The Allocation of Incentives in Multi-Layered Organizations

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Motivation

- Organizations are divided in multiple, hierarchical layers
  [Wilson 1989, Wade 1985]



- Effort of workers in the different layers all contribute to production of final output

Motivation

- How should incentives be allocated across the different layers of an organization?

Motivation

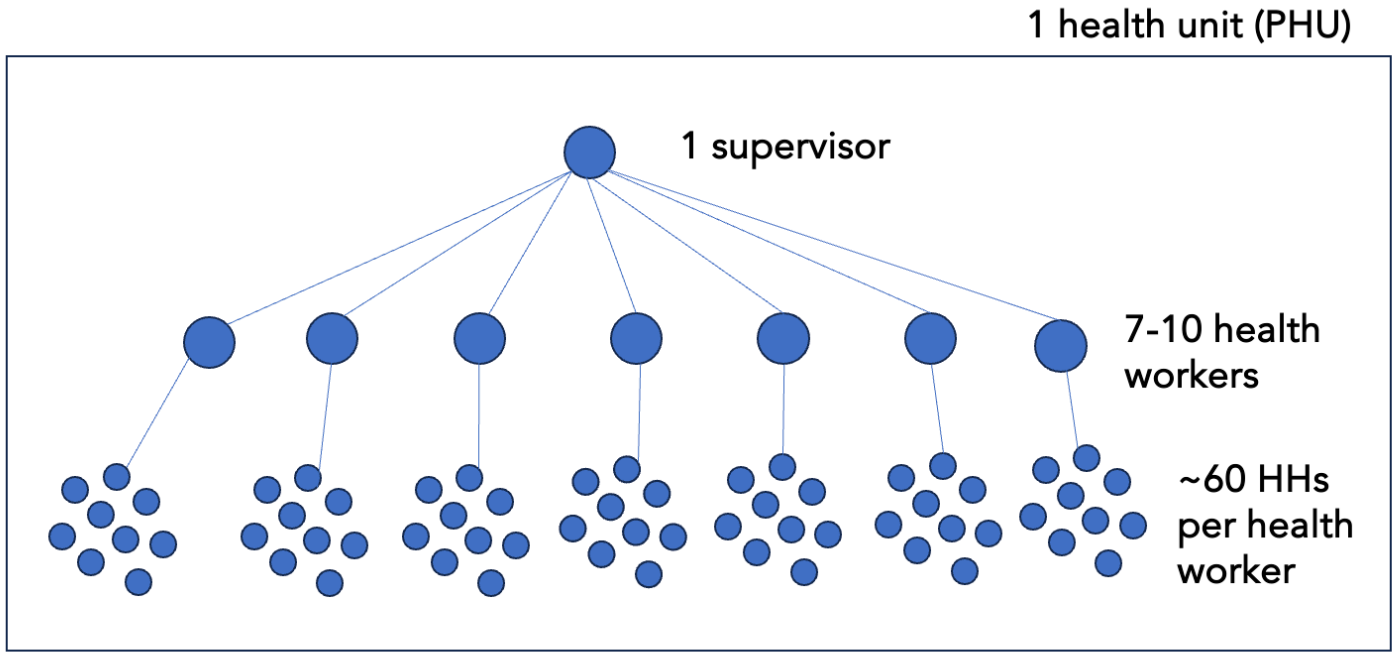
- How should incentives be allocated across the different layers of an organization?
- Extensive literature on the effect of varying the *level* of the incentives
  - ... in the bottom layer: e.g., frontline workers
    [Lazear 2000, Glewwe et al. 2010, Muralidharan et al. 2011, Duflo et al. 2012, Ashraf et al. 2014]
  - ... in the top layer: e.g., managers, supervisors, CEOs
    [Bandiera et al. 2007, Bertrand 2009, Rasul and Rogger 2018]
- Limited evidence on the *allocation* of the incentives
  - For a given level of the incentive, *who* should be incentivized?

Coasian vs. Alternative View

- Coasian view: any initial allocation of incentives results in same output [Coase 1937, 1960; Gibbons 1999]
  - agents offset initial allocation through side transfers
- "Alternative" view: initial allocation of incentives matters [Garicano & Rayo 2016; Atkin et al. 2017]
  - contractual frictions prevent side contracts/transfers across layers $\rightarrow$ incentive "sticks where it hits"
  - choosing the right allocation of incentives is crucial
  - ... especially with effort complementarities $\rightarrow$ low effort in one layer cannot be offset by higher effort in another [Alchian & Demsetz 1972; Kremer 1993; Brynjolfsson & Milgrom 2013]

Empirical Setting

- Community Health Program in Sierra Leone
  - created by the Ministry of Health to increase access to health services in rural villages
  - organized into health units (PHUs)



Empirical Setting

- Health workers provide basic health services through household visits
  - pre and post-natal checks, information about health, treat basic diseases, refer to local clinic
- Supervisors train and advise health workers
  - general monthly training, on-site training (accompanies workers on household visits)
  - transfer knowledge and help build trust $\rightarrow$ important to create demand for health worker's services

Empirical Setting

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  - transfer knowledge and help build trust $\rightarrow$ important to create demand for health worker's services
- Success of the program requires health workers to be willing and able to provide health services
  - requires health worker *and* supervisor effort $\rightarrow$ effort complementarities across layers

Experimental Design

- Introduction of a new incentive scheme across 372 PHUs
  - SLL 2k ($0.25) per household visit on top of fixed salary
- Allocation of the incentive is randomized:
  - **Worker incentives treatment** (93 PHUs): incentive paid entirely to health worker
  - **Supervisor incentives treatment** (93 PHUs): incentive paid entirely to supervisor
  - **Shared incentives treatment** (93 PHUs): incentive shared between health worker and supervisor (1k each)
  - **Control group** (93 PHUs): no incentive
- Recipient of the incentives varies across treatments but payout per unit of output is held constant
- Goal: assess which allocation maximizes output and why

Structure of the Incentives Scheme

- Incentives are paid every month, based on a reporting system
  - visits reported by SMS to toll-free number indicating date, service type, contact of patient
  - workers in the treatments are paid based on the reports
- Because of misreporting, we measure output (visits) with a household survey
  - under-reporting is common, especially in the supervisor incentives treatment and the control group
  - limited over-reporting because of frequent back-checks

Pay Transparency and Side Payments

- Supervisors are informed about presence of worker incentives (if any) but not vice-versa
  - limits negative morale concerns of pay inequality
    [Deserranno et al. 2021, Breza et al. 2018]

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  - limits negative morale concerns of pay inequality
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- Supervisors are told that they can transfer incentives to workers at their discretion
  - yet, less than 10% transfer anything

Data Across All Organizational Layers

Supervisors (N=372)

Surveyed at baseline (May 2018) and endline (Sept 2019) on side payments to/from health workers, contractual frictions

Health Workers (N=2,970)

Surveyed at baseline (May 2018) and endline (Sept 2019) on side payments, training and monitoring received from supervisor

Households (N=8,910)

Random ~10% of households surveyed at endline (Sept 2019) on quantity/quality of visits received from health worker + presence of the supervisor during the visits

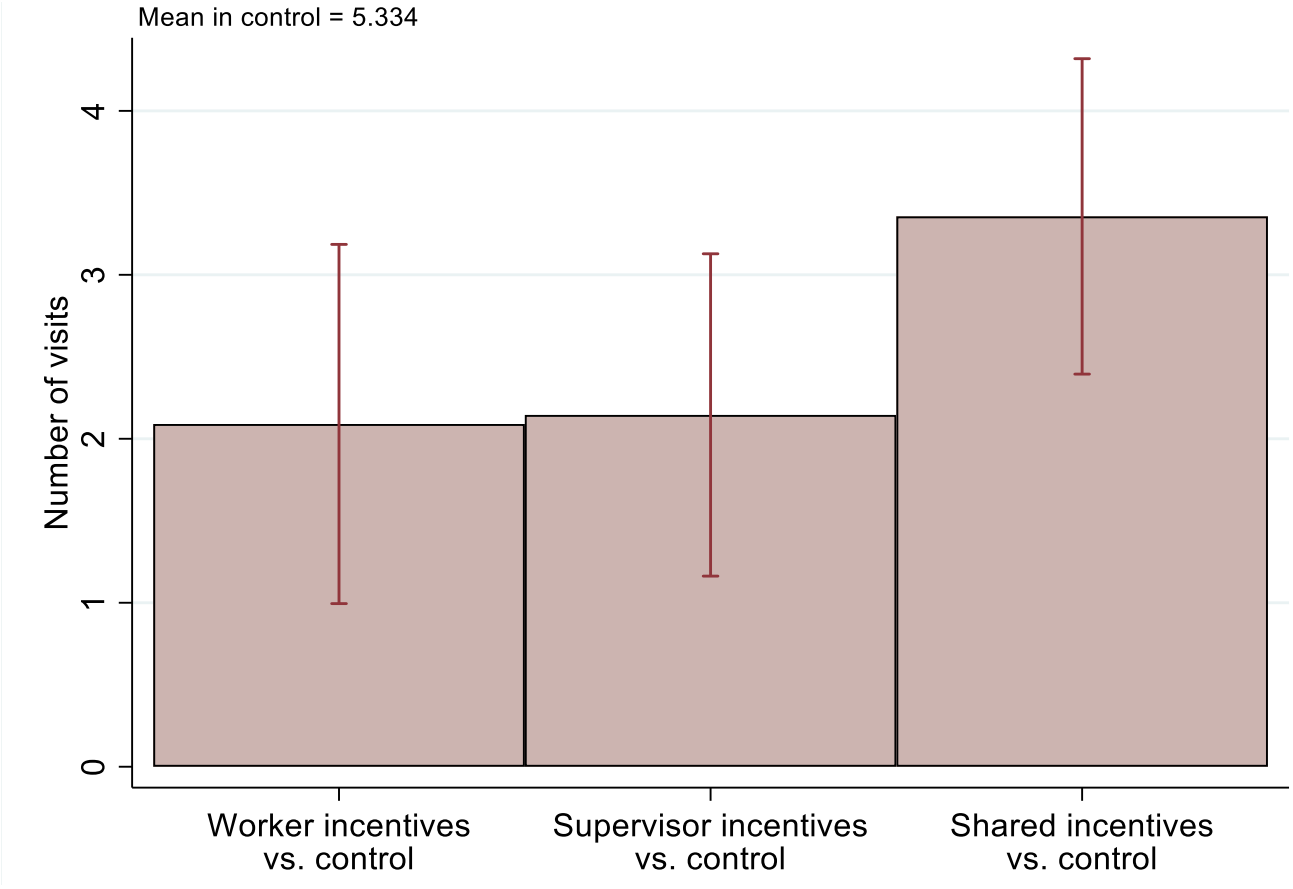
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Main Empirical Results

