Performance Pay Increases Dog Vaccinations to Reduce Human Rabies

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Abstract

Rural development projects often depend on local community members to coordinate community participation. Using a randomized controlled trial, this paper examines how pay-for-performance for community coordinators affects participation in dog vaccination events to prevent human rabies in Tanzania. Three treatments were implemented: fixed payment only, pay-for-performance only, or a mix of fixed payment and pay-for-performance. Using dog vaccination histories, the experiment equalizes the total expected payment across treatments, isolating the effect of payment type. Mixed payment increases dog vaccinations by 16% compared to fixed payment. Each 10% increase in per-dog payment raises vaccinations by 0.4%. Changing the fixed payment rate has a negligible effect. Thus, pay-for-performance induces higher effort than the fixed component. The findings suggest pay-for-performance can improve the effectiveness of rural development projects such as mass immunization events.

1 Introduction

Rural development projects often depend on local community members to promote project participation and engagement. A key question is how best to motivate these individuals to achieve project goals. The optimal design of incentives to promote worker effectiveness is a central issue in personnel economics.

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While the standard adage that "workers respond to incentives" suggests that piece rates, or performance pay, is the most promising strategy, principal-agent models suggest that fixed wages can be important to motivate risk-averse agents when the relationship between worker effort and output is noisy or difficult to observe (Lazear and Shaw, 2007). This paper uses a randomized experiment to study the role of fixed and performance incentives to motivate community workers in the context of a dog rabies vaccination campaign.

Human rabies has the highest case fatality rate of any known infectious disease and kills approximately 59,000 people annually, mostly children (Hampson et al., 2009; Knobel et al., 2005). Domestic dogs are responsible for over 99 percent of human rabies infections. Mass dog vaccination is a highly cost-effective approach to reducing and eliminating human rabies incidence.[1] The vast majority (>99%) of human rabies fatalities occur in Africa and Asia, primarily in remote locations (Hampson et al., 2015; Lankester et al., 2014).

Across Africa and Asia, it is standard to deliver mass dog vaccination through one-day 'central point' vaccination clinics hosted annually in convenient locations in villages, with vaccinations delivered to dogs brought to the clinics by their owners (Gibson et al., 2016; Minyoo et al., 2015). The effectiveness and cost-effectiveness of these clinics rely on mobilizing sufficient voluntary participation by local dog owners so that the vaccination coverage achieved is sufficiently high to sustain 'herd immunity' throughout the year, until the vaccination team returns for another round of vaccination. However, dog vaccination campaigns frequently fail to reach the required target.[2]

In an attempt to improve vaccination coverage, mass dog vaccination programs often utilize local community members (henceforth called village vaccination coordinators) to assist the traveling vaccination team with the organization of the clinic, informing the community about the event and encouraging dog owners to bring their dogs in for vaccination (Gibson et al., 2016). Such activities have been shown to increase participation in central point vaccination campaigns (Fishbein et al., 1992).

The objective of this study is to examine whether and to what extent the type of payment scheme offered to village vaccination coordinators affects dog vaccination rates at mass dog vaccination clinics. The study describes a randomized experiment conducted in 2017 and 2018 during an ongoing mass dog vaccination campaign in northern Tanzania. Village vaccination coordinators were offered one of three different types of payments: i) a fixed daily wage similar that typically offered to prospective village coordinators, ii) a performance-based payment per dog vaccinated, or iii) a two-part (mixed) payment consisting of a fixed payment plus a performance-based per-dog payment. Using dog vaccination data from previous years, the payment rates were set to equalize expected total pay across treatment groups,

[1] The World Health Organization (WHO), the Food & Agricultural Organization (FAO) and the World Organization for Animal Health (OIE) have recognized human rabies as a global health priority and have united in a commitment to its global elimination by 2030 (Organization et al., 2018). Mass dog vaccination is a key pillar of this campaign.

[2] To eliminate rabies on a regional scale, these once-per-year campaigns must vaccinate at least 70% of each community's dog population in order to maintain the minimum coverage above 20 – 45% (critical threshold) throughout the year (Hampson et al., 2009). Otherwise, natural turnover in the dog population leads to drops in coverage that allow sustained rabies transmission.

but randomized expected total payment within these groups.The paper finds that a mixed payment scheme outperforms a pure fixed payment in terms of dogs vaccinated, consistent with principal-agent theory. Higher performance-based payments induce more dog vaccinations, and outperform fixed payments in effectiveness and statistical significance. A mixed payment scheme is also marginally more effective than a purely performance-based payment, though not statistically so.

The primary contribution of the study is to show that performance pay can motivate effort by non-professional community members involved in rural public service provision, which adds to the broader literature on the role of performance pay in public service delivery.[3] A key question raised for incentives in public service provision is the interplay between financial incentives and the "intrinsic" motivation of service providers—the desire to do good. Benabou and Tirole (2003) and Bénabou and Tirole (2006) show theoretically that incentives can "crowd out" intrinsic motivation, raising the possibility that performance-based incentives could actually reduce performance. Ashraf et al. (2014) highlight the role of intrinsic motivations for local community members promoting an HIV prevention project in Zambia. They find that non-financial rewards were more effective than financial rewards, though they do not find evidence for crowd-out. On the other hand, Goldberg et al. (2023) find that financial incentives were more effective than non-financial encouragement at motivating tuberculosis patients to refer others in their community for testing and treatment. Since the village vaccination coordinators live in the community and observe the benefits of rabies vaccination for children's health in their village, this setting is particularly well suited to studying this question. Moreover, because total expected payment across the treatment groups was equalized, the paper identifies the specific effect of performance pay separately from overall income effects. The paper finds that performance-based pay induces higher effort than a fixed payment alone, suggesting that any crowd-out of intrinsic motivation is not sufficient to reverse the positive effect of financial incentives on effort.

This study also contributes to the literature on unconditional salary increases in public service provision. One hypothesis about fixed wages in health settings is that the payment may have a gift value that encourages pro-social behavior (DellaVigna and Pope, 2018). In this case, higher fixed wages could induce more effort. However, this study finds little evidence of this effect conditional on participation: the elasticity of effort with respect to the size of the fixed wage is positive but not statistically or economically significant.

This article also makes an important contribution to the literature on the implementation of MDV as a means to control human rabies. The global history of success in reducing and in many places virtually eliminating human rabies, primarily by means of mass dog vaccination, suggests real potential for success in areas where it remains endemic (Yoder et al., 2019, see for example). This paper is the

[3]The literature on the effects of performance incentives on public service provision and on health or educational outcomes is extensive. See, for example, Muralidharan and Sundararaman (2011), Basinga et al. (2011), Gertler and Vermeersch (2013), Olken et al. (2014), Andreoni et al. (2022), Filmer et al. (2020), and Leaver et al. (2021). Finan et al. (2017) provides a comprehensive review of this literature.

first to describe the effect of payment incentives on canine vaccination outcomes. Scaling up MDV across areas where the disease remains endemic is required to achieve current commitments to eliminate human rabies globally by 2030 (Organization et al., 2018). However, MDV campaigns as currently implemented are often quite costly, and these costs are a major barrier to delivering these interventions in the low-income, remote communities where the burden of rabies is highest. The costs associated with delivering these interventions are frequently calculated as a cost-per-dog vaccinated and have been estimated in a number of settings to range from approximately $1.20 to $22.50 per dog vaccinated (Bögel and Meslin, 1990; Fishbein et al., 1992; Hatch et al., 2017; Kaare et al., 2009; Kayali et al., 2006; Lapiz et al., 2012; Wallace et al., 2017). The results of this study suggest that pay-for-performance can generate cost savings in the delivery of these interventions. This study's novel focus on and evidence for cost effectiveness in the context of rabies management is of timely importance.

