WHAT DETERMINES HIV PREVENTION COSTS AT SCALE? EVIDENCE FROM THE AVAHAN PROGRAMME IN INDIA

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ABSTRACT

Expanding essential health services through non-government organisations (NGOs) is a central strategy for achieving universal health coverage in many low-income and middle-income countries. Human immunodeficiency virus (HIV) prevention services for key populations are commonly delivered through NGOs and have been demonstrated to be cost-effective and of substantial global public health importance. However, funding for HIV prevention remains scarce, and there are growing calls internationally to improve the efficiency of HIV prevention programmes as a key strategy to reach global HIV targets. To date, there is limited evidence on the determinants of costs of HIV prevention delivered through NGOs; and thus, policymakers have little guidance in how best to design programmes that are both effective and efficient. We collected economic costs from the Indian Avahan initiative, the largest HIV prevention project conducted globally, during the first 4 years of its implementation. We use a fixed-effect panel estimator and a random-intercept model to investigate the determinants of average cost. We find that programme design choices such as NGO scale, the extent of community involvement, the way in which support is offered to NGOs and how clinical services are organised substantially impact average cost in a grant-based payment setting. © 2016 The Authors. *Health Economics* published by John Wiley & Sons Ltd.

1. INTRODUCTION

The UNAIDS strategic investment framework for an effective response to human immunodeficiency virus (HIV)/AIDS proposes the scale-up of HIV prevention for key populations as one of its core interventions (Schwartländer *et al.,* 2011). This prioritisation is supported by strong evidence of the cost-effectiveness of HIV prevention to key populations (Vassall *et al.,* 2014). However, resources to expand HIV prevention to all who may benefit from it remain scarce. Because of the recent flat lining of development assistance for health, increased attention has been placed on identifying potential economic efficiency (achieving optimal HIV prevention service provision at the lowest cost) gains in HIV prevention in low-income and

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middle-income countries, in order to reduce the funding gap and ensure value for money (Murray *et al.,* 2012). For example, several global funding bodies are now considering programmes to promote efficiency and/or the setting of benchmark costs (The Office of the US Global Aids Coordinator, 2014).

Understanding the drivers of costs of HIV prevention is essential for those implementing HIV prevention programmes to design interventions that are both effective and economically efficient (Marseille *et al.,* 2004; Marseille *et al.,* 2007b). Empirically based cost functions can be used in resource allocation models that seek to optimise resource allocation between packages of interventions at different scales. Cost functions are also of critical importance to resource needs estimates more generally (Over *et al.,* 2006). Finally, cost functions can help those monitoring the efficiency of HIV programmes, and understanding the drivers of costs can help programme managers identify areas of efficiency improvement and take corrective action (Schwartländer *et al.,* 2011).

However, the dearth of cost and programmatic data required to conduct such analyses has resulted into very few reports examining the costs and efficiency of HIV services using econometric methods (Marseille *et al.,* 2012; Menzies *et al.,* 2012; Rosen *et al.,* 2008). There are only a few costing studies of HIV prevention projects, and most of these available data sets contain a limited number of observations preventing from conducting any multivariate analysis and have a cross-sectional nature. In particular, little is known about the drivers of costs above the service level, with previous studies focusing on the determinants of service delivery site costs only. Moreover, most previous studies examining cost drivers of HIV services in low-income and middle-income country have not been able to fully develop models that explore the determinants of costs in the non-government sector; despite the increasing reliance of both non-government organisations (NGOs) and community-based organisations to expand essential health services in those countries.

This study therefore aims to begin to address this gap by learning lessons from the Avahan project in India, one of the largest HIV prevention project in the world. Launched in 2003 by the Bill & Melinda Gates Foundation (BMGF) in six Indian states (Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra, Manipur and Nagaland), Avahan's aim was to deliver HIV prevention to high-risk populations at scale. We therefore present here an investigation into the drivers of cost of the Avahan programme during scale-up in order to inform programme managers to design economically efficient HIV prevention services and to inform the design of HIV programmes that provide grants to NGOs more generally.

2. STUDY SETTING AND INTERVENTION DESCRIPTION

Avahan is one of the largest HIV prevention project in the world. NGOs are provided grants by Avahan through state lead partners (SLPs) to build a relationship with key populations (female sex workers (FSWs) and high-risk men who have sex with men or transgenders) in order to provide HIV prevention services. The package of HIV prevention services provided includes outreach through peers, behaviour change communication, condom distribution, clinical services for sexually transmitted infections (STIs), community mobilisation, advocacy and enabling environment activities. Peer educators provided services to about 25–50 people each, sharing prevention information, distributing supplies (condoms and lubricants) and providing referral for STI management. STI clinics followed standard protocols for STI management. Community mobilisation, advocacy and enabling environment activities varied across the sites and included the formation of self-help groups, various drop-in centre (DIC) events, skills training, legal literacy workshops, police and stakeholder sensitisation, crisis response teams and access to social entitlements. HIV prevention across all four states was guided by a common minimum programme. These included a set of implementation standards for technical and managerial areas, project milestones, a common management framework and a common set of indicators. Beyond this, there was flexibility to adapt services based on local context.

In the four study states (Andhra Pradesh, Karnataka, Tamil Nadu and Maharashtra), the Avahan initiative was implemented by 138 NGOs, supported by six SLPs and pan-Avahan capacity building partners (contracted by the BMGF, which also had a national level office at Delhi). SLPs provided technical assistance to develop programme strategies, developed communication materials, enhanced the expertise of NGO staff, provided supportive supervision and supported the purchase and distribution of commodities. At the national level, Avahan

developed over-arching programme strategies and organised annual partners meetings to coordinate with Indian authorities. The national level office also developed and maintained a computerised monitoring and information system, provided financial oversight and monitored programme evaluation. International and national technical assistance was primarily focused on enhancing the expertise to deliver STI services, improving interpersonal communication and providing support for advocacy and community mobilisation.

