The Influence of Family Planning Logistics Systems on Contraceptive Use

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Abstract

This paper studies the influence of family planning logistics systems' performance on contraceptive use. The performance of logistics systems in 24 countries was measured during 1995 and 1999 using an index constructed from 17 items. Family planning and socioeconomic indicators for the same periods were obtained from Demographic and Health Surveys and other published sources. An areal analysis, using a country-level fixed-effects regression model accounting for measurement error of the independent variables, shows that the increase in logistics systems' performance scores over the period is associated with an increase in contraceptive use, net of the secular trend and the changes in other family planning program efforts, fertility desire, external population assistance, female education, female labor force participation, and per capita gross domestic product. The study supports the notion that an effective supply chain is essential for the success of family planning programs; about one-fifth of the contraceptive prevalence rate in the sampled countries is attributable to the logistics systems.

Background

Contraceptive availability is an essential component of the quality of care of family planning programs (Bruce 1990; Jain 1989; Mensch, Arends-Kuenning, and Jain 1996). A growing body of literature indicates that contraceptive availability at service delivery points (SDPs) is associated with higher contraceptive use (Chen and Guilkey 2003; Magnani et al. 1999; Tsui et al. 2002). Making a range of high-quality and affordable contraceptives available at SDPs, as per clients' need, is a routine function of the logistics systems that involves the selection of appropriate commodities, forecasting needs, obtaining adequate financing, procuring products on timely basis, and delivering them reliably to clients (Ashford 2002; Chandani and Breton 2001; Davis and Hart 2002; Hart 2004; John Snow Inc./DELIVER 2004; Setty-Venugopal, Jacoby, and Hart 2002). In most developing countries, the commodities for the family planning program are dependent on external resources. In such cases, the different functions of the logistics systems are generally carried out by different agencies, including Ministries, donors, international financing institutions, international manufacturers, and private and public sector procuring agents. Therefore, a strong commitment and coordination between different players of the different functions of the logistics systems are required for uninterrupted delivery of contraceptives to the end users (Davis and Hart 2002; Hart 2004). Understandably, a logistics system or the supply chain is considered as the part and parcel of successful family planning programs (Chandani et al. 2000; Ghana Statistical Service 1997; Kinzett and Bates 2000; Rao 2000; Setty-Venugopal et al. 2002).

Improving the logistics systems of reproductive health programs that rely on external assistance is one of the priorities of the United States Agency for International Development (USAID). Since 1986, USAID has funded John Snow, Inc. (JSI), as the prime contractor to implement Family Planning Logistics Management (FPLM) project, which has evolved to become DELIVER, as USAID increased the project’s focus from contraceptives to include other essential health commodities. The project strengthens logistics management information systems, streamlines distribution, enhances forecasting and procurement capacity, and manages all aspects of actual product pipelines, from warehousing and transportation to inventory and tracking (Davis and Hart 2002). For the purpose of monitoring and evaluating, JSI, with the Centers for Disease Control and Prevention (CDC), developed a tool to quantify the functional level of the logistics systems of family planning programs that are supported by international donor agencies (John Snow, Inc., and the Centers for Disease Control and Prevention 1999). Using this tool, unbalanced time-series data on the functional level of family planning logistics systems was collected from 28 countries in 1995, 1999, and 2000. An earlier analysis of the data showed that the logistics systems of the selected countries where FPLM provided technical assistance improved over the period (Gelfeld 2000). Programmatic expectation is that the improvement in logistics systems in the selected countries would lead to improvement in contraceptive availability at SDPs, which, in turn, would lead to an increase in contraceptive use. To test the hypothesis, this paper seeks cross-national evidence of the influence of logistics systems on contraceptive use.

Conceptual Framework

Although there is a controversy among the population scientists regarding the affect of family planning programs on fertility preferences (Bongaarts 1997; Freedman 1997; Pritchett 1994; Schultz 1994), there is a wide consensus that such programs influence the increase in contraceptive use (Angeles et al. 2001; Chen and Guilkey 2003; Magnani et al. 1999; Tsui et al. 2002). Figure 1 presents the schematic framework that shows the influence of family planning programs, including logistics systems, on contraceptive use. The framework is adapted from earlier work by Lapham and Mauldin (1985) and Bertrand et al. (1996, 2002), and incorporates the findings from Pritchett (1994), Schultz (1994), and Tsui (2001). Pritchett (1994) highlights that fertility desire is the main force for fertility control. Therefore, fertility desire is expected to influence demand for and use of contraceptives. Demand for contraception is expected to create demand for family planning programs and contraceptive availability. Fertility desires, with the