Section 2 provides some additional background on rabies and relevant specifics of MDV for this application. Section 3 describes the experimental design, including the randomization procedure. Section 4 provides data context and summaries, Section 5 describes the empirical estimation strategy, Section 6 presents results, and Section 7 concludes.

2 Background

As elsewhere in the world where rabies remains a public health concern, the disease in northern Tanzania is driven by viral transmission to humans (mostly children) through bites from the reservoir host, the domestic dog. Irrespective of this risk, domestic dog ownership is relatively common in Tanzania, with human to dog ratios varying between approximately 7:1 in rural areas (Cleaveland et al., 2003; Czupryna et al., 2016) to 14:1 in urban areas (Gsell et al., 2012). In the rural agro-pastoral study area of northern Tanzania, a high proportion (>95%) of dogs are owned or at least informally attached to households, and receive food from and interact with household members. Households own dogs for a number of reasons, including hunting, security for the home, and companionship. Nonetheless, many of these dogs in rural villages in Tanzania are free roaming. While they are typically not restrained and may appear 'stray' or feral, their caretakers — often the children of the household, can and do collect them and bring them for vaccination at central point vaccination clinics (Cleaveland et al., 2003; Gsell et al., 2012).

In Tanzania, mass dog vaccination events within each administrative district are typically hosted at the level of the village and are coordinated through the respective District Veterinary Office. The events are implemented by a team of veterinarians and paraprofessional animal health workers (e.g. livestock field officers). To generate community awareness, community sensitization activities are carried out which typically include the vaccination team posting posters in prominent places within the village and using loud-speakers to inform villagers about event details. In addition, village coordinators who belong to the local tribe, are familiar with the village and are known to the community are recruited for the day to assist with the coordination of the event. An important role that the village coordinators can perform is encouraging people to bring their dogs for vaccination. This can be done in a number of ways, including informing the community leadership (e.g. village executive officers) and school authorities (children often are responsible for bringing household dogs for vaccination) about the event and spreading the word amongst the villagers, typically by word of mouth.

3 Experimental Design

The authors conducted a randomized experiment in a sample of 241 villages in Tanzania in the context of an ongoing mass dog vaccination campaign. Both the randomization and data are at the village-year level. The experiment was implemented over the course of two years. Prior to the experiment, one-day mass dog vaccination events had been occurring yearly in most of the villages for more than ten years. A village vaccination coordinator was hired to be responsible for informing village residents about the vaccination event and encouraging them to bring their dogs for vaccination. The village vaccination coordinator was randomized to one of three payments schemes: i) a fixed payment for the day; ii) a variable payment per dog vaccinated; or iii) a combination of fixed and variable payments. In addition, both fixed and variable pay rates were randomized.

3.1 Payment design

There were three payment schemes: fixed only, variable only, or mixed. The fixed payment scheme is the payment scheme used in previous years (i.e. the status quo): coordinators were paid a lump sum, flat fee for their work on the one-day dog vaccination camp. In the variable pay scheme, coordinators were paid a piece-rate based on the number of dogs vaccinated in their village and received no minimum payment. That is, in the variable scheme, if coordinators were unsuccessful at getting any dogs to be vaccinated, they would not be paid. In the mixed scheme, coordinators received a minimum flat fee for their work as well as a per-dog piece rate on top of the flat fee.

A concern to consider in the design of pay-for-performance is cheating or gaming the system. In the current setting, there may be concern that the village coordinator could artificially inflate the number of dogs recorded as vaccinated. Given the roles and responsibilities of the coordinator and the vaccination team, this would be exceedingly difficult to do. While the village coordinators help in preparation for vaccination events and help with general management of an event (for example advertising and disseminating information about the event), they are not responsible for bringing dogs for vaccination, nor are they involved in the actual vaccination activity (marking the dogs as vaccinated, or the record keeping associated with vaccination numbers). A village coordinator would generally not have access to manipulate the data, nor a sufficiently strong incentive to collude with the vaccination team given the relatively small per-dog payments provided in this study.

There may also be a concern that coordinators try to get dogs vaccinated more than once. Mass dog vaccination campaigns typically recommend that every dog be vaccinated once every year.[4] At each MDV event, each owner that brings a dog for vaccination has their and their dog's name entered into a register by the vaccination teams, which are comprised of 3-5 specialists qualified for carrying out the vaccination. Any owner or dog returning more than once would likely be spotted, although in some large events it might be possible for dogs to be vaccinated more than once.[5] However, the incentives to do this are very weak. Bringing dogs to vaccination clinics is time-costly, even for children, and the per-dog payment to the coordinator is just too low to imagine collusion between dog owners and coordinators to induce returns. a further reason that "cheating" is unlikely is that the dogs in these villages are not frequently handled and are often brought in without leashes and following vaccination most run away. Consequently, vaccinated dogs would be very difficult to catch and encourage to return for a second vaccination. And finally, in some cases vaccination teams mark vaccinated dogs with a dab of spraypaint to informally or informally assess coverage rates, but this helps avoid accidental re-vaccination and makes intentional revaccination less viable as well.

The experiment was conducted over the course of two years. In each year, village coordinators were identified a few days before the dog vaccination camp and offered the randomly selected payment scheme. In most cases, a new village coordinator was hired in the second year; the same coordinator was hired again in only 14 villages (6% of the sample), and this is balanced across the treatment groups. There are only 10 known cases in which the same individual was offered payment schemes in both 2017 and 2018 (about 3%), reducing the likelihood of intertemporal spillovers. It was possible for coordinators to refuse the payment offer as examined in Section 6.

3.2 Randomization

A two-stage randomization of the payment scheme and the payment rate was conducted. First, approximately one-eighth of the sample was assigned to the fixed scheme (n=30), one-eighth to the variable scheme (n=30), and the remainder to the mixed scheme (n=181). A larger proportion was assigned to the mixed scheme because the mixed scheme in principle provides the most information about the effects of marginal changes in each payment type conditional on the other.

Pay rates were then randomly assigned for each coordinator. To do this, the total expected payment

[4]The vaccine is protective for 3 years (MSD Animal Hub, 2022). However, the once-per-year strategy because it is often children who bring dogs for vaccination, frequently not all dogs in a household are able to be brought, families can have difficulties remembering which dogs were vaccinated in prior years (Lugelo et al., 2022; Minyoo et al., 2015).Additionally, the turn over of the population is rapid (high mortality and birth rate) (Czupryna et al., 2016). There is no detrimental effect to vaccinating a dog every year (MSD Animal Hub, 2022), while mistakenly *not* vaccinating a dog has significant detrimental effects on herd immunity.