Mechanisms

Structural Model

Number of Visits (Reported by Households)



Quality of the Visits

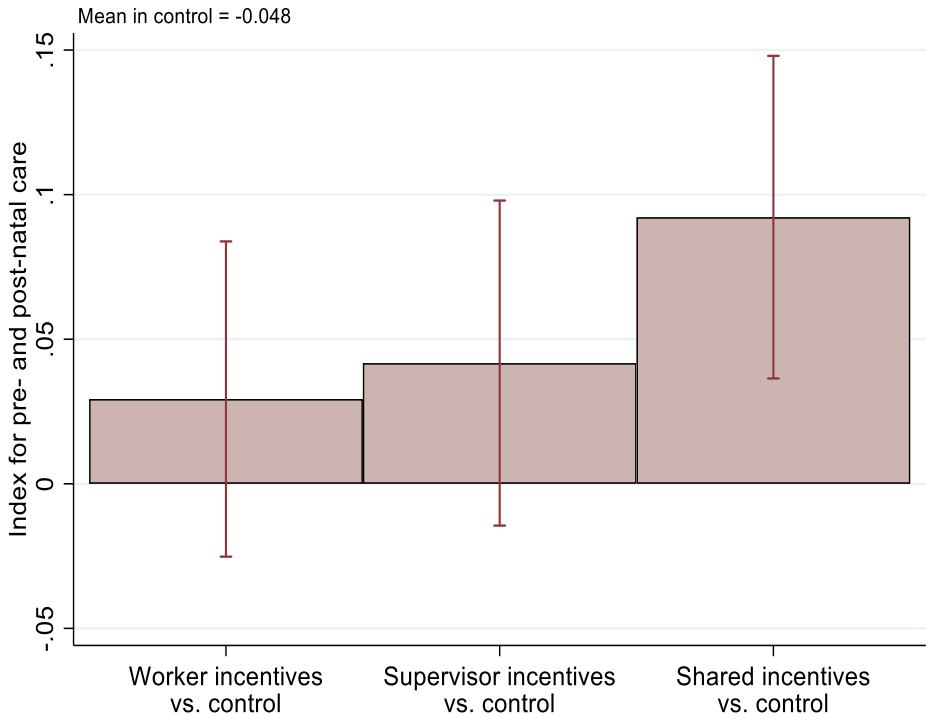
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- What about quality?

Quality of the Visits

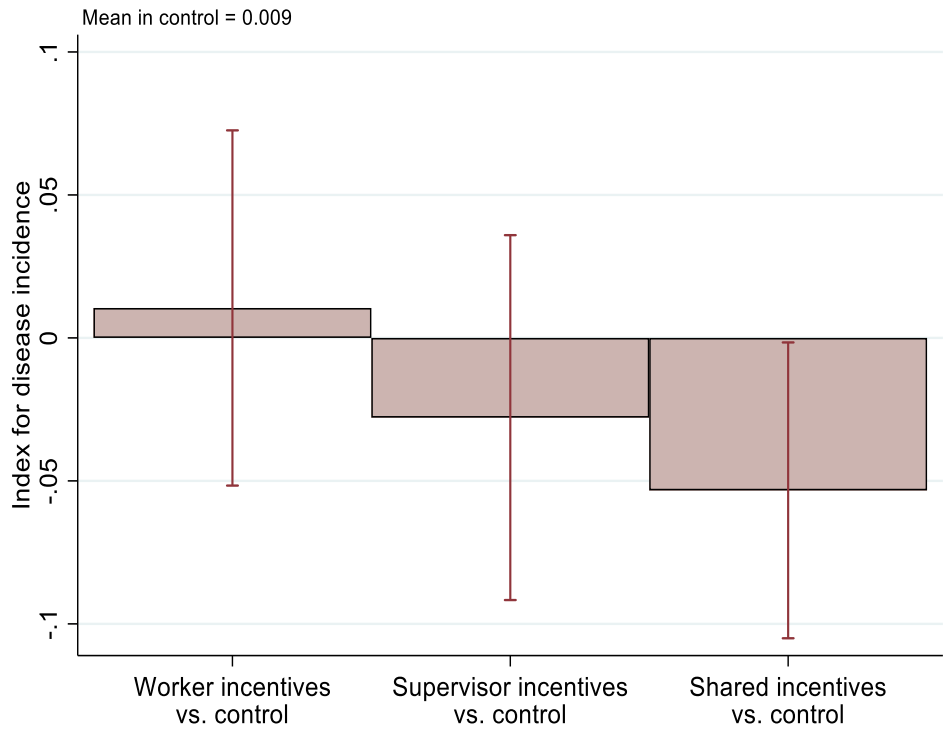
- Quantity of visits ↑ 61% more with shared incentives than with one-sided incentives
- What about quality?
- ... it increases too (or at least does not go down)!
  1. number of health topics discussed during the visits increases, while visit length is unchanged
  2. more trust in the health worker and more knowledge about disease prevention
  3. no differential targeting by distance and wealth

Health Outcomes

Pre- and post-natal care
(4 pre-natal visits, institutional birth, post-natal visit within 2 days, breastfeeding 6 months, up-to-date vaccination)



Disease incidence
(fever, cough and diarrhea in children under-5)



- Similar results using health facilities' admin data

Reporting and Cost of the Interventions

- Output with two-sided incentives > one-sided incentives
- But which treatment is more costly for the organization?

Reporting and Cost of the Interventions

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- But which treatment is more costly for the organization?
- Recall: payments are based on SMS reports
- Reporting rate varies across treatments
  - 90% of visits are reported in worker incentives treatment
  - 51% in shared incentives treatment
  - 41% in supervisor incentives treatment, 23% in control group

Reporting and Cost of the Interventions

- Output with two-sided incentives > one-sided incentives
- But which treatment is more costly for the organization?
- Recall: payments are based on SMS reports
- Reporting rate varies across treatments
  - 90% of visits are reported in worker incentives treatment
  - 51% in shared incentives treatment
  - 41% in supervisor incentives treatment, 23% in control group
- Effective incentive per actual visit: 510 SLL each in shared treatment vs. 1,800 SLL (worker treatment) and 820 SLL (supervisor treatment)
- Worker incentives lead to lowest output at highest cost
- Shared incentives maximize # actual visits per $ spent

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Mechanisms

- Why are shared incentives so effective?

Mechanisms

- Why are shared incentives so effective?
- Model and empirical evidence suggest that this is because of effort complementarity + contractual frictions
  - here: simplified version of the model in the paper but that conveys the intuition

A Simple Model of Service Provision

- A worker and a supervisor jointly produce visits y
  - worker first commits to a reporting rule: report a visit if its (stochastic) reporting cost is below a threshold $\rightarrow$ a share q of visits is reported
  - supervisor chooses e_{supv} and offers to pay the worker $s \geq 0$ for each reported visit (at a cost zs due to frictions, $z > 1$)
  - worker observes e_{supv} and s, and chooses e_{worker}
- Efforts are strategic complements:

$$y = \alpha e_{worker} + \gamma e_{worker} e_{supv}$$

- Incentive m paid based on reported visits
- Organization chooses the share of the incentive assigned to the worker ($p \in [0, 1]$) to maximize actual visits (only reported visits are observed)