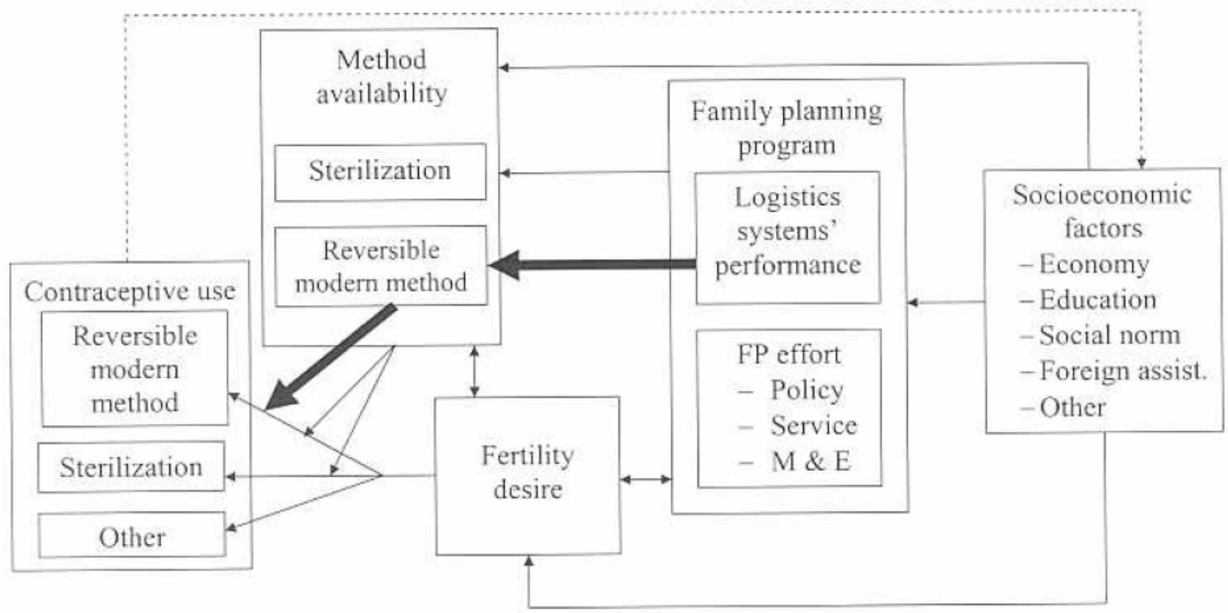

Figure 1: Framework for understanding the role of logistics system performance on contraceptive use

demand for and supply of family planning services, are affected by a number of individual, socioeconomic, cultural, and political factors. The family planning program is also expected to influence fertility desire.

Among the different functions of a family planning program, the logistics systems are liable to ensure contraceptive availability, especially for the methods that require resupplies (i.e., pill, male and female condom, injectable, implant, spermicides, and IUD). Family planning programs with strong political commitment, well-equipped clinics with trained providers and strong social mobilization activities may fail to perform if the logistics systems of the program are not adequate to make contraceptives available, even in an environment where there is a strong desire to control fertility. The model assumes (1) a well functioning logistics system ensures contraceptive availability at the SDPs; and (2) a strong desire for fertility control in developing countries often remains unmet by the private sector due to clients' inability to pay the high cost of contraceptives. The thick black arrows in Figure 1 show the pathway of the influence for logistics systems' performance on contraceptive availability. The dashed line indicates that among other factors, contraceptive use enhances socioeconomic development through meeting the fertility desire of the population.

Data and Measurements

Dependent variables

The dependent variable of interest is the contraceptive prevalence rate (CPR) for modern methods. Because logistics systems would primarily affect contraceptive availability for temporary or reversible methods (i.e., pill, injectable, condom, IUD, implant, spermicides, and female condoms) requiring resupply, and because the information on logistics systems is limited to the public sector, two other dependent variables are also of interest for this study – reversible/ temporary method contraceptive use rate and the temporary method contraceptive use rate from public sector sources. The estimates of the dependent variables were obtained from Demographic and Health Surveys, ORC Macro International. For Demographic and Health Surveys (DHS) that were not conducted precisely in 1995 or 1999, the estimates for the reference years are derived by interpolating the values between the two closest surveys available for the period. However, no values for the outcome are extrapolated.

Independent variables

The tool to quantify the functional level of logistics systems of family planning programs that was developed by JSI and CDC is based on a framework describing the logistics cycle (see

Figure 2). The tool, the Composite Indicators (CI), used 23 items to obtain information on eight aspects of the logistics systems of a family planning program, including logistics management information systems (LMIS), forecasting, procurement, warehousing, distribution, organization and staffing, policy, and adaptability [i]. To obtain information for the CI, logistics advisors conducted in-depth interviews during workshops or group discussions with key informants, i.e., program policy makers and program managers who are knowledgeable about the reference country's logistics systems. The CIs have two scores for each item, one for performance and one for sustainability. The scores for each of the items are recorded using Likert-type scales ranging between zero and four or zero and two. The actual score for each item is recorded based on consensus among the key informants. This analysis uses only the performance score, not the sustainability score, because the latter is less likely to influence short-term programmatic outcome such as the CPR. Six items on policy, adaptability, organization and staffing are dropped from the scale because the items are not directly related to logistics functions. Item analysis supported the omission of the items from the scale. The values of the 17 remaining items are summed to obtain an index or scale measuring logistics systems' performance. The Cronbach's reliability alpha[1] of the index is 0.94. Table 1A in the appendix gives the description of the 17 items used for constructing the index.