[5]As shown in Appendix Table S1 in the supplementary online appendix, available with this article at *The World Bank Economic Review* website, the mean number of dogs vaccinated is nearly 200, the minimum is 11, the maximum is about 1,100. The median (not shown in the table) was 167.

Table 1: Randomization procedure

Payment scheme (randomly assigned)	Total predicted payment (cross-randomized)	Fixed payment (F)	Variable payment, Piece rate (V)
Fixed (n = 32)	$\hat{R} \sim U(7.5, 15)$	$F = \hat{R}$	$V = 0$
Mixed (n = 180)		$F \sim U(0, \hat{R})$	$V = (\hat{R} - F)/D^{M5}$
Variable (n = 30)		$F = 0$	$V = \hat{R}/D^{M5}$

Source: Author's description This table describes the variables used in the randomization of payment schemes and pay rates in the experiment.

$\hat{R}$ was first randomly selected from a uniform distribution between \$7.50 and \$15 to roughly coincide with daily fixed payments paid to coordinators in previous years (around \$10 USD depending on exchange rates). The pay rate includes two elements: a fixed amount F and a variable per-dog amount V (i.e., piece rate). The fixed amount F and the piece rate V were determined according to the payment scheme. In the fixed payment scheme, the fixed amount is simply the randomly assigned total amount: $F = \hat{R}$. In the variable payment scheme, the mean number of dogs vaccinated in previous years was used to calculate a prediction for the total payment, in expectation.[6] The piece rate was set so that coordinators would earn the randomly assigned total amount in expectation: $V = \hat{R}/D^{M5}$, where D^{M5} is the average number of dogs vaccinated in a given village between 2012 through 2016.[7] In the mixed payment scheme, a fixed payment amount $F \in (0, \hat{R})$ was randomly selected. The piece rate V was then set to obtain the randomly assigned variable payment: $V = (\hat{R} - F)/D^{M5}$. This randomization process is depicted in Table 1. Given the definition of V, $\hat{R} = F + V \times D^{M5}$ represents the expected total payment based on previous years' mean dog vaccination numbers. In summary, the randomization generates variation in the payment scheme, total expected payment for the work, and the distribution of pay across fixed and variable payments.

This randomization procedure was implemented three times: twice in year 1 and once in year 2. In year 1, an initial randomization was conducted, but shortly after implementation of the study began, the sample of available villages changed due to merging of villages and changes in village boundaries. The randomization procedure was repeated on the new sample, but the study was incidentally implemented in 13 villages prior to this sample update. There is no reason to believe that these villages were differentially selected; hence, this is akin to conducting randomization in two blocks. These 13 villages are included in the analysis sample, and the estimation equations control for this using a block fixed effect. In year 2, all villages were completely re-randomized using the same procedure. Hence, the unit of randomization is the village-year. The histogram of fixed and variable payments is shown in Appendix Figure S1.

[6] Data from up to previous five years were used to calculate the mean number of dogs vaccinated in previous vaccination events (D^{M5}, *Vaccinated 2012-16*). The mean number of dogs vaccinated in village i is: $D_{it}^{M5} = \sum_{t=1}^{\min(T,5)} D_{it}$, where T is the total number of previous years available. If only one year of previous data was available, the district mean was used instead.

[7] D^{M5} corresponds to *Vaccinated 2012-16* in Section 4 below.

4 Data

The primary analysis sample consists of 346 villages: 174 villages in year 1 and 172 villages in year 2. This sample was constructed in the following way. The initial randomization was conducted on a sample of 241 villages. These villages were drawn from six districts in the Mara and Simiyu regions of northern Tanzania. Villages are then dropped from this sample for two reasons.

First, villages from one district were dropped entirely. This district was dropped because environmental factors fundamentally changed the nature of the treatment. In this district, Bariadi, there was a large decrease in the dog population in 2017 due to a regional drought the reduced the local water supply. This was descrived by the vaccination team after the event based on their experience vaccinating dogs that year and interacting with dog owners and other community members. Consistent with this dog population decline, the data show that the number of dogs vaccinated in Bariadi dropped by nearly 40 percent between 2016 and 2017, while increasing in all other districts. Because the variable payment rates were calibrated based on the number of dogs vaccinated in previous years (see Section 3.2 above), this large decrease in the dog population reduced the total expected payment for coordinators with mixed or variable payment schemes, so that the total expected payment was no longer comparable across treatment groups. Coordinators likely recognized the impacts of the drought on their total expected payment, but dog population data are not available and therefore it is not possible to control for this change. Because this event fundamentally changed the treatment, data from this district are excluded from the main analysis. The decision to drop this district was made after data collection based on discussions with the implementation teams instigated by preliminary data examination, but prior to estimation of the main treatment effects. Since the treatment assignment is uncorrelated with the district, by design, dropping the entire district does not threaten the validity of the randomization in the remaining districts. Nevertheless, results from all six districts are shown in Appendix Table S5. Dropping this district leaves us with a sample of 194 villages.

Second, village boundaries can be fluid in rural Tanzania, and in some cases, villages had disappeared or merged when the vaccination team arrived on site. From the original sample of 194 villages, mass dog vaccination events were implemented in 179 villages in 2017 and 173 villages in 2018. Six additional villages are missing baseline dog vaccination data. Omitting these yields the final analysis sample of 346 villages.

Coordinators were paid in current Tanzanian Shillings (TSh). The data and analysis are reported in U.S. Dollars (USD) with base year 2021. The conversion was carried out by first inflating TSh by 13.8% to approximately account for TSh inflation between 2017/18 and 2021 (WorldData.info, 2022). The inflated values were then divided by an exchange rate of 2,300 TSh/USD that falls in the range of purchasing power parity exchange rates for 2021 (World Bank, 2022). Prior to these conversions, 1 Shilling was added to the fixed and variable payment to avoid missing observations upon logarithmic transformation for estimation of Regression 2. The actual total payment received by each coordinator during the trial is $R = F + VD$, where D is the actual dogs vaccinated (and the basis for the log-transformed dependent variable in Regressions 1 and 2).

The primary outcome is number of dogs vaccinated at the mass dog vaccination events (D, *Dogs Vaccinated*). Vaccination records were collected by the vaccination team during/after vaccination events. Data were collected for two mass dog vaccination events held over two years (2017 and 2018) in each village. In addition, the study makes use of administrative data on dogs vaccinated in prior years (D^{M5} and D^{16}), as well as a short baseline survey conducted with potential village vaccination coordinators before job offers were made. The survey collected information on candidates' age, gender, employment status, and previous experience working with the village vaccination team. Summary definitions of all variables used in the analysis are provided in Table 2 and summary statistics are provided in the Appendix (Table S1). The summary statistics show that coordinators were generally middle-aged, with a mean age of 37.41 years. The vast majority were male (97.6 percent), and the majority had only a primary school education. Only 15 percent of the coordinators had another form of employment. Most of the coordinators were new to the team, with only 17.5 percent having worked with the vaccination team before. Most had some form of transportation, either a bicycle (29.3 percent) or a motorbike (54.6 percent).