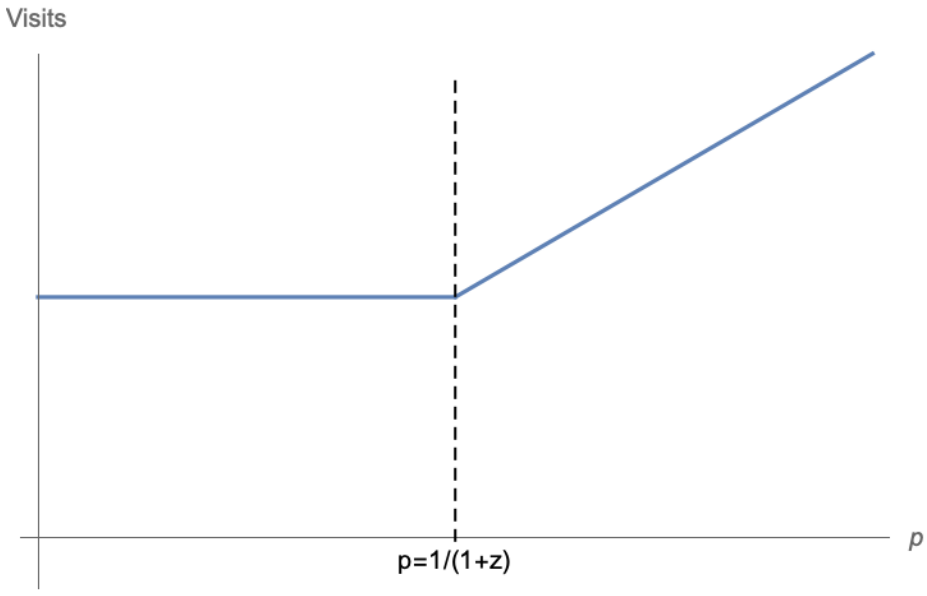
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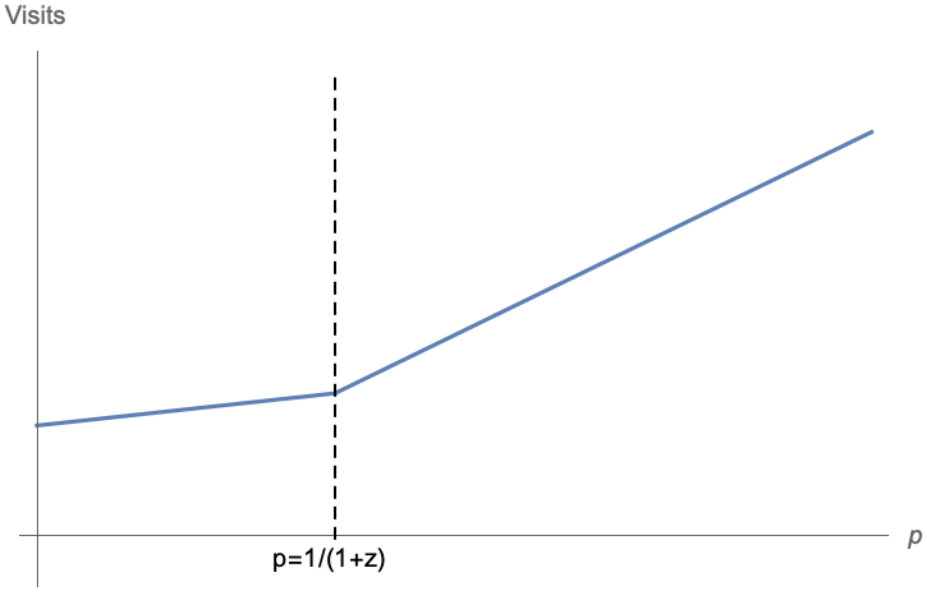
$$y = \alpha e_{worker} + \gamma e_{worker} e_{supv}$$

- Incentive m paid based on reported visits
- Organization chooses the share of the incentive assigned to the worker ($p \in [0, 1]$) to maximize actual visits (only reported visits are observed)
- Optimal contract p^* is a function of effort complementarity (γ) and contractual frictions (z)

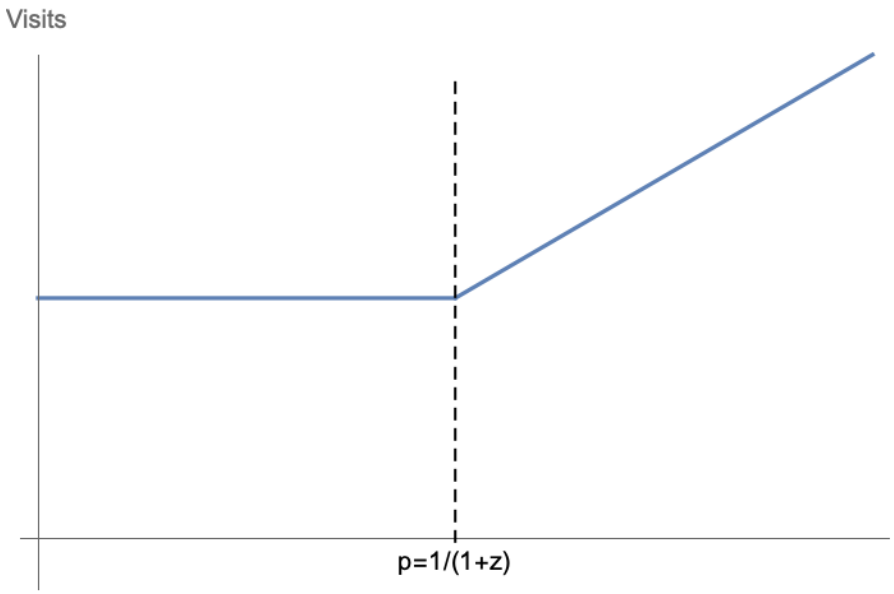
Weak Effort Complementarity + No Frictions (γ<t, z=1)



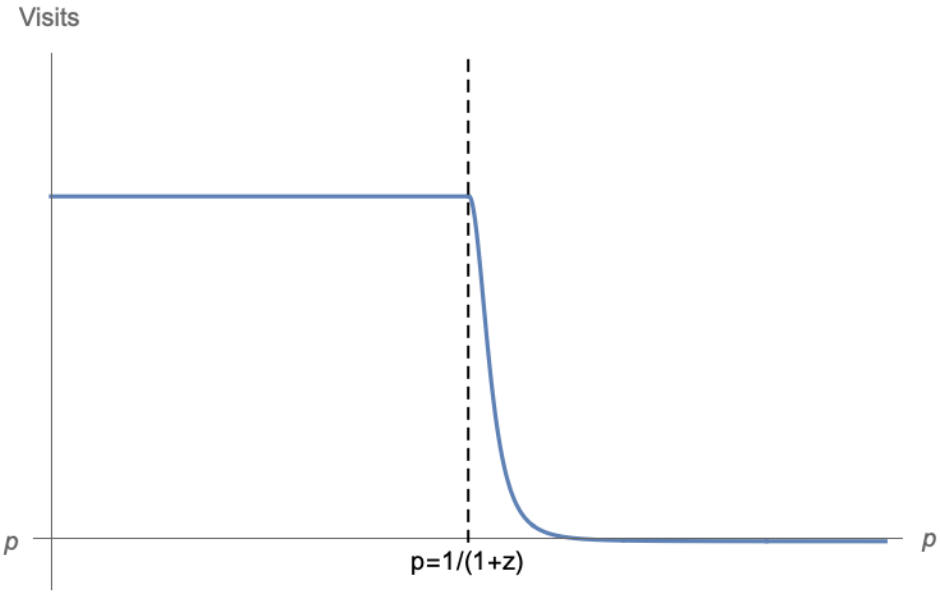
Weak Effort Complementarity + Frictions (γ<t, z>1)



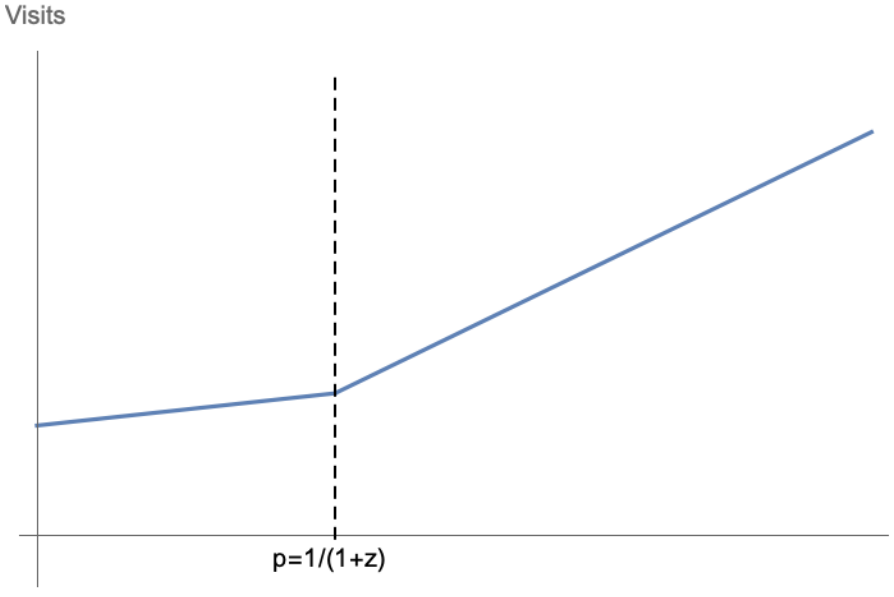
Weak Effort Complementarity + No Frictions ($\gamma < t$, $z=1$)



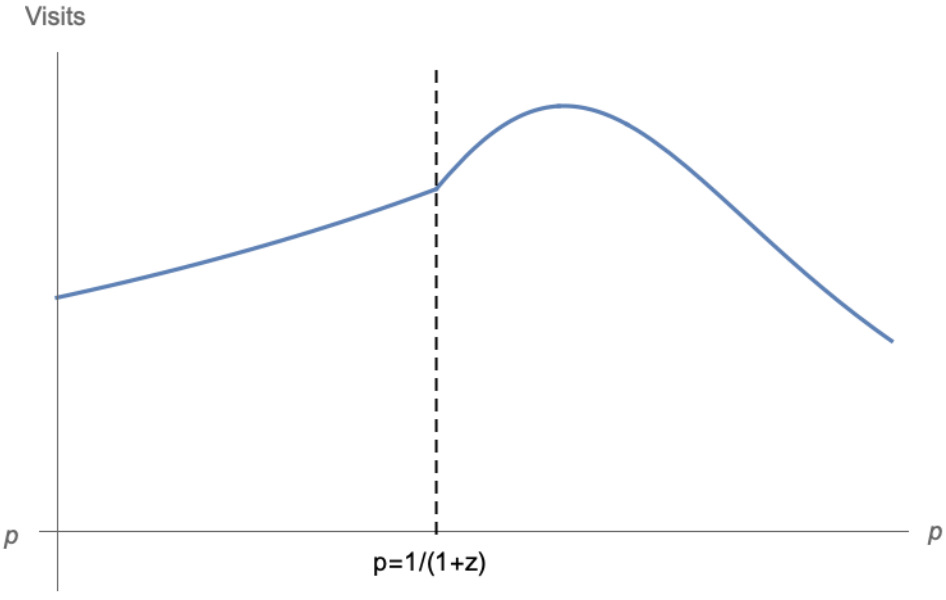
Strong Effort Complementarity + No Frictions ($\gamma \geq t$, $z=1$)