Avahan achieved an exceptionally rapid pace of scale-up of HIV prevention services, going from a coverage of 22 000 persons covered in December 2003 to 280 000 persons reached per year in December 2007 (Bill and Melinda Gates Foundation, 2008). In total, in the data we collected, we observe that 725 040 high-risk persons (FSWs and their clients and men who have sex with men) were reached between 2004 and 2007, 177 million condoms were directly distributed by Avahan NGOs and 529 381 STI visits were provided. Extensive research has been conducted to evaluate the impact and cost-effectiveness of the Avahan programme. Pickles *et al.* (2013) reported decline in FSW HIV prevalence and between 142 and 2092 FSW HIV infections averted per district, with twofold to ninefold more among FSW clients. Correspondingly, Vassall *et al.* (2014) found a mean incremental cost per HIV infection averted of $US785 and a mean incremental cost per disability-adjusted life year averted of $US46 well below a willingness to pay threshold of one gross domestic product per capita of around $US1500 (data.worldbank.org) Future antiretroviral treatment cost savings over the lifetime of the FSW cohort exposed to Avahan were estimated to be over $US77 million. This is modest compared with the total health expenditure in India but important in a context with around $US20 health expenditure per capita (Organisation of Economic Co-Operation and Development, 2014).

3. METHODS

3.1. Cost data

Avahan has produced one of the largest cost data set globally; further details can be found in Chandrashekar *et al.* (2014). Cost data were collected from 138 NGOs in 64 districts of four Indian states over 4 years from 2004 to 2007. Costs were collected from NGOs, SLPs, the BMGF Avahan office and pan-Avahan capacity building partners. Cost data were collected prospectively using a top–down approach to allocate costs to NGOs and specific HIV prevention activities. The same costing method was used across NGOs and over time, limiting bias resulting from the heterogeneity of the costing method. Every NGO partner was automatically included in the sample, allowing us to have an exhaustive sample of the NGOs in the Avahan programme over the period considered. Expenses prior to the first person being reached by the programme were treated as start-up costs and were annuitised. Costs included all recurrent costs (personnel costs, building operating expenses, travel expenses, STI supplies, monitoring costs, information education and communication costs, training costs, condom supplies and indirect expenses) and capital costs (buildings, equipment, furniture, vehicles, initial training, insurance and deposits and start-up costs).

Methods for allocating costs above the NGO level to NGOs were derived based on programme records, expenditures reports and interviews with BMGF Avahan and SLP staff. The first step was to allocate national level programme costs to each SLP. This was carried out first by allocating specific grants to each SLP and then for general programme management costs by using expenditure reports and mapping estimates of the key population covered by each SLP (the method reported by BMGF staff to be used for budget/grant allocation to each SLP). Thereafter, SLP costs (including BMGF costs) were first allocated to specific activity areas (for example, programme management and expertise enhancement) within the SLP. This was carried out primarily on the basis of the description provided in detailed salaries reports and expenditure records, and where the allocation was not clear, interviews with SLP staff were conducted. Thereafter, an allocation criterion for each activity cost was applied to allocate the cost to NGOs. The criteria used were derived after extensive interviews with staff on how they allocated their time and resources among NGOs. In the main, the allocation criterion used was either an equal division of cost or an allocation based on estimated population size covered by the NGO. This latter measurement does not

necessarily measure true output of each NGO, as they did not always cover the entire population in need, and there was some measurement error. However, this was the best information SLPs had to hand when allocated resources such as communication materials. For some activities, costs could be directly allocated as the expenditure records including this description. This latter situation particularly applied in the case of support and supervision costs where detailed travel records were often described. Items such as STI drugs management could also be directly allocated based on order levels.

At the NGO level, costs were disaggregated by activity and input type. Field visits and time sheets were conducted in order to estimate the share of labour costs allocated to different NGO sub-activities (outreach, community mobilisation, etc.). Unpaid volunteer time was estimated by the amount of time spent on the project and calculated based on peer educator salary. Other donated goods, such as commodities were valued using market prices. Average cost per person reached at least once by the NGO over the year was calculated using the numbers of persons reached obtained from Avahan's central management information system. All costs are presented in $US 2008 in Table I.

3.2. Model specification

We investigated the determinants of average cost, that is, the cost per person reached. We analyse the determinants of two types of costs: (1) average NGO costs AC_ngo_{it} include all the costs incurred at the NGO level and (2) programme average cost AC_tot_{it} that is made of the sum of NGO cost, SLP cost and national level cost. Average cost for each year (AC_{it}) for NGO i in year t is described in terms of NGO and programme costs (the sum of NGO cost, SLP cost and national programme level cost) in order to investigate separately the determinants of NGO and programme average costs. The major share of programme average cost (73%) incurred above the level of service delivery (Chandrashekar *et al.,* 2014). The average programme cost across

Table I. Total economic costs by organisational level and input 2004 to 2008 ($US 2008)

Input	2004–2005	%	2005–2006	%	2006–2007	%	2007–2008	%	Total	%
				State lead partner						
Capital cost	321 707	10	710 314	9	740 217	8	828 565	9	2 600 803	9
Personnel	1 461 108	44	3 326 119	43	3 346 931	37	3 794 869	40	11 929 028	40
Travel	260 931	8	583 292	8	552 527	6	794 457	8	2 191 207	7
Building operating and maintenance	128 889	4	685 979	9	875 273	10	839 026	9	2 529 167	9
Commodities and supplies	315 164	9	928 084	12	1 137 772	13	1 130 847	12	3 511 867	12
Monitoring and evaluation	473 509	14	578 504	7	726 454	8	430 071	5	2 208 540	7
Trainings	302 135	9	612 627	8	1 248 216	14	1 027 480	11	3 190 457	11
Indirect expenses	69 596	2	349 340	4	389 641	4	658 639	7	1 467 216	5
Grand total	3 333 038	100	7 774 257	100	9 017 032	100	9 503 954	100	29 628 284	100
				District level (NGO)						
Capital cost	335 362	15	771 906	11	986 912	9	1 242 946	9	3 337 127	10
Personnel	988 547	43	3 248 881	47	4 557 267	43	6 335 755	44	15 130 451	44
Travel	148 326	6	456 460	7	696 232	7	973 823	7	2 274 841	7
Building operating and maintenance	161 702	7	386 134	6	515 022	5	1 109 663	8	2 172 521	6
Commodities and supplies*	430 133	19	1 724 818	25	3 264 794	31	3 938 449	27	9 358 194	27
Monitoring and evaluation	119 348	5	91 711	1	89 520	1	152 707	1	453 286	1
Trainings	103 761	5	228 316	3	388 067	4	647 648	4	1 367 792	4
Indirect expenses	7958	0	33 313	0	151 883	1	140 755	1	333 906	1
Grand total	2 295 137	100	6 941 539	100	10 649 697	100	14 541 746	100	34 428 119	100