Randomization balance for the analysis sample is presented in Table 3. Column 1 shows the number of observations, means and standard errors for each variable in villages assigned to the fixed payment scheme. Columns 2 and 3 show the same statistics for villages assigned to the mixed payment scheme and variable payment scheme respectively. Column 4 shows the F-statistics for an F-test for joint orthogonality of each balance variable across all treatment arms. There is an imbalance in dog vaccination history, where villages assigned to the fixed payment scheme historically had higher levels of dog vaccinations by chance. There is also an imbalance in whether coordinators were employed elswewhere. Following common practice, the estimating equations control for the imbalanced variables in all regressions.[8]

5 Empirical strategy

In estimating treatment effects, the empirical strategy reflects two key research questions. First, the study aims to identify the relative effectiveness of three types of payment schemes: fixed pay only, variable pay only (i.e., piece rate), or a mixed payment, in which coordinators receive a fixed payment plus a variable

[8]Since the treatment is randomized, it is still uncorrelated with unobservables conditional on baseline dog vaccination and whether coordinators were employed elsewhere. It is also worth noting that the treatment effects go in the opposite direction of the imbalance in dog vaccination history. The villages assigned to the fixed payment scheme had higher levels of dog vaccination at baseline, while the mixed payment scheme increased dog vaccinations at follow up. There are no heterogeneous treatment effects in the imbalanced variables (not shown). Thus, the imbalance is unlikely to be driving the results.

Table 2: Variable Descriptions

Variable	Description
Fixed rate (F)	Fixed payment amount paid to a village vaccination coordinator for their work. 2021 U.S. Dollars unless otherwise noted. For F
Variable rate (V)	Variable pay rate; i.e., payment per dog. 2021 U.S. Dollars unless otherwise noted.
Dogs Vaccinated (D)	Primary outcome: Number of dogs vaccinated during trial for a given year/village.
Total payment (R)	$R = F + V \times D$. Amount actually paid to vaccination coordinators.
E[Total payment] ($\hat{R}$)	$\hat{R} = F + V \times D^{M5}$. Predicted total payment based on prior vaccination rates $D^M 5$. Used to randomize compensation (See Table 1).
Fixed Scheme (F^b)	Binary variable denoting whether payment scheme is a fixed payment only (yes=1, no=0).
Mixed Scheme (M^b)	Binary variable denoting whether payment scheme is a mixed payment including both fixed and variable components (yes=1, no=0).
Variable Scheme (V^b)	Binary variable denoting whether payment scheme is a fixed payment only (yes=1, no=0).
Vaccinated 2016 (D^{16})	total number of dogs that were vaccinated in each village in the 2016 mass dog vaccination campaign.
Vaccinated 2012-16 (D^{M5})	Average annual number of dogs vaccinated in each village over the five years 2012 through 2016. Only years when vaccinations took place were included in the mean for a given village.
Age	Age of the village vaccination coordinator (years).
Bicycle	Binary variable denoting whether the village vaccination coordinator has a push bike (yes=1).
Motorcycle	Binary variable denoting whether the village vaccination coordinator has a motorbike (yes=1).
Education	Categorical variable denoting education attainment of the village vaccination coordinator (did not complete primary, completed primary, did not complete secondary, completed secondary, or tertiary).
Prior Year	Binary variable denoting whether village coordinator was also the village coordinator in the previous year (yes=1, no=0).
Employed	Binary variable denoting whether the village vaccination coordinator has other employment (yes=1, no=0).
Year	year to which a data record applies. Indicator variables used, which equal 1 for the year indicated and 0 otherwise.
District	District to which a data record applies. Indicator variables used, which equal 1 for the district indicated and 0 otherwise.

Source: Author's description.
Note: This table describes the variables uses in the estimations in this study. Variable names are in italics, one-letter abbreviations are in parentheses where applicable.

Table 3: Randomization balance (analysis sample)

Variable	N	(1) Fixed Mean/(SE)	N	(2) Mixed Mean/(SE)	N	(3) Variable Mean/(SE)	N	F-test for balance across all groups F-stat/P-value
Expected total payment [USD]	52	10.777	242	10.335	52	10.489	346	1.090
		(0.270)		(0.129)		(0.269)		0.337
Fixed pay rate (F) [USD]	52	10.778	242	4.903	52	0.000	346	210.936***
		(0.276)		(0.197)		(0.000)		0.000
Variable pay rate (V) [USD]	52	0.000	242	0.052	52	0.111	346	37.773***
		(0.000)		(0.004)		(0.012)		0.000
Realized total payment [USD]	52	10.778	242	12.239	52	12.652	346	1.203
		(0.276)		(0.477)		(0.947)		0.301
ln(Dogs Vaccinated 2016)	52	5.246	242	4.935	52	4.823	346	6.160***
		(0.083)		(0.043)		(0.096)		0.002
ln(Dogs Vaccinated 2012-2016)	52	5.177	242	4.935	52	4.789	346	4.245**
		(0.095)		(0.045)		(0.092)		0.015
Coord. age	48	34.896	229	37.668	49	38.612	326	1.677
		(1.473)		(0.724)		(1.491)		0.188
Coord. has bike	52	0.308	242	0.289	52	0.308	346	0.059
		(0.065)		(0.029)		(0.065)		0.943
Coord. has motorbike	52	0.481	242	0.570	52	0.481	346	1.171
		(0.070)		(0.032)		(0.070)		0.311
Coord. educ. attainment	52	2.923	242	2.864	52	2.692	346	0.666
		(0.169)		(0.071)		(0.136)		0.515
Coord. previous vacc. experience	52	0.154	242	0.178	52	0.173	346	0.084
		(0.051)		(0.025)		(0.053)		0.919
Coord. employed elsewhere	51	0.216	242	0.161	51	0.039	344	3.451**
		(0.058)		(0.024)		(0.027)		0.033

Source: Authors' analysis based on data the authors collected for this study.
Note: This table display means and standard errors for key pre-treatment variables, by treatment group. The final column tests for statistical differences across the three treatment groups using a joint F test.