Weak Effort Complementarity + Frictions ($\gamma < t$, $z>1$)



Strong Effort Complementarity + Frictions ($\gamma \geq t$, $z>1$)



Evidence of Effort Complementarities

1. Stronger effect of shared incentives for inexperienced health workers, more "enabled" by supervisor

2. Supervisor effort does not $\uparrow$ monotonically with size of the incentives received by the supervisor
   - supervisor provides same effort (accompanied visits) in supervisor and shared treatment

3. Mediation analysis shows that return to supervisor effort increases with worker effort

Evidence of Contractual Frictions

- Few supervisors make side transfers to workers
  - 19% in supervisor treatment, 11% in shared treatment, 2% in worker treatment
- Reported contractual frictions
  - social norms constrain redistribution [Hines and Thaler 1995, Banerjee et al. 2020]
  - informal contracts and difficulty of making binding commitments [Bubb et al. 2018, Casaburi & Macchiavello 2019]

Reject Two Alternative Mechanisms

- Aversion to pay inequality: one-sided incentives are perceived as unfair and ↓ effort of non-incentivized layer
  [Breza et al. 2018, Deserranno et al. 2021]
  - workers are not told about supervisor incentives (if any)
  - job satisfaction is not lower with one-sided incentives than without incentives
- Marginal utility generated by incentive ↓ rapidly after 1,000 SLL for both supervisors and workers
  - no sharp discontinuity in treatment effects by marginal utility (wealth) or cost of effort (distance)

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Mechanisms

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Identification and Estimation

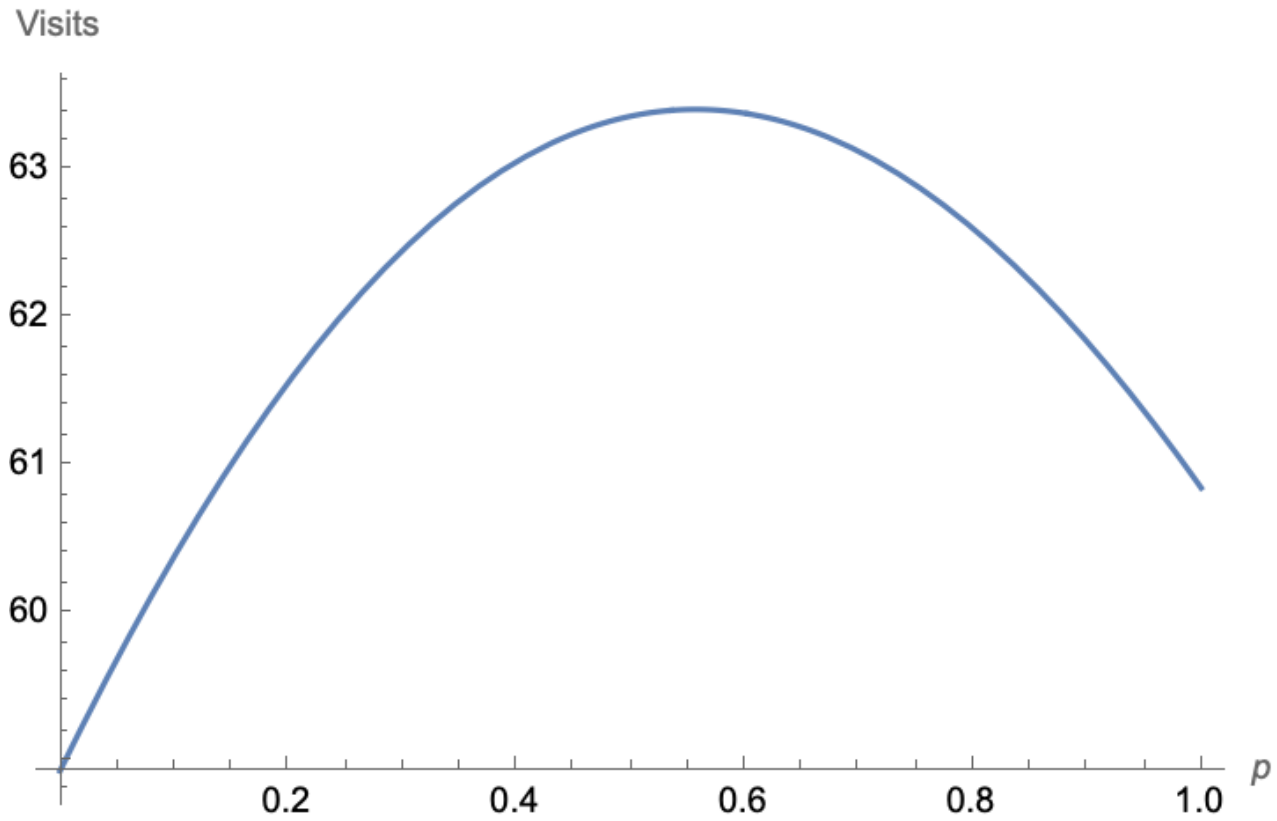
- Structurally estimate our model using a classical minimum distance estimator [Wooldridge 2010]
- Model allows for worker under-reporting and supervisor misperceptions about reporting [reporting costs backed out from observed reporting rates]
- Estimated model precisely reproduces key findings
- Calibrated γ and z confirm strong effort complementarity and large contractual frictions
  - a unit of worker effort generates 99-144% more visits thanks to supervisor effort
  - side payments cost more than 3 times their value ($z = 3.6$)

Counterfactual Policy: The Role of (Under)Reporting

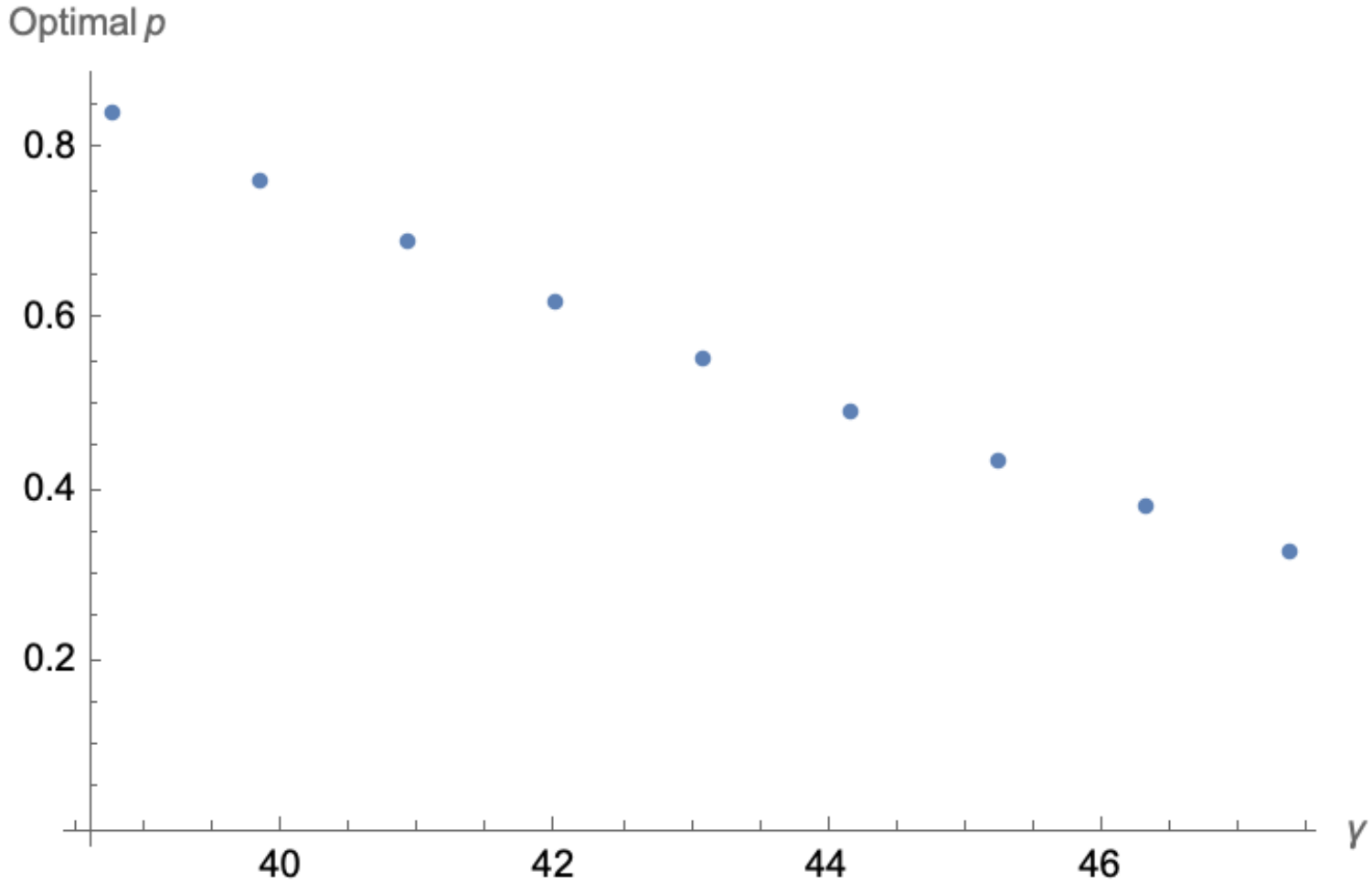
- Does under-reporting (and supervisors' misperception of it) drive our results?
- Counterfactual experiments:
  - enforce uniform reporting in all groups: 90% (as in worker incentives treatment) or 100%
  - halve average reporting costs (e.g., cheaper reporting technology)
- Shared incentives remain the output-maximizing allocation in all cases
  - higher reporting raises supervisor effort but lowers worker effort, and the two responses offset each other