IEC, information, education and communication; NGO, non-government organisation.
*Drugs, condoms and IEC materials.

the whole programme, between 2004 and 2007 was $US362, but two NGOs had extreme values leading to a positive skew of the NGO average cost distribution of 13.92. Following this, to include extreme values and also remove skewness in the residuals, the average unit costs were log transformed.

Based on previous literature (Meyer-Rath and Over 2012; Siapka *et al.,* 2013; Dandona *et al.,* 2005; Chandrashekar *et al.,* 2010; Guinness *et al.,* 2005; Guinness *et al.,* 2007; Kumaranayake and Watts, 2000; Marseille *et al.,* 2007a; Menzies *et al.,* 2012; Rosen *et al.,* 2008), several potential categories of determinants of average cost were explored. The justification of covariates in each of these six categories is detailed in Table II.

Regarding the functional form, we tested a logarithmic form versus a quadratic functional form. We found that the logarithmic fit explains a larger share of the variance than the quadratic fit.[1] Despite the sound theoretical basis, empirically, a number of studies that have analysed average cost function of hospitals suggest that the cost function may be more consistent with an L-shaped curve (Lave and Lave, 1970). The econometric models used were thus defined using a logarithmic cost function (Vitaliano, 1987).

$$\text{Log } (AC_{it}) = \delta_0 + \delta_1 \ \log Y_{it} + \delta_2 \ q_{it} \ + \delta_3 \ O_{it} \ + \delta_4 \ C_{it} + \ \delta_5 \ E_{it} \ + u_i \ + e_{it} \qquad (1)$$

$$\text{Log } (AC_{it}) = \delta_0 + \delta_1 \ \log Y_{it} + \delta_2 \ q_{it} \ + \delta_3 \ O_{it} \ + \delta_4 \ C_{it} + \ \delta_5 \ E_{it} \ + \delta_6 \ E_i \ + \zeta_i \ + e_{it} \qquad (2)$$

where Y_{it} refers to scale or number of high-risk population reached, q_{it} are proxies for the quality of the services provided by the NGO, O_{it} refers to NGO's organisational characteristics, C_{it} are characteristics of high-risk groups reached, E_{it} and E_i are respectively environmental time-variant and time-invariant characteristics, e_{it} is an error term, u_i is the NGO fixed effect and ζ_i is an intercept at the NGO level.

Equation 1, our primary model, is estimated with a panel model given the structure of the data. A Hausman test (1978) was conducted in order to choose between a panel estimator with fixed effects and random effects. The test rejected the null hypothesis that random effects provide consistent estimates, and a panel estimator with NGO fixed effects u_i was therefore selected. Conversely to a random effect model, the fixed-effect estimator allows for arbitrary correlation between NGO unobserved time-constant characteristics and the explanatory variables at any time period. The fixed-effects approach thus allowed us to remove the effect of NGOs' time-constant characteristics from the covariates so that the estimated coefficients of the fixed-effects model are not biased because of omitted time-invariant NGO characteristics. This may be important as theoretically time-constant unobserved characteristics of the NGOs may have a strong effect on average costs, and it may be difficult to know *a priori* how their omission may affect the results. In fact, some NGOs may have better intrinsic characteristics than others. For example, some NGOs may combine both better management (leading to cost minimisation) and a higher ability in targeting vulnerable population (leading to higher scale), and in which case, the omission of these characteristics will lead to an overestimation of economies of scale. But other NGOs may have strong management but may lack of skills to increase scale or vice versa, resulting in an underestimation of economies of scale.

By using a fixed-effect estimator, we implicitly assume that NGO-unobserved heterogeneity is correlated with our covariates. Because of this, any explanatory variable that is constant over time for each NGO becomes swept away by the fixed-effects transformation. This is an issue when one is interested in explanatory variables that are constant over time. For instance, characteristics of the district were obtained from round 3 (2007–2008) of the District Level Household and facility Survey. In order to enable the coefficients of time-invariant explanatory variables to be estimated, Equation 2 is estimated using a random-intercept model. Note that we have also used a generalised estimating equation using a gamma distribution to estimate this model that provided similar results. These results are available upon request. To test multicollinearity, variance inflation factors (VIFs) are used. The VIF shows how much the variance of the coefficient estimate is being inflated by multicollinearity. The mean VIF was around 1.54 and the maximum was 2.4, which does not suggest high multicollinearity. Finally, it should be noted that the parameter δ_1 is interpreted as an elasticity[2] as both variables are log-transformed; other coefficients δ_n are transformed using $(100 * e^{\delta})$.