payment. The estimating equation is the following:

$$\ln(D_{it}) = \beta_0 + \beta_V V_{it}^b + \beta_M M_{it}^b + \beta_R \hat{R}_{it} + \beta_5 \ln(D_{i\bar{t}}^{M5}) + \beta_4 \ln(D_i^{16}) + \boldsymbol{\beta}_x{}' \mathbf{x}_{it} + \epsilon_{it} \tag{1}$$

where D_{it} (*Dogs Vaccinated*) is the number of dogs vaccinated in village i in year t, $\boldsymbol{\beta}$ are parameters to be estimated, V_{it}^b (*Variable Scheme*) is an indicator for variable pay only in village i in year t, and M_{it}^b (*Mixed Scheme*) is an indicator for a mixed payment scheme in village i in year t. Hence, β_V and β_M represent the approximate percentage difference in the number of dogs vaccinated under a variable or mixed pay scheme respectively, relative to the status quo of a fixed, lump sum payment scheme.[9] The equations controls for the cross-randomized total expected payment $\hat{R}_{it}$ (corresponding to R in Table 1) because the study aims to estimate the effect of the payment scheme holding the total expected payment constant. The equation also controls for the mean number of dogs vaccinated in the previous 5 years ($D_{i\bar{t}}^{M5}$). The randomized variable payment rate is conditional on this variable as described in Section 3.2 and Table 1. The equation additionally control for the number of dogs vaccinated in the village in pre-study year 2016 (D_i^{16}) and an indicator for whether the coordinator was employed elsewhere, to account for the imbalances shown in Table 3, and also to capture any annual dynamics relating to year to year variation in dog populations and/or vaccination activity that $D_{i\bar{t}}^{M5}$ averages over. The vector $\mathbf{x}_{it}$ includes year and district fixed effects and coordinator characteristics depending on the regression specification. Standard errors are clustered at the village level to account for serial correlation within villages.

The second research objective is to estimate the response to changes in the fixed or variable payment rates. The estimating equation is the following:

$$\ln(D_{it}) = \eta_0 + \eta_F \ln(F_{it}) + \eta_V \ln(V_{it}) + \eta_1 \ln(D_{it}^{16}) + \eta_2 \ln(D_{i\bar{t}}^{M5}) + \boldsymbol{\eta}_x{}' \mathbf{x}_{it} + \varepsilon_{it}, \tag{2}$$

where F_{it} represents the amount of the fixed payment offered to the coordinator in village i in year t (corresponding to the value F in Table 1 above). V_{it} represents the (piece rate) variable payment offered to the same coordinator (corresponding to the value V in Table 1). For villages in the fixed payment scheme, V_{it} is equal to zero. Conversely, for villages in the variable payment scheme, F_{it} is equal to zero. Because values of zero exist for V and F, one Tanzanian Shilling was added to avoid missing values of the logarithmic transformation. Villages in the mixed payment scheme have positive values for both F_{it} and V_{it}. Because both the dependent variable and the payment variables V and F are transformed to their natural logarithms for estimation, their associated parameters are the elasticities of dog vaccination with respect to fixed payment and variable payment amounts, respectively.

The equation again controls for dogs vaccinated in 2016 (D_{it}^{16}) to account for the imbalance shown in Table 3 and the previous 5 years mean number of dogs vaccinated ($D_{i\bar{t}}^{M5}$, corresponding to the value D in

[9] These are approximate differences. A consistent, unbiased estimate can be generated using the Kennedy transformation (Kennedy, 1983), but applying this transformation does not meaningfully change the results.

Table 1 above). Note that the equation does not include the total expected payment R_{it} (corresponding to the value R in Table 1 above) because it is a linear combination of F_{it}, V_{it}, and $D_{i\bar{t}}$. The equation also controls for fixed effects over time and Districts, as well as coordinator characteristics depending on the specification, all of which are represented by $\mathbf{x}_{it}$ in Equation 2. Standard errors are again clustered at the village level to account for serial correlation within villages.

6 Results

Regression results are first shown for the categorical treatment effects of payment scheme on dog vaccination outcomes, followed by regression results that provide elasticities for fixed and variable payments. These main results are followed by specification and robustness tests and analyses that support the focus on the regressions selected as main results.

6.1 Main results

Table 4 provides the results of the regressions described by Equation 1, which estimate the categorical effect of each of the three pay schemes: a pure fixed payment (the base case), a mixed payment with both a fixed and variable component, and a pure variable payment. Because the dependent variable is a logarithmic transformation of dogs vaccinated, the estimated parameters of *Mixed Payment Scheme* and *Variable Payment Scheme* approximate the percentage difference in dog vaccinations from a pure fixed payment. The regressions in columns labelled (1), (2), and (3) differ in the control variables included: Regression (1) includes only a year fixed effect; regression (2) includes both a year and a district fixed effect; and regression (3) additionally includes coordinator characteristics identified in the table footnote and described in Table 2. The results suggest that a mixed payment scheme increases the number of dog vaccinations by 16 percent relative to a fixed payment scheme.[10] The parameter estimates for the mixed payment scheme are different from zero at the 5% significant level in each regression. The parameter estimates associated with the variable payment scheme are also positive, suggesting a best estimate that the pure variable payment scheme induces dog vaccinations 8 to 10 percent higher than under a pure fixed payment, but these estimates are not different from zero at conventional significance levels.

Comparing the estimated coefficients for the mixed scheme and the variable scheme implies that the mixed scheme increases dog vaccinations by 7 to 8 percent relative to a pure variable payment, though this difference also is not statistically significant. This result is consistent with Frisch and Dickinson (1990), who find in an experimental setting that while a low level of incentive pay leads to higher performance, there was statistically little effect of a higher variable rate relative to fixed rate on productivity. The results are consistent across both years of the experiment: Appendix Table S2 shows that the treatment

[10] The percentage difference calculated using the Kennedy transformation for dummy variable parameters in loglinear regressions Kennedy (1983) is in all cases very similar to the parameter estimate, so parameter estimates are reported.

Table 4: Treatment Effect of Payment Scheme on Dogs Vaccinated.

Dependent Variable:	ln(Dogs vaccinated)		
	(1)	(2)	(3)
M^b (*Mixed Scheme*)	0.178^{**}	0.171^{**}	0.159^{**}
	(0.0762)	(0.0779)	(0.0758)
V^b (*Variable Scheme*)	0.112	0.0949	0.0812
	(0.0946)	(0.0946)	(0.0899)
$\ln(D^{16})$	0.588^{***}	0.556^{***}	0.678^{***}
	(0.120)	(0.119)	(0.105)
$\ln(D^{M5})$	0.302^{**}	0.302^{**}	0.164
	(0.132)	(0.138)	(0.123)
Year FE	X	X	X
District FE		X	X
Coordinator Characteristics			X
Observations	346	346	326
M^b-V^b	0.0662	0.0757	0.0777
p-val: M^b-V^b	0.311	0.224	0.210

Source: Authors' analysis based on data the authors collected for this study.

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses, clustered at the village level. M^b and V^b are binary indicator variables indicating mixed and variable payment only schemes, respectively. The base case is fixed payment only. All regressions include controls for dogs vaccinated in 2016, mean number of dogs vaccinated in previous years, total expected payment, coordinator employment status, and randomization block. Coordinator characteristics include age, type of transportation available, education level, and previous experience as a coordinator. Where district fixed effects are included, the intercept corresponds to year=2017 and District=Bunda.

Table 5: Treatment Effect of Pay Rates on Dogs Vaccinated.