Counterfactual Policy: Optimal Contract p^*

$$p^* = 0.56$$

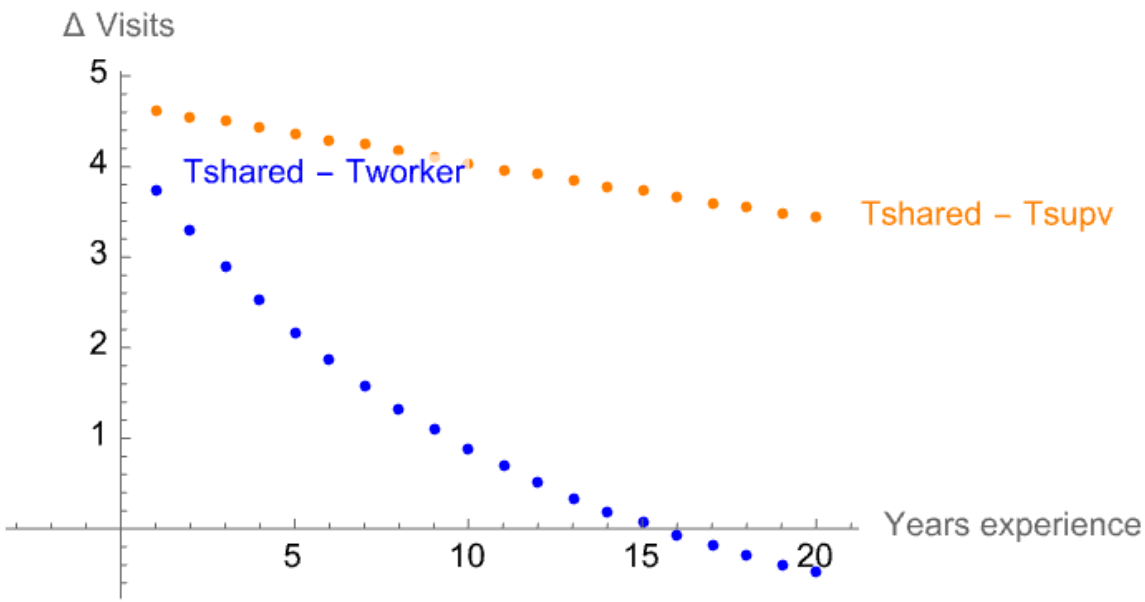


Counterfactual Policy: Optimal Contract p^* by Complementarity γ



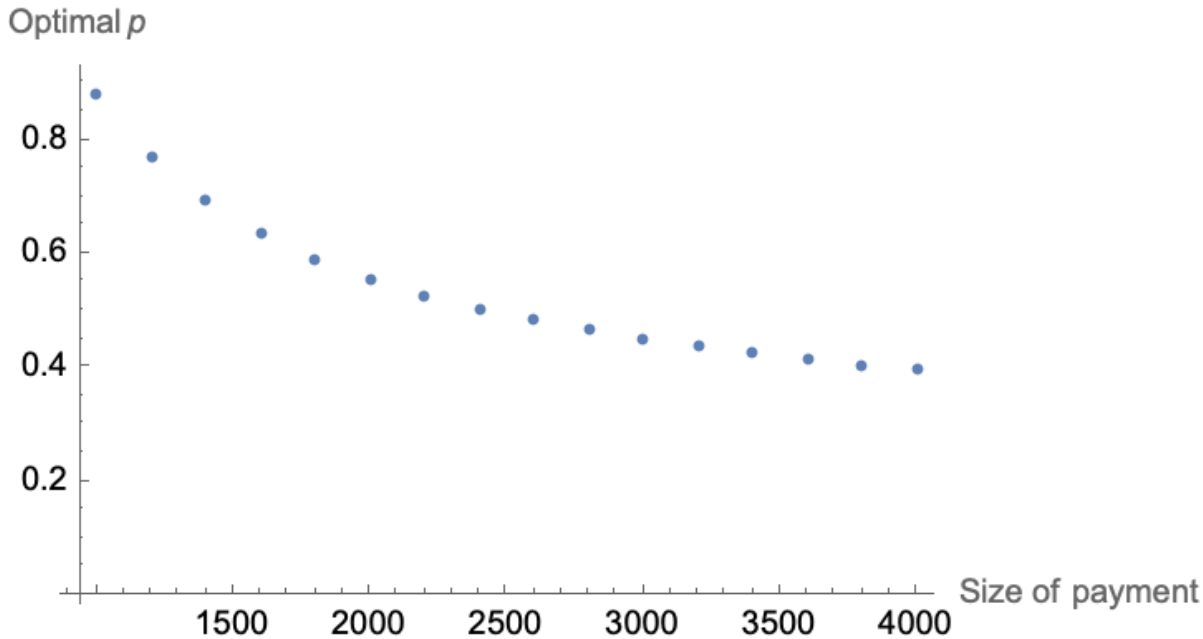
Counterfactual Policy: Shared Incentives by Worker Experience

Shared incentives outperform worker incentives for up to 15 years of worker experience



Counterfactual Policy: Optimal Contract by Size of the Incentive

The smaller the payout, the larger the optimal share offered to the worker



Discussion

- Output is sensitive to the allocation of incentives across layers of the hierarchy
  - inconsistent with a Coasian view of organizations
- In our context, with effort complementarities and frictions, shared incentives maximize output

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  - inconsistent with a Coasian view of organizations
- In our context, with effort complementarities and frictions, shared incentives maximize output
- Shared incentives should be less effective in organizations where ...
  - production function exhibits less complementarities (e.g., supervisor's role is limited to monitoring)
  - contractual frictions are weaker (e.g., longstanding relationships)
- Organizations should calibrate incentives based on effort complementarities, especially with contractual frictions

Thank you!

Backup slides

Empirical Specification

$$Y_{ij} = \alpha + \beta_1 T_{Worker,j} + \beta_2 T_{Supv,j} + \beta_3 T_{Shared,j} + Z_j + \varepsilon_{ij}$$

- Y_{ij} = number of visits provided by health worker i in PHU j, as reported by households
- $T_{Worker,j}$, $T_{Supv,j}$, $T_{Shared,j}$ = treatment indicators
- Z_j = stratification variables (district, avg distance between supervisor and health workers, number of health workers)
- ε_{ij} = error term, clustered at PHU level

Summary Statistics and Balance Checks

Sample of villages:	(1) All	(2) All	(3) Control	(4) Control	(5) Worker Incentives Treatment	(6) Worker Incentives Treatment	(7) Supervisor Incentives Treatment	(8) Supervisor Incentives Treatment	(9) Shared Incentives Treatment	(10) Shared Incentives Treatment	(11) F-test of joint significance (p-value)
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	
A. Characteristics of the supervisors (N=372)											
Male = {0, 1}	0.919	0.273	0.925	0.265	0.925	0.265	0.914	0.282	0.914	0.282	0.988
Age (in years)	37.84	8.856	37.91	9.329	37.46	7.869	36.85	8.690	39.13	9.433	0.317
Completed primary education = {0, 1}	0.739	0.440	0.763	0.427	0.731	0.446	0.785	0.413	0.677	0.470	0.405
Completed secondary education = {0, 1}	0.253	0.435	0.226	0.420	0.269	0.446	0.215	0.413	0.301	0.461	0.534
Wealth score (0 to 8)	3.013	1.227	3.097	1.269	2.914	1.222	2.914	1.239	3.129	1.182	0.507
Number of health workers responsible for	7.984	2.861	7.559	2.799	8.355	2.831	8.011	2.902	8.011	2.899	0.289
B. Characteristics of the health workers (N=2,970)											
Male = {0, 1}	0.708	0.455	0.727	0.446	0.721	0.449	0.710	0.454	0.675	0.469	0.407
Age (in years)	37.12	11.47	35.95	11.14	37.79	11.72	37.48	11.72	37.17	11.21	0.062
Completed primary education = {0, 1}	0.697	0.460	0.727	0.446	0.694	0.461	0.703	0.457	0.666	0.472	0.301
Completed secondary education = {0, 1}	0.077	0.267	0.070	0.255	0.076	0.265	0.078	0.268	0.085	0.278	0.867
Wealth score (0 to 8)	2.454	1.167	2.430	1.231	2.400	1.116	2.438	1.120	2.550	1.199	0.273
Number of households responsible for	55.19	78.59	62.72	120.2	54.08	62.92	53.16	56.37	51.26	60.24	0.375
Distance to supervisor (in km)	3.415	2.945	3.267	2.887	3.815	3.610	3.107	2.141	3.447	2.895	0.190
C. Characteristics of the female household respondent, aggregate at village level (N=2,970)											
Age (in years)	27.79	4.576	28.13	4.741	27.69	4.410	27.56	4.572	27.84	4.586	0.266
Completed primary education = {0, 1}	0.248	0.269	0.259	0.268	0.225	0.261	0.261	0.272	0.247	0.273	0.203
Completed secondary education = {0, 1}	0.035	0.119	0.039	0.126	0.033	0.118	0.036	0.118	0.033	0.116	0.912
Wealth score (0 to 8)	1.103	0.872	1.199	1.021	1.044	0.822	1.117	0.843	1.062	0.790	0.111
Distance to health worker (in km)	1.433	2.630	1.189	2.124	1.591	2.575	1.438	2.894	1.483	2.785	0.506
D. Characteristics of the village (N=372)											
Accessible road to health facility = {0, 1}	0.766	0.424	0.778	0.416	0.762	0.426	0.775	0.418	0.747	0.435	0.797
Phone network available = {0, 1}	0.838	0.368	0.824	0.381	0.845	0.362	0.862	0.345	0.821	0.384	0.490
E. Services provided by the health facility per month (N=372)											
Number of pregnant women services	47.71	45.80	43.76	42.98	51.22	57.17	48.43	37.10	47.34	44.10	0.769
Number of institutional births	13.44	8.266	12.58	6.087	13.67	7.814	13.38	6.845	14.13	11.33	0.509
Number of fully immunized infants	11.41	10.75	10.88	10.10	11.92	12.58	10.67	7.060	12.14	12.39	0.684
Number of malaria cases treated	45.89	32.03	42.29	26.88	51.44	38.88	46.63	31.52	43.23	29.38	0.286
Number of diarrhea cases treated	20.45	17.03	19.62	13.25	21.81	19.47	20.58	21.58	19.76	12.02	0.809

