)	707
Pair Assets (win)	17651.12	17986.75	-1203.07	(0.46)	708
Pair Equipment (win)	2240.31	2283.19	-179.59	(0.39)	708
Gini Hours	11.97	12.26	-0.59	(0.44)	710
Gini Sales	22.76	22.02	1.46	(0.17)	705
Gini Gross Profits	22.64	21.90	1.43	(0.19)	700
Gini Profits	21.49	21.00	0.89	(0.41)	703
Gini Firm Size	8.80	9.13	-0.76	(0.35)	707
Gini Wagebill	14.44	14.45	-0.29	(0.86)	707
Gini Assets	25.78	26.24	-0.97	(0.39)	708
Gini Equip.	24.55	25.39	-1.65	(0.32)	708
F-test of joint sig. (p-value)				(0.13)	

Notes: Each coefficient is from a separate regression of baseline pair-level covariates on treatment assignment and strata fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A3: Survey Round Tracking Attrition Matrix

	(1) Attrited	(2) Attrited	(3) Attrited	(4) Attrited	(5) Attrited
Treated	0.0146	0.00178	0.0239	0.00408	0.0285*
	(0.0116)	(0.0122)	(0.0149)	(0.0197)	(0.0165)
Observations	2840	710	710	710	710
Mean (Control)	0.04	0.03	0.03	0.07	0.04
Round	All	Sep 2022	Oct 2022	Dec 2022	May 2023

Notes: Attrition equals one if one of the pair owner is not reachable, deceased, or refused to participate in the survey. Regressions include round fixed effects, strata fixed effects and imbalanced baseline control variables. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A4: Pair Performance Outcomes (Unadjusted Metrics)

	(1) Pair Sales (win)	(2) Pair Gross Profits (win)	(3) Pair Profits (win)
Treated	445.4	83.25	51.11
	(393.7)	(79.23)	(70.75)
Observations	1378	1378	1378
Mean (Control)	4797.51	1223.15	1086.90
Round	Aug, Sep 2022	Aug, Sep 2022	Aug, Sep 2022

Notes: This table reports the ITT effects of assignment of wage subsidy on pair-level output (unadjusted). Top 1% of firm-level sales, gross profits, and profits are winsorized. Pair sales equals the sum of sales of firms in a pair. Pair gross profits equals the sum of profits and wagebills of firms in a pair. Pair profits equals the sum of profits of firms in a pair. Regression includes strata fixed effects, round fixed effects, and imbalanced baseline variables. Standard errors are clustered at the pair level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A5: Combined Pair Incomes

	(1) Pair Income All Sources (win)	(2) Pair Gross Profits w/ Subsidy (win)
Treated	68.74	234.9***
	(87.90)	(80.10)
Observations	1378	1378
Mean (Control)	1351.00	1223.15
Round	Aug, Sep 2022	Aug, Sep 2022

Notes: This table reports the ITT effects of assignment of wage subsidy on pair-level income. Top 1% of firm owner-level income and profits are winsorized. Pair income all sources equals the sum of profits, wage job incomes, and farming incomes from both owners in a pair. Pair gross gross profits w/subsidy equals the sum of profits and wagebills of firms in a pair, plus the program subsidy received by the pair. Regression includes strata fixed effects, round fixed effects, and imbalanced baseline variables. Standard errors are clustered at the pair level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.