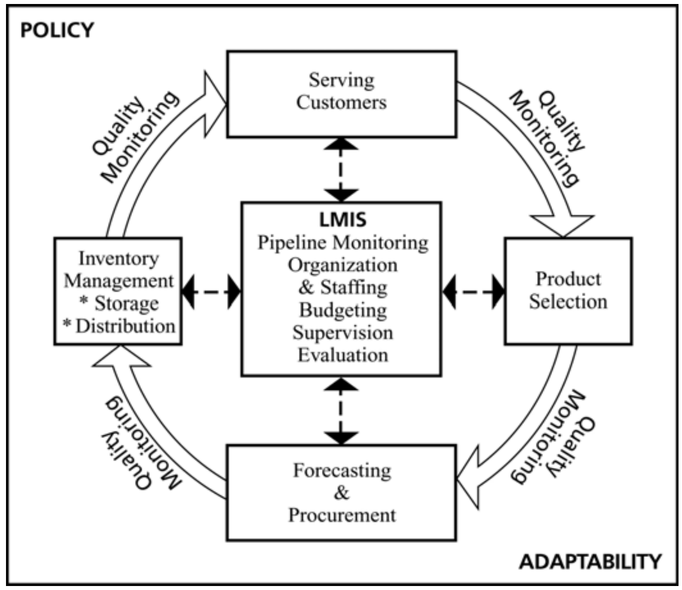

Figure 2: The logistics cycle (Source: JSI/DELIVER 2004)

[1] The alpha coefficient measures the internal reliability (how well the scale measures the underlying construct) of an index or scale. An index is considered to have acceptable reliability if the alpha is 0.70 or greater (StataCorp, 2003).

The CI tool was implemented to evaluate family planning programs in 28 countries in 1995 and repeated in 15 and 22 countries during 1999 and 2000, respectively. The 1999 and 2000 scores were averaged to get a single score for each program, for the reference period 1999–2000. Only the CI scores for public sector family planning programs are retained giving a sample size of 27 countries for 1995 and 23 countries for 1999.

The CI is criticized for its subjectivity of the respondents, inter-rater reliability, and variance of the quality and source of data (Gelfeld 2000). Correction for the measurement error of the logistics systems' performance score (LSPS) is discussed later in the methodology section.

The family planning effort (FPE) of the countries included for this study is measured using an index conceptualized, and it is repeatedly implemented in several developing countries by Mauldin and Berelson (1978), Lapham and Mauldin (1985), Mauldin and Ross (1991), Ross and Mauldin (1996), and Ross and Stover (2001). Relatively higher scores for FPE indicated higher family planning program effort. FPE index is often used by population scientists to measure family planning program efforts of developing countries (Bongaarts 1990, Pritchett 1994, Schultz 1994, and Tsui 2001). Using the method, four components of the family planning program effort (FPE) of a country are measured, including (1) policies, resources, and stage-setting activities; (2) service and service-related activities; (3) record keeping, evaluation, and management's use of evaluation findings; and (4) availability and accessibility of contraceptive supplies and services. Data on the FPE index is available for 1972, 1982, 1989, 1994, and 1999.

For the purpose of this study, the FPE scores from 1994 and 1999 are used with the assumption that the score remained constant between the years 1994 and 1995.

Due to missing values on the dependent and control variables, a few more countries had to be dropped from the analysis, leaving a total of 24 countries with data for at least one of the years. The analysis is limited to the 17 countries for which all information is available for both points in time. Nine of the 17 countries included are from the African region, four countries from the Asia and the Near East (ANE) region, and four countries from the Latin America and the Caribbean (LAC) region.

As per the conceptual framework of this study, several other independent variables were measured. These included fertility desire measured by the wanted total fertility rate (WTFR); economic status measured by per capita gross domestic product, adjusted for purchasing power parity (GDP PPP); external assistance for population and reproductive health programs; female labor force participation rate; and female education (secondary) rate. Like the dependent variables, the WTFR and female education is obtained from DHS. The GDP PPP and female labor force participation rate is obtained from World Bank sources (2003) and external population assistance is obtained from UNFPA sources (UNFPA 1996; 2000).

Analytic Methods

The major threat to the validity of this analysis included the measurement error of the independent variables of interest, mainly LSPS and FPE, and the non-independence of repeated country-level observations. The FPE is criticized for measurement error because the raters of the index had prior knowledge of the outcome, i.e., contraceptive use and total fertility rate; therefore, it is considered endogenous in the equation for predicting contraceptive use (Schultz 1993; Tsui 2001). The bias due to the measurement error manifests as omitted variables in the regression equation that jointly determine the outcome (i.e., contraceptive use) and FPE (Schultz 1994; Pritchett 1994). Like FPE, the LSPS may also be biased for similar reasons. Time invariant unobserved/unmeasured country-level factors/confounders (i.e., the omitted variables) that jointly determine the outcome and the independent variable/s are differenced out by using country-level fixed-effects model (Schultz 2004; Tsui 2001). The fixed-effects model is analogous to the difference model (Wooldridge 2003) that assesses the association between the changes in LSPS and the changes in CPR during the same period, netting out the influence of changes in FPE and other socioeconomic indicators. The influence of logistics systems on contraceptive use is controlled for FPE, WTFR, female education, female labor force, GDP PPP, and external assistance for population programs. An indicator variable for the survey period is included in the model to account for the secular change in contraceptive use due to all other factors that are not accounted for by the observed variables. To account for the potential bias from the perceived subjectivity of the FPE (and LSPS), the analysis controls for foreign assistance for population programs, as suggested by Tsui (2001). By definition, the country-level fixed-effects model also accounted for the non-independence of the observations (Hsiao 1986). The following fixed-effects linear regression model is estimated:

$$\text{CPR} = \beta_0 + \beta_1\text{trend} + \beta_2\text{logistics} + \beta_3\text{WFR} + \beta_4\log(\text{GNP}) + \beta_5\text{edu} + \beta_6\text{labor} + \beta_7\text{assist} + \beta_8\text{FPE} + \upsilon + \varepsilon ....(1)$$

Where, $\beta_0, \beta_1, \ldots \beta_8, \textit{and } \upsilon$ are estimated by the regression model; υ is the country-level fixed effect, i.e., country-level unobserved determinates of contraceptive use that remain constant over time; β_1 estimates the secular trend; β_2 estimates the effect of LSPS; β_2, β_3, … β_8 estimates the effect of the other independent variables; and, ε indicates the unobserved/unmeasured factors/ confounders that vary over time. The major assumption for the model is that ε is not correlated with any of the independent variables. The lag period between logistics systems' performance and contraceptive use is considered to be less than one year — disruption of the contraceptive supply chain would need at least few months to affect the stock status at the SDPs, which in turn would take another few months to affect contraceptive use.