Dependent Variable:	ln(Dogs vaccinated)		
	(1)	(2)	(3)
ln(Fixed pay rate) [USD]	0.0117	0.0126*	0.0117
	(0.00788)	(0.00755)	(0.00741)
ln(Variable pay rate) [USD]	0.0416**	0.0393**	0.0351*
	(0.0188)	(0.0193)	(0.0187)
Year FE	X	X	X
District FE		X	X
Coordinator Characteristics			X
Observations	346	346	326

Source: Authors' analysis based on data the authors collected for this study.
Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses, clustered at the village level. All regressions include controls for dogs vaccinated in 2016, total expected payment, mean number of dogs vaccinated in previous years, coordinator employment status, and randomization block. Coordinator characteristics include age, type of transportation available, education level, and previous experience as a coordinator. Where year and district fixed effects are included, the intercept corresponds to year=2017 and District=Bunda.

effects are not statistically different in the second year of the experiment relative to the first.

Table 5 includes results for three related regressions based on Equation 2. Instead of including indicator variables for each of the three types of payment schemes, these regressions include the logarithms of the variable and fixed payment amounts offered to village coordinators, along with the same sets of control variables as the regression in Table 4. The parameter estimates associated with $ln(F)$ and $\ln(V)$ represent the elasticity of dog vaccinations with respect to the fixed or variable payment that coordinators received.

All three regressions in Table 5 show a small weakly positive effect of higher fixed payments on dog vaccinations of around a 0.01 percent increase in vaccinations in response to a 1 percent increase in fixed payment ($\ln(F)$), with one of three elasticity estimates statistically significant at 10 percent (regression (2) in Table 5). In comparison, the variable pay rate ($\ln(V)$) has a still small but larger effect, inducing about a 0.04 percent increase in dog vaccinations in response to a one percent increase in variable pay, with all three estimates significant at the 10 percent level or better. These results are also consistent across both years of the experiment (Appendix Table S2). These results are consistent with a hypothesis that the piece-rate component of a coordinator's payment based on the number of dogs vaccinated provides a stronger incentive for village coordinators to recruit dog owners to participate in vaccination clinics than does the fixed rate component.

6.2 Robustness and specification analysis

Various robustness checks were carried out. First, the log-log regression form was chosen through a series of functional form comparisons. Specification tests based on the box-Cox regressions reject both linear and loglinear models based on the generalized Box-Cox regression, but the χ^2 statistic was smallest for the log-log specifications ($\chi^2 = 86$ for log-log compared to $\chi^2 = 128$ for the linear model). Further, while Box-Cox parameter estimates are neither marginal effects nor elasticities, the parameters on fixed pay and variable pay in the Box-Cox regressions are qualitatively similar to the loglinear regression in that they are both positive, but only the variable payment parameter estimate is significant at conventional levels (p=0.059). The Shapiro–Wilk test for normality of errors is rejected for all specifications, and the Breusch–Pagan/Cook–Weisberg test rejects homoskedasticity for both log-log and linear models. robust standard errors clusted at the village level are used to account for heteroskedasticity. The main results are also robust to using dog vaccination levels, inverse hyperbolic sine transformed dog vaccinations, and winsorized dog vaccinations as alternative outcomes (Appendix Table S3). Robustness based on permutation tests to determine statistical significance is also shown (Appendix Table S4). Constant Elasticity of Substitution (CES) specifications were attempted, but they resulted in non-convergence or unstable parameter estimates.

Appendix Table S5 shows the results for all districts, including Bariadi District where significant dog death occurred, as described in Section 4. As might expected, since the treatment was not implemented as intended due to unanticipated changes in the dog population, the inclusion of this district attenuates the effects.

The field research team provided an offer of a fixed, variable, or mixed payment to prospective coordinators according to the randomization described in Section 3.2. some individuals declined the offer. Once an individual declined an offer, the field research team did not renegotiate for another (presumably higher) offer with the same individual. Instead, they identified another candidate and provided the same (randomized) offer. Of the individuals offered an opportunity to participate, the data suggest that 25 (5.75% of offers) declined. Of these, 9 refusals (2.07%) were in 2017 and 16 (3.68%) were in 2018. Out of the 16 refusals in 2018, 5 were from the Bariadi district (11 from the other 5 districts). In contrast, no refusals occurred in Bariadi 2017. Refusals were spread over 24 villages (including those in Bariadi); 12% in variable pay only villages, 20% in fixed pay only villages, and 68% in mixed pay villages, corresponding relatively closely with the randomized payment scheme distribution across villages of 12.5% variable pay and fixed pay respectively, and 80% mixed pay.

Unfortunately, missing data lead to uncertainty about the number of rejections summarized in the previous paragraph. Some of the records interpreted as rejections for the summary statistics above are included because records are missing for the variable that indicates whether a prospective coordinator was hired. Rejections were inferred to correspond to those cases in which (a) a rejection was identified explicitly or (b) hiring status was missing but a coordinator name is recorded. Records were not counted in these numbers if no payment offer was recorded or if no dog vaccination number was recorded.

Uncertainty about interpreting the missing data as offer rejections notwithstanding, the possibility of systematic bias due to coordinator refusals is examined using Heckman selection models for equations (2) in Tables 1 and 2. The results of these regressions are reported in Appendix Table S6, with Bariadi data omitted. The selection index equation for both regressions includes the logarithm of the offered fixed pay, variable pay, the log of the number of dogs vaccinated in 2016, and the interaction between the number of dogs vaccinated in 2016 and the log of variable pay. Coordinator characteristics are omitted because records are missing in most of the cases identified as rejections.

Table S6 shows that the main regression equation parameters in the Heckman model are very similar in magnitiude and significance as the main regressions in Tables 1 and 2. The selection equation for both Heckman regressions show that the magnitude of fixed pay has little explanatory power. By itself, the magnitude of variable pay has a weak negative effect on being hired (a positive effect on rejecting an offer). But the product of variable pay and the number of dogs vaccinated in 2016 has a strong positive effect on offer acceptance, and therefore a strong negative effect on the likelihood of rejecting an offer. This is an interesting result given that the product of the per-vaccination pay and the number of dogs vaccinated in a recent year (2016) can be taken as an estimate of the total variable payment that a coordinator might receive if vaccination numbers are correlated across years, as they are.

If Bariadi data are included in the Heckman model, the selection equation indicates a larger and stronger negative effect of variable pay and a stronger and larger positive effect of expected total variable pay (the product of actual variable rate offered and the number of dogs vaccinated in 2016). Fixed pay remains insignificant in the selection equations. These effects are stronger still if only 2018 data are included. These results provide support that coordinators were pessimistic about their prospects in Bariadi in 2018 given the drought-induced dog population crash that was reported.

Although the selection equations in the Heckman models provide interesting insight, there is no evidence of a selection effect on the main results. The null hypothesis of no selection effect is $\rho = 0$, where ρ is parameter associated with the inverse Mills ratio. The null hypothesis is not rejected in either equation ($p = 0.59$ and $p = 0.76$ for equations (1) and (2) respectively), suggesting no selection effect. Thus, the regression results presented in Tables 1 and 2 are not biased by self-selection of coordinators into (or out of) the sample. The results fail to reject the null hypothesis of no selection effect on the main equation even if Bariadi data are included.

Ultimately the log-log specifications in Tables 1 and 2 are chosen as a preferred specification for a practical balance between generality and interpretability in the corrent context, and results are qualitively robust to different specifications.