Table II. Variable description and expected effect on average cost

Variable name	Description	Expected effect	Justification
Scale (Y_{it})			
log Y_{it}	Number of persons who have had at least one contact with a peer educator	−	Economies of scale
Quality of outreach (q_{it})			
STI visits/Y_{it}	Number of STI visits per person reached	+	Quality is expected to be positively correlated with cost.
Treated STI/Y_{it}	Number of STI treated per person reached	+ or −	Although quality is expected to be positively correlated with cost, STI services in NGOs with higher treatment levels may be delegated to referral clinic and may then result in NGO cost savings.
Condoms distributed/Y_{it}	Number of condom distributed per person reached	+	Quality is expected to be positively correlated with cost.
NGO organisational characteristics (O_{it})			
Members in community mobilisation/Y_{it}	Number of members of various programmes committees (community and non-community) per persons reached	−	Community mobilisation may decrease average cost through the participation of community to increase scale-up and through the reduction in stigma.
Share of management staff in total staff	Proportion of management staff in total staff	+ or −	Effect on costs results from the wage and productivity of this staff category.
Outreach clinic/Y_{it}	Number of outreach clinic per persons reached. Outreach clinic are periodic clinics conducted at different locations by mobile clinic teams, usually at a DIC/safe space identified by community. They provide field-based health care and only operate on selected days; unit is location of outreach clinic.	−	NGO can delegate services to experienced clinics that will conduct those services in a more efficient way.
DIC/Y_{it} * 10 000	DIC per 10 000 persons reached	−	DIC may affect negatively the cost as they provide an opportunity for the NGO to reach many high-risk persons at one time
Characteristic of high-risk population targeted (C_{it})			
FSW/Y_{it}	Share of FSWs in total reached population (that includes sex workers and men who have sex with men)	−	It may be cheaper to reach FSWs than men who have sex with men because of lower stigma.
Share of group-based FSW	Share of group based (brothel-based, lodge-based and Tamasha-based FSW) in total FSW reached	−	Reaching group-based sex workers may be cheaper than reaching street-based sex workers as peer educators may need to spend less time to reach the same quantity of sex workers.
Environmental time-variant characteristics (E_{it})			
Log of estimated population	Estimated number of high-risk population in the district	+ or −	Possibly acts as a barrier to NGO expansion. But NGOs located in areas with many high-risk persons could also experience some logistic and management issues.
NGOs per district	Number of NGOs in the district	+ or −	There could be some positive or negative externalities on the average cost depending on the density of the NGOs per district.
NGOs per SLP	Number of NGOs supported by the same SLP	+ or −	SLPs that only contract with a few NGOs could lack of experience; however, if the number of NGOs per SLP is too high, it may generate some managerial issues.
NGO replaced	Was coded 1 if the NGO was replaced by another NGO	+	May be a signal for high level of inefficiency. May capture corruption level and a lack of organisation.
Environmental time-invariant characteristics (E_i)			
Electricity	Percentage of households having access to electricity in the district	−	Electricity access may be a source of efficiency
Population	Inhabitants in the district	+ or −	

(*Continues*)

Table II. (Continued)

Variable name	Description	Expected effect	Justification
			Likely to depend on how this is correlated with the share of high-risk population in total population
Distance to nearest town	Average distance to nearest town in the district	+ or −	This may depend on the location of high-risk population in the intervention area of the NGO.
Wealth	Average wealth index of households in the district	+ or −	Wealth in the area should be correlated not only with better infrastructures but also with higher prices.
Access to drinking water	Percentage of households having access to drinking water in the district	−	Access to drinking water may be associated with the quality of infrastructures in the district.
Years in Avahan	Number of years in the Avahan initiative	+ or −	Experience may increase efficiency, but services may be expanded over time.
HIV experience	Coded 1 if the NGO had HIV experience before entering Avahan	−	NGOs with experience in HIV may have already worked with high-risk groups.
Year of experience	Year of experience of the NGO working as an NGO.	−	NGOs that are experienced may be more efficient.
Solo district	Takes the value of 1 if the NGO is alone to operate in the district, and the value of 0 if there is a co-intervention with other state AIDS control society intervention or a non-Avahan intervention	−	Competition between NGOs of different projects may be a source of efficiency.
SLP	State lead partner dummies	+ or −	Depending on the SLP characteristics

DIC, drop in centres; FSW, female sex workers; HIV, human immunodeficiency virus; NGO, non-government organisation; SLP, state lead partners; STI, sexually transmitted infection.

4. RESULTS

Descriptive statistics of all dependent variables and covariates are presented in Table III. In the data, the average yearly NGO cost is $US81, and the average yearly programme cost is $US362. On average, 1868 high-risk persons were reached by each NGO per year, and each person reached received 0.7 STI visit, 0.4 STI treatments and 248 condoms per year on average. Regarding the staff structure, the peer educators represent 79% of the total labour force in the NGO, while medical staff and management staff account for 11% and 10%, respectively. On average, 1.3% of the persons reached participated in community mobilisation and there are on average 27 DIC per 10 000 persons reached. FSWs represent 78% of the total number of persons reached. Among those FSW, 19% are group based. There are on average 2.6 NGOs in each district and 19 NGOs per SLP, and around 3% of the Avahan NGOs were replaced during the reporting period by another NGO. Forty-five percent of Avahan NGOs had a previous experience in working on HIV, and on average, NGOs have 3 years of experience in working for Avahan during the reporting period and 19 years of experience in working as an NGO.

4.1. Determinants of average cost at the NGO level

Table IV shows the determinants of NGO average cost. Models (1a) and (1b) present our primary model; the panel estimator with NGO fixed effects. In model (1b), the typology of sex workers reached is added as a covariate, and thus, column (1b) focuses only on the FSW population (explaining the drop in the number of observations). Results presented in models (2a) and (2b) are estimated with the random intercept estimator allowing the associations of time-invariant covariates to be explored. Model (2a) does not include SLP dummies, while model (2b) does, which allows to control for unobserved effects of the SLP.