Notes: Each row states the sample mean and standard deviation of a variable, and by treatment group. The last column reports the p-value from the F-test of joint significance of the treatment dummies. This is derived from a regression of each variable on the three treatment dummies, controlling for the stratification variables and using standard errors clustered at the PHU level in worker/village level regressions or robust standard errors in PHU/supervisor level regressions. Data source is the supervisor survey in Panel A, the health worker survey in Panel B, the household survey (aggregate at the health worker/village level) in Panel C, the health worker's leaflet in Panel D, the facility admin data in Panel E. The wealth

Number and Quality of Visits

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Household visits provided by the health worker in the past 6 months							**Trust**
Dep. Var.	Number of visits	Average visit length	Average visit length *(conditional on at least one visit)*	Average number of health topics discussed per visit	Average number of health topics discussed per visit *(conditional on at least one visit)*	% households visited	Number of visit types	% households who trust the health worker as a health provider
Worker incentives	2.090***	2.024**	0.603	0.164	0.001	0.072***	0.250***	0.037
	(0.558)	(0.941)	(1.423)	(0.127)	(0.174)	(0.025)	(0.094)	(0.023)
Supervisor incentives	2.145***	1.933**	-0.070	0.173	0.003	0.082***	0.325***	0.031
	(0.501)	(0.926)	(1.409)	(0.130)	(0.181)	(0.025)	(0.100)	(0.024)
Shared incentives	3.356***	4.134***	1.590	0.528***	0.425**	0.127***	0.565***	0.071***
	(0.490)	(0.927)	(1.290)	(0.134)	(0.185)	(0.023)	(0.092)	(0.024)
Unit	Worker	Worker	Worker	Worker	Worker	Worker	Worker	Worker
Observations	2,926	2,926	1,803	2,926	1,803	2,926	2,926	2,926
Mean dep. var.	7.296	14.388	23.404	2.248	2.922	0.709	1.745	0.745
Mean dep. var. in Control	5.334	12.324	22.736	2.015	2.782	0.637	1.448	0.707
p-value Worker = Supervisor	0.932	0.927	0.635	0.946	0.990	0.710	0.492	0.808
p-value Supervisor = Shared	0.038	0.024	0.196	0.017	0.033	0.060	0.026	0.102
p-value Worker = Shared	0.046	0.033	0.451	0.013	0.026	0.026	0.002	0.147

Notes: Data source is the household survey, aggregate at the health worker level. Cols. (3) and (5) limit the sample to households that have received at least one visit in the past 6 months. All regressions include stratification variables. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Visit Type

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	% households who received [visit type] from the health worker in the past 6 months							
	Natal-related visits				Disease-related visits			
Dep. Var.	Pregancy visit	Accompanied woman for birth to the health facility	Pre and post-natal visit	Index (cols. 1-3)	Routine visit	Treatment / referrals of under-5 children	Follow-up visit of under-5 children	Index (cols. 5-7)
Worker incentives	0.037**	-0.005	0.027	0.069	0.068**	0.053**	0.042*	0.155***
	(0.016)	(0.007)	(0.017)	(0.049)	(0.033)	(0.025)	(0.022)	(0.060)
Supervisor incentives	0.027*	0.004	0.037*	0.092*	0.089***	0.071**	0.031	0.178***
	(0.016)	(0.008)	(0.019)	(0.051)	(0.030)	(0.028)	(0.024)	(0.061)
Shared incentives	0.064***	0.008	0.051***	0.168***	0.151***	0.111***	0.079***	0.324***
	(0.017)	(0.008)	(0.017)	(0.051)	(0.029)	(0.024)	(0.021)	(0.056)
Unit	Worker	Worker	Worker	Worker	Worker	Worker	Worker	Worker
Observations	2,926	2,926	2,926	2,926	2,926	2,926	2,926	2,926
Mean dep. var.	0.179	0.041	0.132	0.000	0.517	0.504	0.201	0.000
Mean dep. var. in Control	0.145	0.038	0.103	-0.087	0.437	0.443	0.162	-0.171
p-value Worker = Supervisor	0.543	0.193	0.604	0.650	0.540	0.527	0.669	0.733
p-value Supervisor = Shared	0.037	0.660	0.455	0.154	0.046	0.143	0.046	0.024
p-value Worker = Shared	0.132	0.069	0.151	0.056	0.014	0.020	0.094	0.008

Notes: Data source is the household survey, aggregate at the health worker level. The index in col. (4) [resp., col. (8)] estimates an equally weighted average of the z-scores of variables in cols. (1)-(3) [resp., cols. (5)-(7)]. All regressions include stratification variables. Standard errors clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

Household Targeting

Dep. Var.	(1) Number of visits to households with wealth score above vs. below the median	(2) Number of visits to households with distance above vs. below the median	(3) Number of visits to households who are family members vs. not family members	(4) Number of visits to households who received vs. did not receive a visit accompanied by the supervisor
Worker incentives	-0.525	0.764	-0.501	-0.591
	(0.522)	(0.624)	(0.544)	(0.556)
Supervisor incentives	0.791	-0.104	-0.208	-0.820
	(0.603)	(0.598)	(0.544)	(0.620)
Shared incentives	-0.161	0.118	-1.372**	-0.832
	(0.663)	(0.692)	(0.577)	(0.555)
Unit	Worker	Worker	Worker	Worker
Observations	2,970	2,970	2,970	2,970
Mean dep. var.	0.071	-0.169	-1.003	-2.727
Mean dep. var. in Control	0.067	-0.351	-0.520	-2.201
p-value Worker = Supervisor	0.041	0.241	0.631	0.752
p-value Supervisor = Shared	0.214	0.778	0.070	0.987
p-value Worker = Shared	0.605	0.428	0.176	0.719

Notes: Data source is the household survey, aggregated at the health worker level. For each health worker, we compute the differential in the number of visits received by households based on various criteria: those with a wealth score above versus below the median (col. 1), those whose distance from the health worker's home is above versus below the median (col. 2), family members versus non-family members of the worker (col. 3), those who received a visit accompanied by the supervisor vs. who never received such a visit (col. 4). In cases where the number of households in a subcategory equals zero, we assign a value of zero to the variable. The wealth score is determined by counting the ownership of items from a list of eight

Access to Natal Care and Disease Incidence

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Pre- and post-natal care in the past 2 years						**Diseases incidence**			
Dep. Var.	Index (cols. 2-6)	% women who received at least 4 ante-natal visits before birth	% women with institutional birth	% women who received post-natal visit within 2 days of birth	% women with at least 6 months of breastfeeding	% households with up-to-date infant vaccination	Index (cols. 8-10)	% children under-5 who had fever	% children under-5 who had cough	% children under-5 who had diarrhea
Worker incentives	0.029	0.017	0.022	0.007	-0.002	-0.008	0.010	-0.028	0.016	0.005
	(0.028)	(0.024)	(0.021)	(0.026)	(0.025)	(0.018)	(0.032)	(0.022)	(0.012)	(0.007)
Supervisor incentives	0.042	0.032	0.035*	-0.022	0.016	0.015	-0.028	-0.014	-0.005	-0.005
	(0.029)	(0.026)	(0.019)	(0.024)	(0.025)	(0.019)	(0.032)	(0.028)	(0.012)	(0.005)
Shared incentives	0.092***	0.058**	0.036*	0.017	0.040	0.025	-0.053**	-0.058***	-0.007	-0.001
	(0.028)	(0.025)	(0.019)	(0.027)	(0.025)	(0.019)	(0.026)	(0.022)	(0.011)	(0.005)
Unit	Worker	Worker	Worker	Worker	Worker	Worker	Worker	Worker	Worker	Worker
Observations	2,499	2,499	2,499	2,499	2,499	2,499	2,826	2,823	2,825	2,826
Mean dep. var.	-0.006	0.778	0.868	0.305	0.666	0.230	-0.009	0.183	0.072	0.016
Mean dep. var. in Control	-0.048	0.750	0.845	0.303	0.652	0.222	0.009	0.208	0.071	0.017
p-value Worker = Supervisor	0.656	0.509	0.491	0.258	0.439	0.223	0.273	0.580	0.088	0.129
p-value Supervisor = Shared	0.077	0.243	0.963	0.138	0.330	0.630	0.397	0.086	0.868	0.343
p-value Worker = Shared	0.024	0.052	0.469	0.703	0.077	0.091	0.025	0.105	0.056	0.360