7 Conclusion

Domestic dogs are the primary source of rabies transmission to humans, and in order to control rabies within a community with endemic rabies in the domestic dog population, a certain proportion of dogs need to be immunized to achieve the state of herd immunity whereby dog-to-dog transmission will cease. Consequently, the number of dogs that remain unvaccinated following a vaccination campaign is important because the number of susceptible dogs in a community will determine whether rabies is sustained in the population and therefore sustain risk of transmission to people and other animals.

The results suggest that pay-for-performance incentives for village vaccination coordinators increase the number of dogs vaccinated at central point vaccination clinics. To the extent that these incentives are implemented, they can help reduce rabies transmission and have positive impact on human and animal health outcomes in this setting. The effects are modest in size, but are consistent with theory in the sense that variable piece-rate payments have a larger and statistically stronger impact on performance than a fixed payment component conditional on participation. A mixed scheme including a fixed component induces higher effort than a pure performance-based scheme, a result consistent with the findings of (Frisch and Dickinson, 1990). In light of the literature on contract design in principle-agent settings, if a mixed payment scheme is preferred to strict variable pay by risk-averse village coordinators, they may have an incentive to perform well in hopes of being hired again in future years (Bonner and Sprinkle, 2002; Lazear and Shaw, 2007). Given the range of payments offered, participation of coordinators was not significantly affected by payment, so the results should be interpreted primarily as an incentive payment to support increased dog vaccination rates conditional on community coordinator participation. Presumably, if much lower fixed and/or variable payments had been offered, participation could have been affected by the magnitude of payment offers.

Another dimension of the effectiveness of community support staff is the tools at their disposal to carry out their task of promoting participation in the vaccination event. It could be that providing communications tools might increase the marginal effect of incentive payments on outcomes. To illustrate this point, Regression Tables 1 and 2 each report one regression with coordinator characteristics. These parameter estimates are not shown and none of them are statistically significant at conventional levels. However, in exploratory regressions, an interaction between $\ln(V)$ and a variable indicating motorcyle use for coordination is weakly positive relative to a base case of foot travel only. This is suggestive that the marginal effectiveness of the incentive payment may be higher with more effective transport. This interpretation should be considered with care because transportation mode is chosen by the coordinator based on their opportunity set, which may be conflated with ability or ambition. Nonetheless, it is a reasonable conjecture that transport or other tools to improve communication effectiveness might increase the marginal effect of an incentive payment, and the study does find some weak evidence to support this.

The findings of this study also have implications for mass drug administration beyond the control of human rabies — wherever the health outcomes of an intervention depend on the proportion of a population reached and on the effort of a paid workforce. For example, the mass delivery of drugs to communities affected by neglected tropical diseases such (i) soil transmitted helminths (in which de-worming drugs are typically delivered through school based programs (World Health Organization, 2011); (ii) trachoma, the world's leading causes of infectious blindness, which can be controlled through the mass distribution of antibiotics to affected communities (Organisation mondiale de la Santé, 2022); and (iii) onchocerciasis or river-blindness, in which population-based treatment with the antiparasitic drug ivermectin is the core strategy with a minimum requirement of 80 percent therapeutic coverage required to achieve elimination (World Health Organisation, 2022).

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Data availability

Cleaned data and Stata code sufficient for replication are available in the online Supplementary Data section in the files named WBER-2023-242_R1_StataData.dta and WBER-2023-242_R1_StataCode.do

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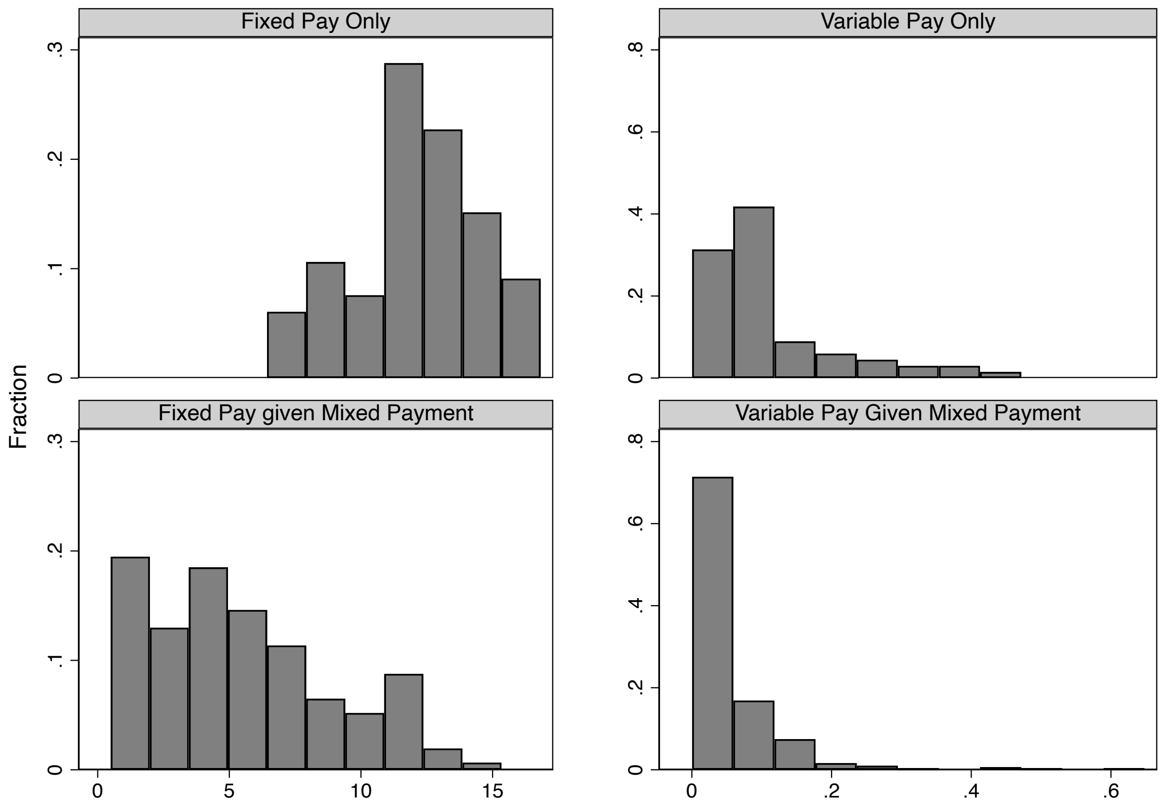
Supplementary Tables and Figures

Figure S1: Histograms of variable (V) and fixed (F) pay rates by payment scheme.



Authors' analysis based on data the authors collected for this study.