Table III. Descriptive statistics

Variables	Obs.	Mean	Std. dev.	Min	Max
Average cost (AC_{it})					
NGO average cost (AC_ngo_{it}) in \$US	388	81.113	272.045	9.3	3870.8
Log of NGO average cost ($LogAC\_ngo_{it}$)	388	3.906	0.7291	2.230	8.261
Total average cost (AC_tot_{it}) in \$US	389	361.652	1931.44	36.8	32 056.4
Log of total average cost ($LogAC\_tot_{it}$)	389	5.0604	0.803	3.605	10.375
Scale (Y_{it})					
Number of persons reached (Y_{it})	388	1868.66	1729.984	20	12 071
Log of number of persons reached (log Y_{it})	388	7.148	0.973	2.996	9.399
Quality of outreach (q_{it})					
Number of STI visit per person reached (STI visit/Y_{it})	388	0.773	0.810	0	10.75
Number of treated STI per person reached (treated STI/Y_{it})	388	0.399	0.685	0	7.830
Number of condom distributed per person reached (condom distributed/Y_{it})	388	248.438	242.512	0	1561.993
NGO organisational characteristics (O_{it})					
Members in community mobilisation per person reached	388	0.013	0.035	0	0.469
Share of management staff in total staff	424	10.283	10.995	0	100.02
Outreach clinic per person reached	388	0.0002	0.0004	0	0.003
DIC for 10 000 persons reached	388	27.481	52.449	0	506.329
Characteristic of high-risk population targeted (C_{it})					
Share of FSWs among persons reached (%)	388	77.739	34.198	0	100
Share of group-based FSW among total FSW (%)	303	19.988	32.037	0	100
Environmental time-variant characteristics (E_{it})					
Log of estimated high-risk population	387	7.220	0.796	3.932	9.467
NGOs per district	492	2.652	2.188	1	10
NGOs per SLP	522	19.138	6.697	9	35
NGO was replaced	552	0.029	0.168	0	1
Environmental time-invariant characteristics (E_i)					
Electricity access in district (%)	492	0.780	0.158	0.290	1
Population in district (%)	492	3447.544	1632.698	720.842	8756.521
Distance to nearest town in district (%)	492	15.853	5.005	7	34.6
Wealth in district	552	0.058	0.420	−0.606	1.174
Drinking water access in district (%)	492	0.869	0.169	0.286	1
Years in Avahan	552	3	1.149	0	4
HIV experience of the NGO	444	0.450	0.498	0	1
Year of experience of the NGO	464	18.810	8.451	2	57
Only NGO in district (solo district)	469	0.537	0.499	0	1
2. SLP (ref 1. SLP)	552	0.116	0.320	0	1
3. SLP	552	0.101	0.302	0	1
4. SLP	552	0.145	0.352	0	1
5. SLP	552	0.203	0.402	0	1
6. SLP	552	0.289	0.454	0	1

AC, average cost; DIC, drop in centres; FSW, female sex workers; NGO, non-government organisation; SLP, state lead partners; STI, sexually transmitted infection.

4.1.1. Scale. Referring to our primary model in column (1a), we find a negative association between scale and unit cost. If NGO scale increases by 1%, unit cost decreases by 0.36%. This association is greater (0.4%) when we restrict the sample to sex workers (e.g. column 2a).

4.1.2. Quality of outreach. The number of STI visits per person reached and the number of condoms distributed per person reached have a positive association with NGO average cost (as shown in Figure 1(a)). An increase in one STI visit per person reached increases NGO average cost by 15%,[3] while distributing 100 additional condoms to every person reached results in an increase in NGO average cost by approximately 10%. Conversely, we find that the number of treated STIs per person reached is negatively correlated with NGO average cost.

4.1.3. NGO organisational characteristics. The share of management staff of overall NGO is positively correlated with NGO average cost, an increase in 1% in the proportion of management staff increased NGO average cost by 3%. Conversely, we also investigated the role of the proportion of other categories of staff (peer educators and

Table IV. Determinants of NGO average cost

	Variables	(1a) LogAC_ngo$_{it}$ Coef	SE	(1b) LogAC_ngo$_{it}$ Coef	SE	(2a) LogAC_ngo$_{it}$ Coef	SE	(2b) LogAC_ngo$_{it}$ Coef	SE
(Y_{it})	log Y_{it}	−0.364***	(0.046)	−0.404***	(0.046)	−0.379***	(0.036)	−0.364***	(0.038)
(q_{it})	STI visit/Y_{it}	0.143***	(0.026)	0.132**	(0.049)	0.159***	(0.030)	0.175***	(0.029)
	Treated STI/Y_{it}	−0.098**	(0.030)	−0.053	(0.040)	−0.061	(0.040)	−0.078	(0.040)
	Condom distributed/Y_{it}	0.001***	(0.000)	0.001***	(0.000)	0.001***	(0.000)	0.001***	(0.000)
(O_{it})	Members in community mobilisation/Y_{it}	−0.993*	(0.405)	−0.321	(0.360)	0.124	(0.570)	−0.170	(0.565)
	Share of management staff in total staff	0.034***	(0.009)	0.055***	(0.013)	0.043***	(0.005)	0.042***	(0.005)
	Outreach clinic/Y_{it}	141.756***	(59.050)	82.673	(59.586)	112.766***	(57.179)	118.021*	(55.805)
(C_{it})	DIC/Y_{it} * 10 000	0.000	(0.001)	−0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
	FSW/Y_{it}	−0.008**	(0.003)	−0.007***	(0.001)	−0.001	(0.001)	−0.001	(0.001)
	Share of group-based FSW			−0.008**	(0.003)				
(E_{it})	Log of estimated population	0.116	(0.084)	0.142	(0.114)	0.145***	(0.040)	0.132***	(0.038)
	NGOs per district	0.009	(0.033)	−0.001	(0.028)	−0.049*	(0.022)	−0.027	(0.022)
	NGOs per SLP	0.003	(0.007)	−0.020**	(0.007)	0.005	(0.005)	0.005	(0.006)
	Replaced	0.196*	(0.089)	0.079	(0.075)	0.200	(0.109)	0.240*	(0.107)
(E_i)	Access electricity in district					−0.591**	(0.199)	−0.197	(0.215)
	Population in district					−0.000	(0.000)	−0.000	(0.000)
	Distance to nearest town in district					−0.003	(0.006)	−0.005	(0.006)
	Wealth in district					0.080	(0.117)	−0.003	(0.116)
	Access drinking water in district					−0.329	(0.199)	−0.115	(0.282)
	Years in Avahan					0.098**	(0.031)	0.109***	(0.031)
	HIV experience					−0.000	(0.054)	−0.042	(0.048)
	Year of experience					−0.001	(0.003)	−0.001	(0.003)
	Solo district					0.020	(0.057)	−0.019	(0.056)
	2. SLP (ref 1. SLP)							0.004	(0.259)
	3. SLP							0.101	(0.118)
	4. SLP							−0.364***	(0.109)
	5. SLP							−0.337**	(0.131)
	6. SLP							−0.139	(0.125)
	Observations	385	287	293	293				
	R-squared	0.649	0.667						
	Number of NGOs	130	122	99	99				