Bongaarts (1997) indicated that the country-level areal analysis to observe the family planning program effect on fertility should account for the population size of each country. Applying analytic weights to equation (1), so that the scores for the independent variables for larger countries had a greater influence on the outcome, the following model is implemented:

$$\mathrm{CPR}\sqrt{\mathrm{n}} = \beta_0\sqrt{\mathrm{n}} + \beta_1\mathrm{trend}\sqrt{\mathrm{n}} + \beta_2\mathrm{logistics}\sqrt{\mathrm{n}} + \beta_3\mathrm{WFR}\sqrt{\mathrm{n}} + \beta_4\log(\mathrm{GNP})\sqrt{\mathrm{n}} + \beta_5\mathrm{edu}\sqrt{\mathrm{n}} + \beta_6\mathrm{labor}\sqrt{\mathrm{n}} + \beta_7\mathrm{assist}\sqrt{\mathrm{n}} + \beta_8\mathrm{FPE}\sqrt{\mathrm{n}} + \upsilon\sqrt{\mathrm{n}} + \varepsilon.\sqrt{\mathrm{n}} \text{......(2)}$$

Where n is the population size.

A dose-response relationship is expected between LSPS and contraceptive use, i.e., comparatively high score for LSPS is expected to be associated with higher contraceptive use. By definition, the service and service related component of the FPE index is expected to capture programmatic input related to logistics systems. Therefore, the FPE index and the LSPS are likely to be collinear in a regression model predicting contraceptive use. To assess the matter, regression models are estimated with and without the FPE index. Models are assessed for multicollinearity, heteroskedasticity and normal distribution of the error term. If there is evidence of violation of the homogeneity and/or normality assumptions of the model, then the

Huber/White correction is applied to obtain robust standard error of the model estimates. The statistical software Stata's *areg* procedure is used to obtain model estimates (StataCorp 2003).

Results

Table 1 shows the mean and standard deviation of selected indicators from 17 countries for 1995 and 1999. The statistical significant changes in the means between the two points in time are assessed using paired t-test and the p-values reported. Between the analysis period, the WTFR significantly declined from 4.0 births to 3.7 births per women (p<.001). The declining WTFR in the selected countries is accompanied by a significant increase in contraceptive use, GDP PPP, female secondary education rate, and female labor force participation rate during the same period. The average CPR for modern methods increased from 21 percent to 26 percent (p<.001); the GDP PPP increased from 1,950 U.S. dollars to 2,125 U.S. dollars (p<.05); the female

Table 1: Changes in contraceptive use, logistics systems' performance score, family planning effort index, and socioeconomic indicators between 1995 and 1999, 17 countries

	1995	1999	p-value (paired t-test)
	mean (sd)	**mean (sd)**	
Dependent variable			
Contraceptive prevalence rate (CPR)	21.4 (15.4)	26.2 (16.6)	<0.001
CPR for temporary methods	13.7 (9.3)	17.6 (10.2)	<0.001
CPR for public sector temporary methods	6.8 (5.8)	9.5 (7.3)	<0.001
Independent Variable			
Wanted total fertility rate	4.0 (1.3)	3.7 (1.3)	<0.001
GDP (adjusted PPP, US $)	1,950 (1,497.2)	2,125 (1,703.4)	0.036
Female secondary education rate	62.8 (26.4)	68.4 (25.4)	<0.001
Female labor force participation rate	40.3 (8.9)	40.7 (8.0)	0.072
Population assistance (US $, 000)	8.1 (9.3)	22.5 (21.7)	0.001
Family Planning Program Effort Index	50.8 (9.6)	53.8 (8.6)	0.209
Logistics systems' performance score (LSPS)	45.9 (21.4)	69.5 (13.9)	<0.001
LMIS	39.0 (27.6)	62.9 (20.3)	0.001
Forecasting system	45.9 (31.6)	69.4 (19.8)	0.005
Procurement system	48.8 (28.2)	79.8 (17.0)	<0.001
Warehousing system	57.7 (21.8)	73.7 (10.5)	0.004
Distribution system	41.4 (22.5)	66.5 (18.9)	0.002

Notes: sd: standard deviation; PPP: purchasing power parity.

education rate increased from 63 percent to 68 percent (p<.001); and the female labor force participation rate showed a meager increase from 40.3 percent to 40.7 percent (p<.10). The increase CPR for modern methods included the increase in temporary method of contraception use rate (from 14 to 18 percent, p<.001), as well as the increase in use rate of temporary method contraceptives from the public sector (from 7 to 9 percent, p<.001). It is interesting to note that the average external population assistance in the selected countries increased significantly from about 8 thousand U.S. dollars in 1995 to about 22 thousand U.S. dollars in 1999 (p<.01).