Table S1: Summary Statistics

	(1)				
	count	mean	sd	min	max
Expected total payment [USD]	348	10.42	1.997	6.861	13.69
Fixed pay rate (F) [USD]	348	5.760	4.561	0	15.34
Variable pay rate (V) [USD]	348	0.0605	0.0815	0	0.589
Realized total payment [USD]	348	13.73	7.732	4.799	107.8
Dogs Vaccinated (D)	348	196.0	136.2	11	1095
Dogs Vaccinated 2016	348	176.5	125.1	16	1145
Dogs Vaccinated 2012-2016	348	176.8	125.2	15.17	1044.5
Coord. age	328	37.41	10.78	18	68
Coord. male	327	0.976	0.155	0	1
Coord. did not complete primary school	348	0.0201	0.141	0	1
Coord. completed primary school	348	0.537	0.499	0	1
Coord. attended secondary school	348	0.118	0.323	0	1
Coord. completed secondary school	348	0.230	0.421	0	1
Coord. employed elsewhere	346	0.150	0.358	0	1
Coord. previous vacc. experience	348	0.175	0.381	0	1
Coord. has bike	348	0.293	0.456	0	1
Coord. has motorbike	348	0.546	0.499	0	1

Source: Authors' analysis based on data the authors collected for this study.

Note: This table provides summary statistics for the data used in the estimating equations. "Coord." refers to the village vaccination coordinator.

Table S2: Treatment Effects by Year. Treatment effects are not statistically different in the second year of the experiment relative to the first as indicated by the insignificance of parameters associated with *YEAR=2018* $\times X$, where X is one of the four payment variables in columns (1) and (2).

Dependent Variable:	ln(Dogs vaccinated)	
	(1)	(2)
YEAR=2018	0.0290	-0.0124
	(0.104)	(0.132)
Mixed Payment Scheme=1	0.152	
	(0.0961)	
Variable Payment Scheme=1	0.110	
	(0.114)	
YEAR=2018 × Mixed Payment Scheme=1	0.0371	
	(0.120)	
YEAR=2018 × Variable Payment Scheme=1	-0.0307	
	(0.148)	
Expected total payment [USD]	0.00627	
	(0.0116)	
ln(Fixed pay rate) [USD]		0.0124
		(0.0107)
ln(Variable pay rate) [USD]		0.0481**
		(0.0242)
YEAR=2018 × ln(Fixed pay rate) [USD]		0.000678
		(0.0148)
YEAR=2018 × ln(Variable pay rate) [USD]		-0.0163
		(0.0305)
constant	0.659*	0.894**
	(0.378)	(0.355)
District FE	X	X
Observations	346	346

Source: Authors' analysis based on data the authors collected for this study.

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses, clustered at the village level. M^b and V^b are binary indicator variables indicating mixed and variable payment only schemes, respectively. The base case is fixed payment only. All regressions include controls for dogs vaccinated in 2016, coordinator employment status, mean number of dogs vaccinated in previous years, total expected payment, and randomization block. Where district fixed effects are included, the intercept corresponds to year=2017 and District=Bunda.

Table S3: Effect of Payment Scheme on Dogs Vaccinated: Alternative Transformations of Dependent Variable

	(1) Dogs Vaccinated (D)	(2) Dogs Vaccinated (IHS)	(3) Dogs Vaccinated (Wins)
M^b (*Mixed Scheme*)	31.12***	0.171**	23.21**
	(11.25)	(0.0779)	(11.43)
V^b (*Variable Scheme*)	18.61	0.0949	10.54
	(14.64)	(0.0946)	(14.78)
District FE	X	X	X
Observations	346	346	346

Source: Authors' analysis based on data the authors collected for this study.

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses, clustered at the village level. The dependent variables in each column are defined as follows: Column 1 is the untransformed level of dog vaccinations; Column 2 is the inverse hyperbolic sine transformation of dog vaccinations; Column 3 is dog vaccinations winsorized at the 99% level. M^b and V^b are binary indicator variables indicating mixed and variable payment only schemes, respectively. The base case is fixed payment only. All regressions include controls for dogs vaccinated in 2016, coordinator employment status, mean number of dogs vaccinated in previous years, total expected payment, and randomization block. Where year and district fixed effects are included, the intercept corresponds District=Bunda.

Table S4: Effect of Payment Scheme: Permutation Tests

	Results Coefficient	p-value	SE(p)	CI(lower)	CI(upper)
MixedPay	.158373	.0452	.0020774	.0411283	.0492717
VarPay	.0823871	.7284	.0044478	.7196824	.7371176

Source: Authors' analysis based on data the authors collected for this study.

Note: Results are shown from a Monte Carlo permutation test with 10,000 permutations for our preferred specification. This includes controls for dogs vaccinated in 2016, total expected payment, mean number of dogs vaccinated in previous years randomization block, district fixed effects, year fixed effects, and coordinator age, type of transportation available, education level, employment status, and previous experience as a coordinator.

Table S5: Treatment Effect of Payment Scheme including all districts

Dependent Variable:	ln(Dogs vaccinated)		
	(1)	(2)	(3)
Mixed Payment Scheme	0.137*	0.0905	0.0677
	(0.0736)	(0.0694)	(0.0681)
Variable Payment Scheme	0.108	-0.00646	-0.0362
	(0.102)	(0.0858)	(0.0828)
Year FE	X	X	X
District FE		X	X
Coordinator Characteristics			X
Observations	432	432	407

Source: Authors' analysis based on data the authors collected for this study.

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses, clustered at the village level. All regressions include controls for dogs vaccinated in 2016, total expected payment, mean number of dogs vaccinated in previous years, coordinator employment status, and randomization block. Coordinator characteristics include age, type of transportation available, education level, and previous experience as a coordinator. Where year and district fixed effects are included, the intercept corresponds to year=2017 and District=Bunda.

Table S6: Sample Selection: Heckman model

Dependent Variable: ln(Dog Vaccinated)	ln(Dogs vaccinated)	
	(1)	(2)
Mixed Payment Scheme	0.170**	
	(0.0722)	
Variable Payment Scheme	0.0911	
	(0.0867)	
Expected total payment [USD]	0.0163	
	(0.0112)	
ln(Dogs Vaccinated 2016)	0.689***	0.676***
	(0.104)	(0.105)
ln(Dogs Vaccinated 2012-2016)	0.173	0.212*
	(0.122)	(0.125)
Randomization block	0.0605	0.0709
	(0.0872)	(0.0865)
ln(Fixed pay rate) [USD]		0.0117
		(0.00735)
ln(Variable pay rate) [USD]		0.0373**
		(0.0180)
Constant	0.546	0.854***
	(0.347)	(0.313)
Selection Dependent Variable: hired		
ln(Fixed pay rate) [USD]	0.0149	0.0150
	(0.0319)	(0.0319)
ln(Variable pay rate) [USD]	-0.599	-0.596
	(0.395)	(0.392)
ln(Dogs Vaccinated 2016)	0.622**	0.620**
	(0.245)	(0.243)
ln(Variable pay rate) [USD]	0.125*	0.126*
× ln(Dogs Vaccinated 2016)	(0.0751)	(0.0746)
Constant	-1.354	-1.343
	(1.151)	(1.141)
$\hat{\rho}$	0.0585	0.0334
	(0.110)	(0.118)
$ln(\sigma)$	-0.877***	-0.874***
	(0.0572)	(0.0555)
Year FE	X	X
District FE	X	X