Robust standard errors are in parentheses. (1a) and (1b) are estimated using a panel estimator with NGO fixed effects. In (1b), the sample is restricted to FSW in order to investigate the effect of the type of sex worker on the average cost. (2a) and (2b) are estimated using an NGO random effect. (2b) includes SLP dummies.
AC, average cost; DIC, drop-in centre; FSW, female sex worker; HIV, human immunodeficiency virus; NGO, non-government organisation; SE, standard error; SLP, State lead partner; STI, sexually transmitted infection.
***$p < 0.01$;
**$p < 0.05$;
*$p < 0.1$.

a. Intensity of service provided

b. Scale

Predicted values estimated using the pooled panel with NGO fixed effects for the four years and plotted using a lowess smoothing.
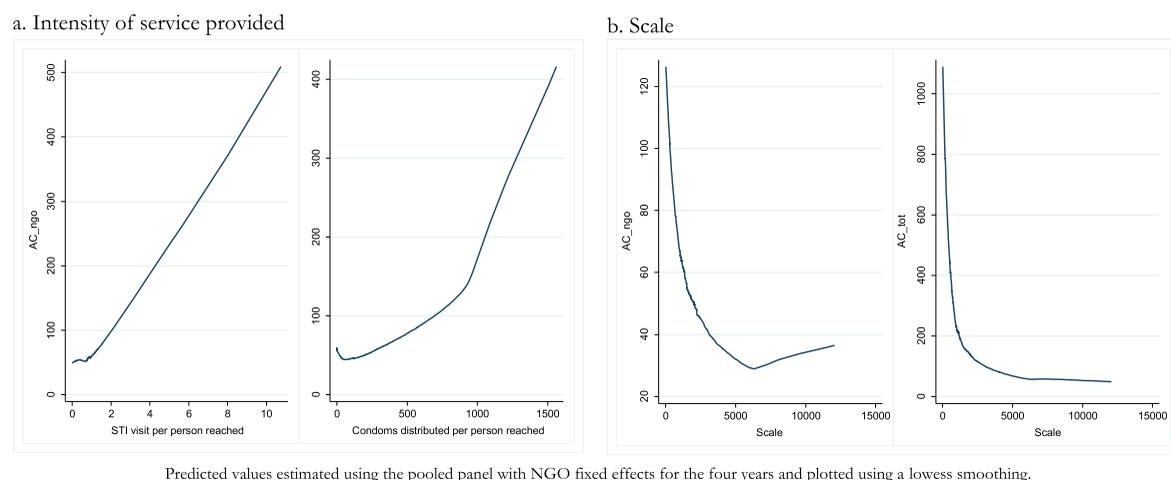
Figure 1. Non-linear relationships between average cost and its predictors. Predicted values estimated using the pooled panel with NGO fixed effects for the 4 years and plotted using a lowess smoothing. NGO, non-government organisation; AC, average cost; STI, sexually transmitted infection

medical staff), and it had no effect on NGO average cost.[4] Correspondingly, the number of outreach clinics per person reached is positively correlated with average costs. We also find a negative influence on average cost of membership by communities in programme organisations. An increase in one additional member (per person reached) would decrease NGO average cost by 63%.[5] However, it should be noted that community mobilisation was nascent in Avahan at the time of the study, so the observed range from which this covariate is derived is extremely low.

4.1.4. Characteristics of high-risk population. The characteristics of populations served by NGOs (FSW/Y_{it}) have a moderate effect on cost because an increase in 1% of FSWs as a proportion of all clients reached decreased NGO average cost by 0.8%. The squared term used to investigate whether there was non-linearity in this effect was not significant, and therefore, there was no potential gain from specialisation that could potentially be obtained if NGOs were to focus on a particular type of key population. We also observe in column (1b) that the type of sex workers reached has a low effect on NGO average cost, although the negative sign conforms to our assumption that reaching group-based sex workers allows reducing NGO average cost.

4.1.5. Environmental time-variant characteristics. With regard to environmental characteristics, the replacement of NGOs is found to have a positive effect on the average programme cost, increasing it by about 22%. However, the number of NGOs per district and per SLP has no impact on cost. The number of estimated population also does not have any effect on NGO average cost.

4.1.6. Environmental time-invariant characteristics. Columns (2a) and (2b) of Table IV allow us to examine the effect of time-invariant environmental characteristics. Regarding setting characteristics, access to electricity in the district is associated with decreased NGO cost as expected. Others characteristics of the district are not statistical significant cost predictors. However, the years in Avahan is positively correlated with NGO average cost, which is unexpected. Finally, our results indicate that the SLP is an important predictor of NGO average cost.

4.2. Determinants of average cost at the programme level

4.2.1. Scale. The main difference in results between the models examining just NGO costs programme costs is the scale effect, as we can see in Table V. This effect is twice as large when focusing at the programme level