Notes: Data source is the household survey, aggregate at the health worker level. The index in col. (1) [resp., col. (7)] estimates an equally weighted average of the z-scores of variables in cols. (2)-(6) [resp., cols. (8)-(10)]. The sample in cols. (1)-(6) is restricted to households with a woman who gave birth in the past year. All regressions include stratification variables. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

Services from the Local Health Facility

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Pre- and post-natal care at the health facility in the past month				**Disease treatments at the health facility in the past month**			
Dep. Var.	Index (cols. 2-4)	Number of pregnant women services	Number of institutional births	Number of fully immunized children	Index (cols. 6-8)	Number of malaria cases treated	Number of diarrhea cases treated	Number of fever cases treated
Worker incentives	0.108	5.001	0.895	2.302	0.175*	9.857*	4.309**	22.269**
	(0.094)	(5.511)	(1.020)	(1.553)	(0.099)	(5.839)	(2.102)	(9.982)
Supervisor incentives	0.097	4.799	1.731	0.852	0.187**	10.104*	2.420	25.311***
	(0.083)	(4.220)	(1.090)	(1.352)	(0.094)	(5.767)	(2.231)	(9.108)
Shared incentives	0.244*	13.918*	2.552*	3.042*	0.223*	9.455	6.309*	24.337**
	(0.126)	(7.283)	(1.389)	(1.625)	(0.132)	(6.621)	(3.269)	(11.949)
Unit	PHU	PHU	PHU	PHU	PHU	PHU	PHU	PHU
Observations	371	371	371	371	371	371	371	371
Mean dep. var.	0.000	41.889	13.776	12.406	0.000	57.464	18.936	132.026
Mean dep. var. in Control	-0.110	36.063	12.513	10.892	-0.155	49.595	15.582	113.274
p-value Worker = Supervisor	0.916	0.971	0.483	0.386	0.908	0.967	0.494	0.776
p-value Supervisor = Shared	0.269	0.209	0.584	0.203	0.800	0.923	0.291	0.937
p-value Worker = Shared	0.323	0.263	0.246	0.690	0.733	0.953	0.569	0.873

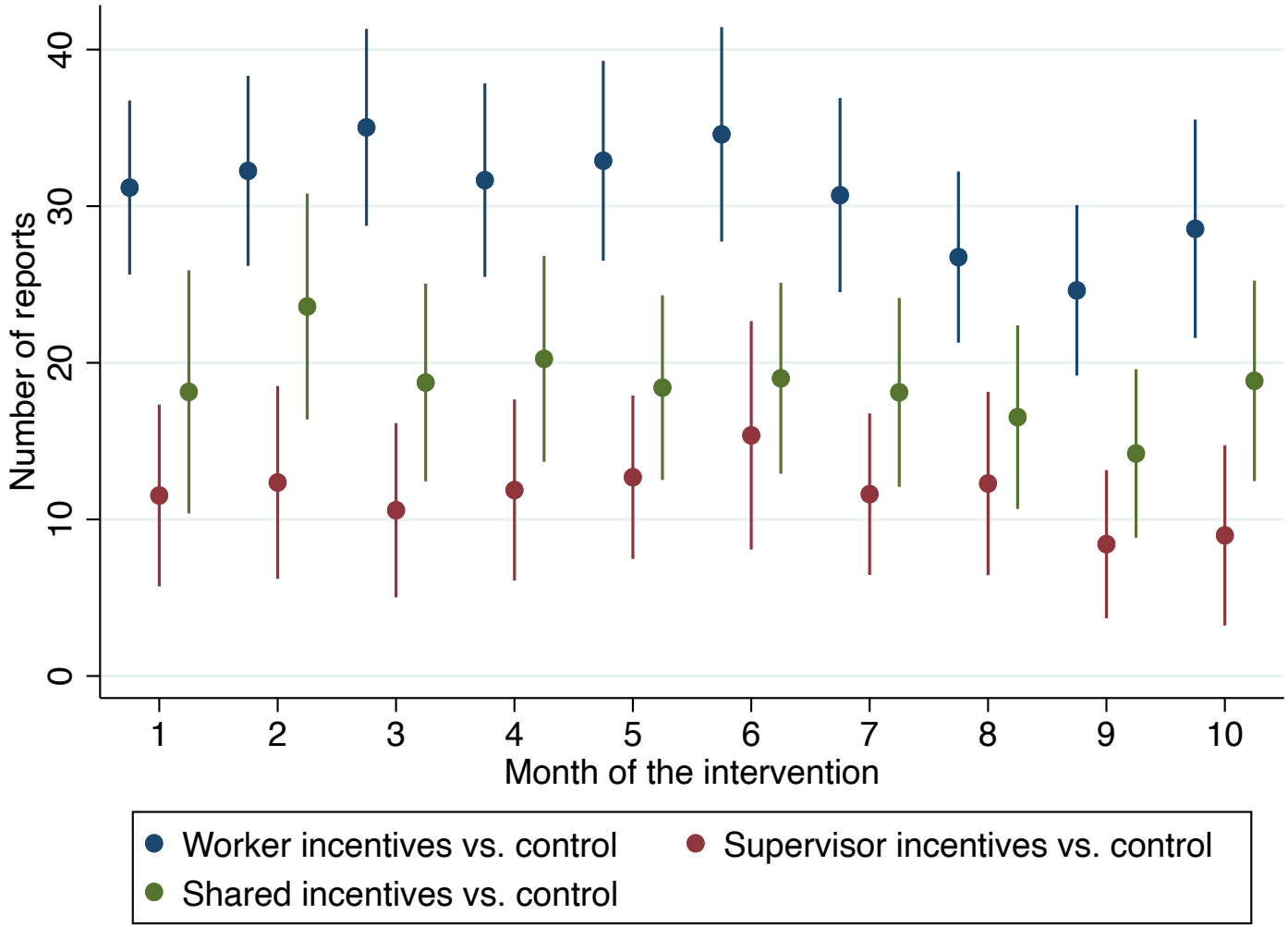
Notes: Data source is the admin data from the local health facilities (one per PHU). The index in col. (1) [resp., col. (5)] estimates an equally weighted average of the z-scores of variables in cols. (2)-(4) [resp., cols. (6)-(8)]. All regressions include stratification variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Reporting Behavior

	(1)	(2)	(3)	(4)	(5)
	Reporting		**Incentives payments per month (in 1,000 SLL)**		
Dep. Var.	Number of reports per month	Reporting rate = number of reports / number of visits	Incentives payments to health worker	Incentives payments to supervisor (per health worker)	Total incentives payments per health worker (col. 3 +4)
Worker incentives	21.547***	0.666***	52.506***	-0.239	52.267***
	(2.278)	(0.128)	(4.385)	(0.475)	(4.397)
Supervisor incentives	6.543***	0.175*	-0.424	22.685***	22.261***
	(1.757)	(0.103)	(0.674)	(3.265)	(3.302)
Shared incentives	14.272***	0.273**	18.816***	18.879***	37.695***
	(2.487)	(0.108)	(2.447)	(2.405)	(4.840)
Unit	Worker	Worker	Worker	Worker	Worker
Observations	2,970	2,624	2,970	2,970	2,970
Mean dep. var.	15.639	0.530	18.575	10.538	29.113
Mean dep. var. in Control	4.574	0.234	0.000	0.000	0.000
p-value Worker = Supervisor	<0.001	<0.001	<0.001	<0.001	<0.001
p-value Supervisor = Shared	0.008	0.398	<0.001	0.348	0.008
p-value Worker = Shared	0.026	0.005	<0.001	<0.001	0.025

Notes: The reporting rate in col. (2) is calculated by dividing the number of SMS reports (from the SMS admin data; col. 1) by the total monthly visit count, adjusted by the inverse of the sampling probability (obtained from the household survey) All regressions include stratification variables. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

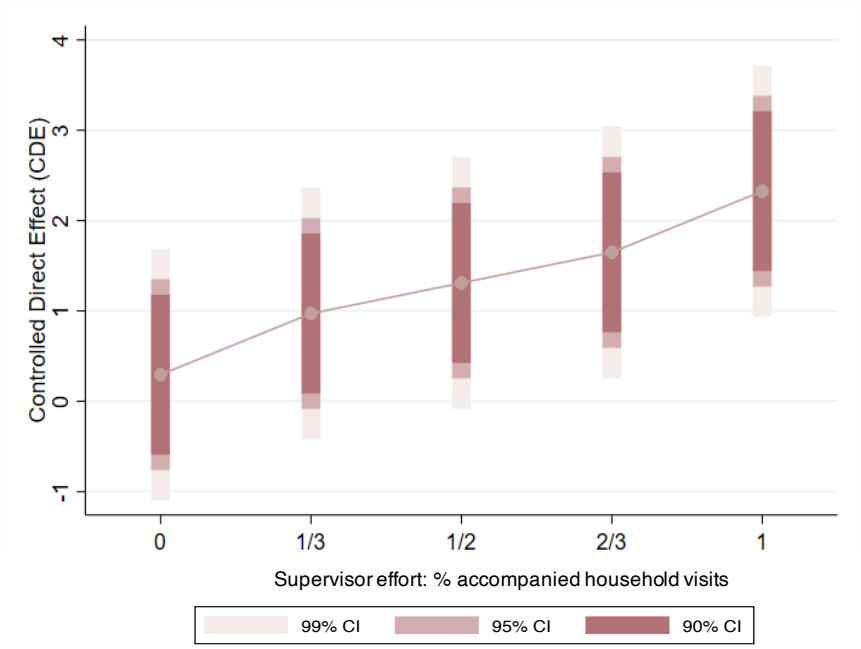
Evolution of SMS Reporting



Notes: The figure plots the difference in the count of SMS reports between each treatment group and the control group. The coefficients are derived from a regression of the number of SMS reports for each individual month on the treatment dummies, controlling for the stratification variables and with standard errors clustered at the PHU level. The bars represent 95% confidence intervals.