The LSPS, with its five component scores, are presented in Table 1 as a percentage of the maximum; a score of zero indicates that the system is not performing at all, and a score of 100 indicates that the performance is at its best. Contrary to the expectation, the increase in FPE score between the two analysis periods is not significant (p>.10), the average LSPS in the selected countries improved significantly from 46 in 1995 to 69 in 1999 (p<.001).

The expectation of this study is that the change in contraceptive use during the analysis period is associated with the improving LSPS during the same period. A preliminary assessment of the relationship between CPR for modern methods and LSPS during the analysis periods is shown in Table 2. For this purpose, the 17 countries are categorized into low-, medium-, and high-performing countries, based on the LSPS. The LSPS for low-performing countries ranged between zero and 49; for medium-performing countries, it ranged between 50 and 70, and for high-performing countries, it ranged between 71 and 100. The analysis period appears in the left-hand column, while the logistics systems’ performance categories appear in the top row.

Table 2: CPR for modern methods for selected countries by logistics systems' performance category and analysis period (1995 and 1999)

Analysis period	Logistics system performance category						Marginal average
	Low		Medium		High		
	Country	CPR	Country	CPR	Country	CPR	CPR
1995	Cell average	20.1	Cell average	17.8	Cell average	31.0	21.4
	Benin	3.4	Cameroon	5.5	Bangladesh	38.4	
	Dominican Republic	57.7	Mali	4.5	Kenya	29.0	
	Ghana	11.4	Nepal	26.0	Philippines	25.6	
	Guatemala	26.9	Peru	41.3			
	Haiti	13.2	Tanzania	11.6			
	Jordan	34.6					
	Malawi	14.4					
	Senegal	6.5					
	Zambia	13.0					
2000	Cell average	7.1	Cell average	23.5	Cell average	29.7	26.2
	Cameroon	7.1	Benin	6.4	Bangladesh	44	
			Dominican Republic	64.1	Haiti	20.9	
			Ghana	14.4	Jordan	39.1	
			Guatemala	30.9	Kenya	31.8	
			Mali	6.5	Malawi	23.8	
			Zambia	18.5	Nepal	33.5	
					Peru	50.4	
					Philippines	28.2	
					Senegal	8.2	
					Tanzania	16.9	
Marginal average		18.8		20.9		30.0	23.8

The cell average by analysis period indicates that contraceptive use is positively related with LSPS. During 1995, the average CPR for modern methods is 31 percent among countries in the high logistics performance category, which declines to 18–20 percent for low- and medium-performing countries.

Table 3 shows the Pearson product-moment correlation coefficients (row) between the dependent and the independent variables in the selected countries. The statistically significant correlation coefficients are flagged. The CPR for modern methods is positively correlated with GDP PPP (row = 0.66, p<.01), female education (row = 0.53, p<.01), and FPE (row = 0.47, p<.01), and inversely correlated with WTFR (row = -0.81, p<.01), as expected. However, the correlation between CPR for modern methods and female labor force participation rate is the opposite of what is expected (row = -0.63, p<.01). The female labor force participation rate decreases with the increase in CPR. Although a spurious relationship between female labor force participation

Table 3: Correlation coefficient matrix between the dependent and independent variables (n=34)

	CPR	Temporary method CPR	Public Sec. CPR	Wanted TFR	GDP PPP	Female education	Female labor force	Population assistance	LSPS
Temporary method CPR	0.77 ***								
Public sector CPR	0.55 ***	0.81 ***							
Wanted total fertility rate	-0.81 ***	-0.69 ***	-0.49 ***						
log(GDP PPP)	0.66 ***	0.42 **	0.11	-0.72 ***					
Female education	0.53 ***	0.54 ***	0.38 **	-0.42 **	0.52 ***				
Female labor force	-0.63 ***	-0.46 ***	-0.09	0.53 ***	-0.83 ***	-0.43 **			
Population assistance	0.32 *	0.53 ***	0.65 ***	-0.36 **	-0.05	0.09	0.13		
LSPS	0.28	0.45 ***	0.54 ***	-0.35 **	-0.04	0.13	0.10	0.57 ***	
FPE	0.47 ***	0.46 ***	0.55 ***	-0.48 ***	0.17	0.10	0.00	0.66 ***	0.54 ***

***p<.01; **p<.05; *p<.10. LSPS: Logistics systems' performance score.

and CPR for modern methods could be due to the sample selection process, it is important to note that the analysis in Table 2 is biased because it does not account for repeated measures, time trends, and other confounders.

The direction of the correlation between LSPS and CPR for modern methods (row = 0.28) is in the expected direction, however, it is not statistically significant (p>.10). As expected, the LSPS is significantly correlated with the CPR for temporary methods (row = 0.45, p<.01), and with the CPR for public sector temporary methods (row = 0.54, p<.01). The magnitude of the correlation coefficient between LSPS and CPR for temporary methods (row = 0.45) is higher than the magnitude of the correlation coefficient between LSPS and CPR for modern methods (0.28), supporting the notion that stronger logistics system is more relevant for temporary contraceptive methods that require frequent resupplies to maintain product availability at the SDPs. The higher magnitude of the correlation coefficient between LSPS and CPR for public sector temporary methods (row = 0.54) compared to the magnitude of the correlation coefficient between LSPS and CPR for temporary modern methods is expected (row = 0.45), because the LCPS for only the public sector family planning programs is included for this study. The positive correlation between LSPS and FPE (row = 0.54, p<.01) indicate that relatively high LSPS is associated with relatively high FPE, which is expected. Except for female labor force participation rate, all the socioeconomic indicators are correlated with each other in the expected directions. WTFR is negatively associated with GDP PPP (row = -72, p<.01) and female education (row = -42, p<.01), while GDP PPP and female education are positively correlated with each other (row = 0.52, p<.01).