Table V. Determinants of programme average cost

	Variables	(1a) $LogAC\_tot_{it}$ Coef	SE	(1b) $LogAC\_tot_{it}$ Coef	SE	(2a) $LogAC\_tot_{it}$ Coef	SE	(2b) $LogAC\_tot_{it}$ Coef	SE
(Y_{it})	$\log Y_{it}$	−0.726***	(0.039)	−0.787***	(0.063)	−0.704***	(0.027)	−0.756***	(0.027)
(q_{it})	STI visit/Y_{it}	0.106***	(0.024)	−0.036	(0.039)	0.071**	(0.024)	0.092***	(0.022)
	Treated STI/Y_{it}	−0.073*	(0.030)	−0.028	(0.028)	−0.011	(0.032)	−0.050	(0.029)
	Condom distributed/Y_{it}	0.001***	(0.000)	0.001***	(0.000)	0.000***	(0.000)	0.000***	(0.000)
(O_{it})	Members in community mobilisation/Y_{it}	−0.388	(0.402)	−0.028	(0.353)	0.636	(0.446)	−0.098	(0.407)
	Share of management staff in total staff	−0.000	(0.006)	−0.001	(0.008)	0.001	(0.004)	−0.002	(0.004)
	Outreach clinic/Y_{it}	−192.175**	(68.595)	−171.563*	(69.524)	−114.478**	(43.924)	−155.846***	(40.391)
	DIC/Y_{it} * 10 000	−0.000	(0.001)	0.000	(0.000)	0.002***	(0.000)	0.001	(0.000)
(C_{it})	FSW/Y_{it}	−0.004**	(0.001)	−0.006***	(0.001)	−0.000	(0.001)	−0.001	(0.001)
	Share of group-based FSW			−0.008	(0.006)				
(E_{it})	Log of estimated population	0.169***	(0.058)	0.291***	(0.084)	0.418***	(0.031)	0.429***	(0.026)
	NGOs per district	−0.069*	(0.033)	−0.017	(0.023)	−0.057***	(0.016)	−0.025	(0.015)
	NGOs per SLP	0.001	(0.005)	−0.001	(0.005)	−0.018***	(0.004)	0.000	(0.005)
	Replaced	0.136	(0.072)	0.092	(0.050)	0.112	(0.087)	0.161*	(0.079)
(E_i)	Access electricity in district					−0.554***	(0.137)	−0.188	(0.143)
	Population in district					−0.000	(0.000)	0.000	(0.000)
	Distance to nearest town in district					0.007	(0.004)	−0.004	(0.004)
	Wealth in district					0.185*	(0.083)	0.078	(0.076)
	Access drinking water in district					−0.172	(0.138)	0.124	(0.184)
	Years in Avahan					0.030	(0.024)	0.097***	(0.022)
	HIV experience					0.027	(0.037)	−0.022	(0.032)
	Year of experience					−0.002	(0.002)	−0.001	(0.002)
	Solo district					0.003	(0.039)	0.053	(0.037)
	2. SLP (ref 1. SLP)							0.213	(0.172)
	3. SLP							0.381***	(0.081)
	4. SLP							−0.017	(0.072)
	5. SLP							−0.573***	(0.088)
	6. SLP							−0.328***	(0.086)
	Observations	387		287		293		293	
	R-squared	0.880		0.901					
	Number of NGOs	130		122		99		99	

Robust standard errors in parentheses. (1a) and (1b) are estimated using a panel estimator with NGO fixed effects. In (1b), the sample is restricted to FSW in order to investigate the effect of the type of sex worker on the average cost. (2a) and (2b) are estimated using an NGO random effect. (2b) includes SLP dummies.
AC, average cost; DIC, drop-in centre; FSW, female sex worker; HIV, human immunodeficiency virus; NGO, non-government organisation; SE, standard error; SLP, State lead partner; STI, sexually transmitted infection.
***$p < 0.01$;
**$p < 0.05$;
*$p < 0.1$.

compared with the NGO level. When NGO scale increases by 1%, programme average cost decreases by 0.73%. The relationship between scale and average cost is shown in Figure 1(b).

4.2.2. Quality of outreach. Some NGO average cost predictors remained important determinants of the programme average cost, including the number of STI visits and condoms distributed per person reached still have a positive relation with average cost, while the number of treated STIs is still negatively correlated with average programme cost.

4.2.3. NGO organisational characteristics. It is important to note that the high coefficient for the number of outreach clinics per person reached was negatively associated with programme average cost; working in the opposite direction to NGO costs – suggesting that programme costs fall as NGOs use outreach rather than referral clinics. However, community mobilisation did not have any statistical significant effect on overall programme average costs.

4.2.4. Characteristics of high-risk population targeted. Our assumption that targeting sex workers results in lower costs than targeting men who have sex with men was confirmed at the programme level; however, the effect is even lower than at the NGO level.

4.2.5. Environmental time-variant characteristics. The number of estimated (mapped) potential persons reached in a district was positively correlated with programme average cost, an increase in 1% in the size of the estimated population increases programme average cost by 0.169%. The number of NGOs per district was negatively correlated with the programme average cost, an additional NGO per district decreased the programme average cost by 7.9%. The non-linear effect, investigated using a squared term, suggested that an additional NGO per district was a source of cost reduction. At the programme level, we do not find that the replacement of NGOs has a positive effect on the average programme cost using the panel estimator with fixed effects although the coefficient remains high (14.5% increase in programme costs). Using the random intercept model with SLP dummies (column 2b of Table V), the coefficient is even greater and statistically significant and suggests that the bankruptcy of an NGO increases programme average cost by 17.3%.

4.2.6. Environmental time-invariant characteristics. Finally, regarding time-invariant characteristics, access to electricity in the district decreased average programme cost by 43%, and wealth in the district was positively correlated with average programme cost. However, these effects disappear after adding SLP dummies. Conversely, the number of years in Avahan remains positively correlated with programme cost, with a similar coefficient than the one obtained from the NGO model. Results at the programme level also confirm that the SLP also plays an important role in the costs of the programme.

5. DISCUSSION

Our study aimed to identify the determinants of costs of and NGO delivered HIV prevention programmes for key populations. Our results suggest that programme design characteristics, including the scale of NGOs used to provide services, the organisation of support organisations, community involvement, the quality of outreach and the strategy used for STI delivery, significantly determined average costs, more so than environmental or population influences. Examining costs at the NGO service level, programme scale, the extent of community mobilisation and targeting group-based sex workers decreased unit costs. Conversely, costs per person reached were associated with higher intensity of service delivery for STI visits, more condoms distributed and a higher number of outreach clinics per person reached as well as by the replacement of the NGO. Average programme costs per person reached decreased with increased scale of the NGO, the number of NGOs per district and the number of outreach clinic and increased with the number of years of programme operation and the number of estimated high-risk group population. Higher intensity of service delivery for STI visits and condoms distributed also increased costs.

Our findings on scale confirm previous studies, for example, similar results were also reported in a study by Dandona *et al.* (2008) where NGOs targeting 6000 high-risk individuals per year experienced economies of scale.