Mediation Analysis

- Portion of the treatment effect that comes from worker effort ↑ with supervisor effort [Acharya et al. 2016]



Notes: This figure plots the controlled direct effect (CDE) of the worker incentives treatment on the number of visits provided by a health worker for different values of supervisor's effort, as measured with the share of visits accompanied by the supervisor. We focus on the comparison between the worker incentives treatment and the control group since a mediation analysis performed on the other treatments would be confounded by the fact that in those treatments, the supervisor is directly incentivized to exert effort. We follow the steps outlined in Acharya et al. (2016) to perform the analysis. First, we regress the number of visits a health worker provides on the worker incentives treatment, the mediator (supervisor's effort), and their interaction. Second, we obtain a de-mediated outcome, defined as the difference between actual visits and the number of visits predicted by the regression model for a given level of the mediator. Third, we run a regression of the de-mediated outcome on the treatment. This regression identifies the CDE of the intervention for a given level of the mediator. We repeat this three-step procedure multiple times, changing the level at which we fix the mediator.

Supervisor's Effort

	(1)	(2)	(3)
	In-the-field training	*General training*	*Knowledge improvement*
Dep. Var.	% accompanied household visits	Supervisor organized general training in the past month = {0, 1}	Difference in health workers' knowledge between baseline and endline
Worker incentives	0.030	0.004	0.158
	(0.022)	(0.005)	(0.116)
Supervisor incentives	0.057**	0.006	0.063
	(0.023)	(0.005)	(0.113)
Shared incentives	0.062***	0.003	0.266**
	(0.021)	(0.005)	(0.121)
Unit	Worker	Worker	Worker
Observations	2,919	2,864	2,927
Mean dep. var.	0.204	0.994	-0.313
Mean dep. var. in Control	0.164	0.991	-0.433
p-value Worker = Supervisor	0.293	0.443	0.372
p-value Supervisor = Shared	0.846	0.463	0.074
p-value Worker = Shared	0.181	0.916	0.350

Notes: Data source is the household survey in col. (1), aggregated at the health worker level. Data source is the health worker survey in the other columns. The dependent variable in col. (1) is equal to the share of household visits accompanied by the supervisor. All regressions include stratification variables. Standard errors are clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1.

Effects by Worker Experience

Dep. Var.	(1) Number of visits	(2) Number of visits	(3) Supervisor effort: % accompanied household visits	(4) Supervisor effort: % accompanied household visits	(5) Side transfers: Supervisor shared incentive with health worker = {0, 1}	(6) Side transfers: Supervisor shared incentive with health worker = {0, 1}	(7) Reporting rate	(8) Reporting rate
A. Treatment effects for workers with experience below the median:								
Low experience * Worker incentives	2.054***	2.395***	0.030	0.030	-0.004	-0.011	0.716***	0.713***
	(0.628)	(0.722)	(0.025)	(0.027)	(0.027)	(0.032)	(0.142)	(0.158)
Low experience * Supervisor incentives	2.576***	2.661***	0.067**	0.067**	0.122***	0.135**	0.151	0.159
	(0.598)	(0.646)	(0.029)	(0.031)	(0.045)	(0.053)	(0.108)	(0.120)
Low experience * Shared incentives	4.022***	4.335***	0.092***	0.104***	0.057	0.066	0.239**	0.232**
	(0.684)	(0.751)	(0.026)	(0.027)	(0.046)	(0.052)	(0.095)	(0.102)
B. Treatment effects for workers with experience above the median:								
High experience * Worker incentives	2.246***	2.056***	0.030	0.031	0.014	0.023*	0.613***	0.659***
	(0.780)	(0.756)	(0.031)	(0.032)	(0.010)	(0.014)	(0.207)	(0.204)
High experience * Supervisor incentives	1.720**	1.657**	0.045	0.045	0.257***	0.283***	0.197	0.238
	(0.669)	(0.643)	(0.030)	(0.031)	(0.063)	(0.067)	(0.167)	(0.179)
High experience * Shared incentives	2.583***	2.638***	0.030	0.022	0.152***	0.175***	0.305*	0.290*
	(0.608)	(0.670)	(0.030)	(0.032)	(0.047)	(0.052)	(0.174)	(0.170)
High experience	1.057**	1.141*	0.017	0.033	-0.055**	-0.067**	-0.081	-0.058
	(0.532)	(0.594)	(0.025)	(0.028)	(0.027)	(0.034)	(0.128)	(0.132)
Unit	Worker	Worker	Worker	Worker	Worker	Worker	Worker	Worker
Extra Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2,909	2,552	2,902	2,547	2,898	2,509	2,607	2,288
Mean Dep. Var.	7.296	7.296	0.204	0.204	0.084	0.084	0.530	0.530
Mean Dep. Var. in Control & Low experience	4.749	4.749	0.131	0.131	0.022	0.022	0.222	0.222
Treatment comparisons in Panel A (Low experience)								
p-value Worker=Supv	0.455	0.733	0.226	0.236	0.005	0.004	0.001	0.003
p-value Worker=Shared	0.011	0.026	0.029	0.010	0.174	0.105	0.003	0.006
p-value Supv=Shared	0.057	0.038	0.431	0.248	0.268	0.287	0.486	0.587
Treatment comparisons in Panel B (High experience)								
p-value Worker=Supv	0.551	0.630	0.643	0.676	0.000	0.000	0.039	0.037

Side Payments

	(1)	(2)	(3)	(4)	(5)
			Monthly transfer amount (in 1,000 SLL)		
Dep. Var.	Supervisor shared incentive with health worker = {0, 1}	Health worker shared incentive with supervisor = {0, 1}	… from supervisor to health worker	… from health worker to supervisor	Net transfer (col. 3-4)
Worker incentives	0.005	0.073***	0.110	0.151***	-0.042
	(0.016)	(0.014)	(0.090)	(0.056)	(0.077)
Supervisor incentives	0.183***	-0.001	0.702***	0.104**	0.598***
	(0.047)	(0.008)	(0.190)	(0.043)	(0.190)
Shared incentives	0.102***	0.041***	0.432***	0.084*	0.348**
	(0.039)	(0.015)	(0.158)	(0.043)	(0.164)
Unit	Worker	Worker	Worker	Worker	Worker
Observations	2,915	2,909	2,488	2,488	2,488
Mean dep. var.	0.084	0.048	0.308	0.101	0.207
Mean dep. var. in Control	0.011	0.019	0.000	0.016	-0.016
p-value Worker = Supervisor	<0.001	<0.001	0.004	0.484	0.001
p-value Supervisor = Shared	0.171	0.005	0.273	0.725	0.318
p-value Worker = Shared	0.013	0.100	0.068	0.325	0.026

Notes: Data source is the health worker and supervisor survey. All regressions include stratification variables. Standard errors clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1

Job Satisfaction

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Health worker is satisfied with […] = {0, 1}			Supervisor is satisfied with […] = {0, 1}				
Dep. Var.	Incentives payments	Organization paying the incentives	Job	Incentives payments	Organization paying the incentives	Job	Health worker perceives the work environment as non-competitive	Health worker self-identifies herself through her job = {0, 1}
Worker incentives	0.344***	0.074***	-0.039	0.086	0.012	-0.067	-0.046	0.006
	(0.032)	(0.024)	(0.036)	(0.056)	(0.049)	(0.061)	(0.044)	(0.026)
Supervisor incentives	-0.003	0.014	-0.040	0.305***	0.082*	-0.073	-0.023	-0.019
	(0.030)	(0.028)	(0.038)	(0.062)	(0.042)	(0.062)	(0.043)	(0.030)
Shared incentives	0.198***	0.048**	-0.054	0.329***	0.092**	-0.040	-0.024	-0.018
	(0.036)	(0.024)	(0.036)	(0.063)	(0.041)	(0.059)	(0.043)	(0.029)
Unit	Worker	Worker	Worker	Supervisor	Supervisor	Supervisor	Worker	Worker
Observations	2,709	2,825	2,876	360	364	359	2,923	2,923
Mean dep. var.	0.357	0.870	0.793	0.311	0.909	0.738	0.727	0.829
Mean dep. var. in Control	0.219	0.837	0.828	0.132	0.860	0.787	0.746	0.838
p-value Worker = Supervisor	<0.001	0.023	0.986	0.001	0.098	0.929	0.598	0.379
p-value Supervisor = Shared	<0.001	0.186	0.709	0.738	0.757	0.605	0.987	0.963
p-value Worker = Shared	<0.001	0.254	0.679	<0.001	0.048	0.664	0.609	0.394

Notes: Data source is the health worker survey in cols. (1)-(3) and (7)-(11), and the supervisor survey in cols. (4)-(6). A worker/supervisor is defined as unsatisfied with the incentive payment if she reports that the incentive she is paid per valid SMS report is "not fair" (too little). A worker/supervisor is defined as unsatisfied with the environment if she reports that the environment is competitive rather than cooperative. ``Health worker self-identifies herself through her job" is a dummy variable that takes value one if the health worker answers "my job as a community health worker" to the following question: "We have spoken with many people in Sierra Leone and they identify themselves to different groups. Some people self identify themselves as belong to an ethnic group, a language, a religion, etc. Others identify themselves describe themselves in terms of their job. Besides being a citizen of Sierra Leone, which specific group do you feel you belong to first and foremost?". Questions in cols. (7) and (8) were not asked to the supervisor. The sample size changes across columns because a number of health workers and supervisors answered "don't know" to the questions. All regressions include stratification variables. Standard errors clustered at the PHU level. *** p<0.01, ** p<0.05, * p<0.1