Next, multivariate analysis is conducted to observe the association between LSPS and contraceptive use, net of secular trend, fertility desire, and other socioeconomic factors. Table 4 presents regression models predicting CPR for modern methods, CPR for temporary methods, and CPR for public sector temporary methods. Models 1, 3, and 5 in Table 4 are country-level fixed-effects linear regression models using Equation 1 (i.e., unweighted for country's population size). Models 2, 4, and 6 in Table 4 are country-level fixed effects linear regression models using Equation 2 (i.e., weighted for country's population size). Because the variance for external population assistance and LSPS significantly varied between the two analysis periods (see Table 1), indicating that the homoskedasticity assumption of the linear regression model is violated. Therefore, the Huber/White correction is applied to obtain robust standard error of the fixed-effects model estimates. The FPE is dropped from all the models because (1) the effect of FPE on contraceptive use measures is significantly inconsistent (see Table 2A in the appendix); and (2) the presence of FPE in the models accentuated the influence of LSPS rather than dampening it, as expected. The WTFR, GDP PPP, female education, and female labor force participation rate were not considered as the proximate determinants of public sector temporary

Table 4: Regression models predicting CPR for modern methods, temporary method CPR, and public sector CPR for temporary methods (n=34)

Independent variable	CPR for modern methods				CPR for temporay methods				CPR for public sector temporary methods			
	Unweighted		Weighted		Unweighted		Weighted		Unweighted		Weighted	
	Coef.	**(SE)**	**Coef.**	**(SE)**	**Coef.**	**(SE)**	**Coef.**	**(SE)**	**Coef.**	**(SE)**	**Coef.**	**(SE)**
	Model 1		***Model 2***		***Model 3***		***Model 4***		***Model 5***		***Model 6***	
Trend (1999 vs. 1995)	0.53	(0.98)	0.06	(0.92)	0.81	(0.70)	0.50	(0.36)	-0.04	(0.57)	-0.435	(0.81)
Wanted TFR	-0.70	(1.44)	-1.52	(1.27)	-0.55	(1.07)	-1.17	(0.70)				
log (GDP PPP)	9.55	(9.07)	8.04	(8.44)	-2.86	(5.83)	-2.86	(4.06)				
Female education	-0.06	(0.17)	-0.02	(0.14)	0.01	(0.07)	0.02	(0.05)				
Female labor force	0.05	(0.70)	0.22	(0.86)	-0.22	(0.40)	-0.13	(0.36)				
Population assistance	0.11	(0.04) **	0.10	(0.03) ***	0.12	(0.02) ***	0.12	(0.01) ***	0.12	(0.02) ***	0.12	(0.02) ***
Logistics systems	0.09	(0.03) **	0.11	(0.03) ***	0.06	(0.02) **	0.06	(0.02) ***	0.04	(0.02) **	0.06	(0.03) **
Constant	-48.56	(59.45)	-43.39	(47.38)	41.04	(41.49)	41.00	(25.71)	3.96	(1.01) ***	4.34	(2.05) *
Goodness-of-fit statistics												
Adjusted Wald's test												
Model	F(7, 10)	15.25 ***		1,466.12 ***		58.76 ***		3,043.63 ***	F(3, 14)	20.48 ***		168.67 ***
Fixed-effect	F(16, 10)	175.29 ***		457.95 ***		222.81 ***		613.46 ***	F(16, 14)	47.94 ***		383.35 ***
Adjusted R-squared		0.99		0.99		0.99		1.00		0.97		0.98

***p<.01; **p<.05; *p<.10

method CPR; therefore, they are not included in Models 5 and 6 in Table 4 (although adding the four predictors to Models 5 and 6 did not change the results [analysis not shown]). Since some of the independent variables are highly correlated with each other (see Table 3), it is possible that inconsistent model estimates are achieved due to multicollinearity. Multicollinearity between the predictors is assessed by eye-balling the variance estimates of the models with and without the possible collinear variables (analysis not shown), which would have inflated the variance in the presence of multi-collinearity (Wooldridge 2003). No evidence of multicollinearity is found. The fixed-effects are significant in all six models in Table 4, indicating the appropriateness of using fixed-effects.

As expected, LSPS is positively associated with CPR for modern methods, with CPR for temporary methods, and with CPR for public sector temporary methods in all the six models. Both the weighted and unweighted analysis provides the same conclusion. Although inconsistent effect estimates for female education is observed in Model 1 and for GDP PPP and female labor force participation rate in the Models 3 and 4, none of the effects are statistically significant. Since model specification is based on previous studies, and no significant (multiplicative) interaction between the independent variables were found in any of the models (analysis not shown), the spurious effect estimates (although not significant) of female education, GDP PPP, and female labor force participation rate on contraceptive use is likely due to (1) small sample size which unable to detect significant interactions between the independent variables; or (2) unobserved determinants of contraceptive use that vary over time and correlated with the three independent variables in question; or, (3) the sample, i.e., the relationship is true within the sample. Similar explanation could also be given for the spurious effect of FPE observed in the models in Table 2A. The conclusion regarding the effect of LSPS on contraceptive use remained unchanged even after dropping female education, GDP PPP, and female labor force participation rate from the models in Table 4 (analysis not shown).