Within the PANCEA project (HIV prevention), Marseille *et al.* (2007a) find that doubling the number of sex workers reached in India would result in a decrease of average cost by 41.8%. In addition to previous results (Siapka *et al.,* 2013), we did not find any diseconomies of scale, suggesting that high reductions in cost can be achieved by increasing the scale of the NGO, rather than recruiting new ones. The inclusion of programme cost strongly increases economies of scale, suggesting that many above service costs are fixed. Indeed, many activities such as programme management (for example, financial management) and setting up systems like information systems are intuitively likely to be fixed per NGO rather than dependent on the scale of that NGO. Other key expertise enhancement activities, such as developing materials and training in community mobilisation, were also provided equally to NGOs. These results highlight the importance of ensuring that above service level costs are considered when examining optimal operational size. Our economies of scale results based on an average NGO size of 1868 high-risk population suggest that encouraging NGOs to merge to a scale beyond this size may substantially reduce average costs. However, care needs to be taken before making strong policy recommendations, to balance any efficiency gain made on the provider side through large NGOs with potential increases in key population costs to access services, and loss of the sense of community ownership that may be a characteristic of smaller NGOs.

Our finding that community mobilisation activities can reduce costs may be due to the potential of community mobilisation to improve the uptake of other services, such as STI treatment, referral for voluntary counselling and testing services, condom promotion and behaviour change communication efforts. A greater number of members of programme committees may allow NGOs to reach high-risk populations at a lower cost, possibly through community mobilisation and stigma reduction, and the involvement of communities in key management decisions may also help improve economic efficiency. However, our results suggest that the manner in which communities are involved in HIV prevention may impact costs. For example, we found that the number of DICs (fixed sites) per person reached was not correlated with NGO and programme average cost – this may a bidirectional influence, with more community involvement in DICs balancing the additional costs of running centres. The fact that we did not find any influence of community involvement on programme average costs could be explained by the fact that overall programme costs may reflect that where communities were involved, NGOs required more programmatic support. However, in the longer run, this need for capacity building support may decrease, and this balance may change.

We also found that the way in which NGOs are supported impacts on costs. While there is a robust debate on incentives provided by different contracting systems, the same grant-making approach was used across Avahan. In addition to grant awarding, Avahan provided other forms of non-monetary support to enhance performance, such as participatory performance reviews and feeding back the analysis of routine monitoring and evaluation data, including surveys and cost data, to NGOs. Our findings suggest that variation in these and other characteristics and practices of SLPs (or other supporting or implementing organisations) may have an important role to play. Further qualitative work is ongoing to better understand how different forms of SLP organisation and approach could influence NGO costs. It also should be noted that higher total costs at the SLP level may not necessarily result in more inefficiency. In some instances, higher total costs may improve the efficiency at NGO level by providing the necessary technical assistance and enhance quality of service delivery.

Our study reports some findings that are at first glance counter-intuitive. For instance, the negative effect on the numbers of STI treated on NGO average contradicts the findings that the number of STI visits increases average cost. These however may be explained by the fact that NGOs with higher levels of treatment used lower cost diagnostic techniques (that may have lower specificity), and these referral clinics may operate at lower cost than NGO-operated clinics. This element then suggests some heterogeneity in STI treatment and that STI treatment is a poor metric of quality. The number of years in Avahan is positively associated with cost, while others studies suggest that costs fall over time because of learning by doing (Menzies *et al.,* 2012). This increase could be explained by an expansion of scope over time not captured by our other controls (including tuberculosis services, for example), but may suggest that prices faced by the programme may be increasing faster than the national rate of inflation (possibly the impact of the large increase in demand for key resources caused by rapid scale-up). It also could reflect the fact that NGOs that first entered into the programme were more efficient because they worked in more accessible towns; as programmes expanded to NGOs in more remote areas, costs increased. At the programme level, we find a positive effect of the estimated population on programme cost. The

most plausible explanation is that the mapping of high-risk groups contained some measurement error. Because NGOs use this information to plan activities, this error could have been a source of inefficiency.

Although this is the first study powered to fully analyse the determinants of the average cost of NGO-delivered HIV prevention services in a low-income setting, there are some limitations. First, this study used data from one country (as there is currently no other data set of this magnitude globally), and more evidence is required from other settings. Second, scale-up and cost may be simultaneously determined, as efficient NGOs may be more likely to scale up their services. This is likely to result in an overestimation of the effect of NGO scale on cost. Third, there could be some measurement error in the proxies used to measure the quality of outreach and community mobilisation (Wheeler *et al.,* 2012). Finally, we only considered provider-side costs and did not take into account societal costs related to factors such as the accessibility of NGOs, because of data availability limitations. However, provider costs are relevant for programme planners, and the inclusion of user costs may be poorly comparable given heterogeneity between areas regarding the level of prices, availability of infrastructure and preferences of targeted populations regarding transport means.

6. CONCLUSION

Where NGOs are funded by grants, decision makers may still be able to influence costs through programmatic decisions and the form of grant provided; organisational factors such as scale of NGOs to provide grants to, specifying the need for active involvement of communities and the approach taken to support and supervision may have a substantial impact on the costs and economic efficiency on programmes that scale up HIV prevention using NGOs. These factors are important to explicitly consider and assess when designing and implementing such HIV prevention and other public health programmes in order to ensure that the greatest number of beneficiaries are reached with these essential services, within the limited resources available.

CONFLICT OF INTEREST

The author(s) declare that they have no competing interests.

ENDNOTES

1. One may want to note that a reasonable reason for such finding comes from the fact that although the squared term is statistically significant at 1%, the minimum of the cost function at the programme level and NGO level is 6995 and 5595 high-risk persons reached, which corresponds to the last percentile in both cost distributions including only four and three NGOs, respectively, with diseconomies of scale.
2. That is, as the ratio of the percentage change in one variable to the percentage change in another variable.
3. $e^{0.143} = 1.15$.
4. Results are available upon request.
5. $e^{0.993} = 0.37$.

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