Interestingly, all six models indicated that countries that receive comparatively high external assistance for population programs have comparatively high contraceptive use. Similar finding was observed by Tsui (2001). However, the relationship between external population assistance and contraceptive use could be biased by the selection process for the assistance and its amount.

It is interesting to note that, though the correlation matrix in Table 3 indicated that external population assistance and LSPS are likely to be collinear in the models predicting temporary method use and public sector temporary method use (in Table 4), it is not so[2]. Rather, the presence of both variables in the models accentuated the effect of each other, indicating (1)

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[2] The correlation between external population assistance and LSPS is significant (row = 0.57, see Table 3); external population assistance and LSPS are also significantly correlated with CPR for temporary methods (row = 0.53 and row= 0.45, respectively) and with CPR for public sector temporary methods (row = 0.65 and row=0.54, respectively), suggesting possible collinearity, i.e., both the independent variables could be explaining a common variation in contraceptive use. In such cases, it is expected that external population assistance and LSPS would dampen the effect of each other in the models predicting temporary method CPR and public sector CPR.

possible interaction between LSPS and external population assistance, or (2) the reflection of the correction for the measurement error (i.e., endogeneity) of the LSPS. The second explanation is more plausible because the multiplicative interaction between external population assistance and LSPS was assessed and found not significant (p>.10) in any of models in Table 4 (analysis not shown).

Using the unweighted models (i.e., Models 1, 3, and 5) in Table 4, the impact of logistics systems' performance on contraceptive use is simulated (see Figure 3). The fraction of the CPR attributable to logistics systems' is the percentage difference between the average CPR when the LSPS is at its observed level (the blue bars in Figure 3) and the average CPR when logistics system performance is at zero (the green bars in Figure 3), holding the value of all the other variables constant. The analysis showed that in 1995 about 19 percent (100 × [21.4 – 17.4] ÷ 21.4) of the average modern method CPR, 20 percent (100 × [13.7 – 11.0] ÷ 13.7) of the average temporary method CPR, and 28 percent (100 × [6.8 – 4.9] ÷ 6.8) of the average public sector temporary method CPR are attributable to logistics systems' performance. Similarly in 1999, about 23, 23, and 31 percent of modern method, temporary method, and public sector temporary method use rate, respectively, is attributable to the performance of the logistics systems.

The fraction of the increase in contraceptive use attributable to the improvement in the logistics system is the percentage difference between the changes in contraceptive use when the LSPS is set at its observed level (i.e., changes in blue bars in Figure 3) and the changes in contraceptive

use when the LSPS does not change over time (i.e., changes in the red bars in Figure 3), holding the values of the other variables constant. Accordingly, about 42 percent (100 × ({[26.2 – 21.4] –

[24.1 – 21.4]} ÷ [26.2 – 21.4])) of the increase in average modern method contraceptive use rate is attributable to the improvement of the logistics system in the selected countries. Similarly, 36 percent of the increase in temporary method use and 37 percent of the increase in public sector temporary method use is attributable to the improvement in logistics systems of the selected countries.

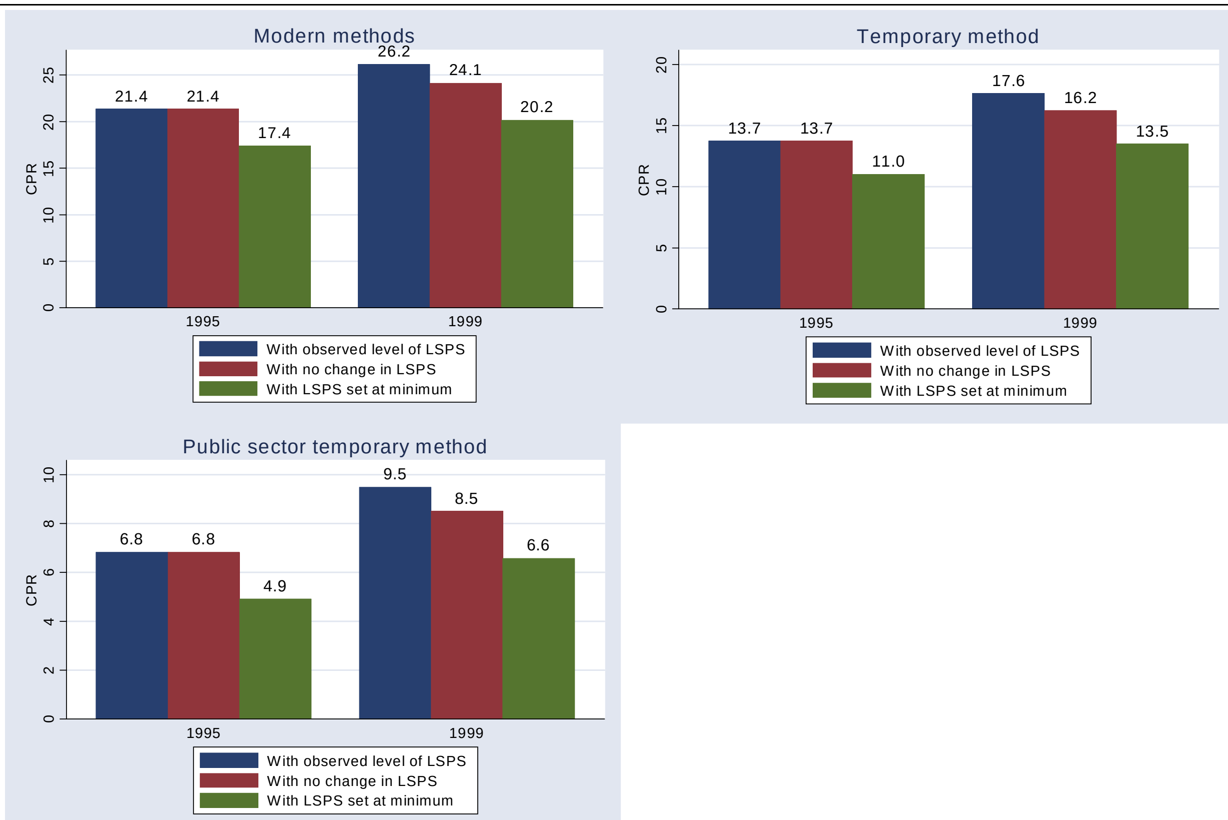

Figure 3: Impact of logistics systems on contraceptive use.

Limitations

One of the major limitations of this study is that the generalization of the findings is restricted among the countries analyzed. However, it can be argued that if the validity of the relationship between logistics and contraceptive use within the sample is acceptable, there is no obvious reason to believe that the relationship between the two will be different for other countries.

Another criticism may be raised that logistics advisors to show program impact encouraged the key informants to provide high scores for the CI during the follow-up. However, it can be expected that such practice would be systematic over time, and as such it would be correlated with the secular trend; therefore, partly accounted for.

Lastly, the impact of logistics system observed in this study may be biased by the other programmatic factors (such as the supply environment, quality of care, public sector financing for family planning commodities etc.) not accounted by FPE.

Discussion

The study provides empirical evidence that the performance level of the logistics systems of a family planning program has a significant contribution on contraceptive use, which is net of fertility desire, family planning program effort, external population assistance, and socioeconomic factors. Improving contraceptive availability alone would not ensure increase in contraceptive use unless the demand for contraceptives is not created by other means. A well performing logistics system is necessary but not sufficient for achieving program outcomes; however, this study suggests that investing in logistics systems can be one of the most effective program components to invest in.

The relationship between the logistics systems and contraceptive prevalence rate in the expected direction indicates that the assumption that improving logistics systems improves product availability at SDPs is not unreasonable. However, further studies will be required to confirm it. In this respect, it is worth mentioning that DELIVER has redesigned the tool for the CI in order to minimize the measurement errors and make it applicable to other reproductive health programs. The new tool, the Logistics System Assessment Tool (LSAT) is currently being implemented in countries where DELIVER provides technical assistance (for details on the LSAT, see DELIVER 2002). With the availability of growing number of surveys assessing product availability at SDPs, the LSAT would provide the opportunity to assess whether higher scoring logistics systems is associated with higher product availability at SDPs. The LSATs could also be used to validate the findings of this study by replicating it.

End Notes

i. *Serving customers* on the top of the logistics cycle indicates meeting customer needs for health and family planning commodities. *Product selection* is another logistics activity that is required in order to offer high-quality products to clients. Funding requirements for public sector and donor sources for procuring health and family planning commodities continues to rise to meet current demand. Therefore, *forecasting and procuring* an adequate quantity of contraceptives to meet clients' needs remains an essential logistics activity in order to efficiently utilize the scarce resources. *Inventory management,* including storage and distribution is another vital function of the logistics system in order to maintain adequate stocks at SDPs and fulfill clients' need. Each activity—serving customers, product selection, forecasting and procurement, and inventory management—depends on the other activities. For example, product selection is based on serving customers needs, which, in turn affects procurement, storage, and distribution. A logistics management information system is the heart of the framework because all the logistics activities depend on utilizing accurate logistics information. The framework also highlights the importance of trained staff, constant supervision, monitoring, and evaluation of all the logistics activities. As with all health systems, the performance of logistics systems is influenced by the policy environment; therefore, adaptability of the organization to the environment is also important (for details on the logistics cycle, see JSI/DELIVER 2004).

Appendix

Table 1A: Description of the items used to construct the logistics systems' performance index

Items		Potential Score
LMIS		
8.	Program has basic elements of LMIS.	4
9.	LMIS information is used in management decision making.	4
10.	LMIS information is fed back to all lower levels in the distribution system.	2
11.	Commodity data are validated by cross-checking with other data sources.	2
Forecasting		
6.	Periodic forecasts of consumption are prepared, updated, and validated.	4
7.	Forecasts are incorporated into cost analysis and budgetary planning.	4
Procurement		
12.	Consumption forecasts are used to determine short-term procurement plans.	4
13.	The right amount of contraceptives is obtained in an appropriate time frame.	4
Warehouse		
14.	Adequacy of storage capacity and conditions.	4
15.	Conducts at least one physical inventory of contraceptives per year at each warehouse.	2
16.	Knows and complies with standards for maintaining product quality.	2
17.	Issues stock according to first expiry/first out (FEFO) inventory control procedures.	4
Distribution		
1.	Has appropriate distribution system and schedule for stocking each level.	4
2.	Each level is stocked adequately.	4
3.	Minimal stockouts have been experienced during the previous year.	4
4.	Has a system for tracking and documenting system losses.	2
5.	Has adequate transportation system for moving supplies.	4
	Total	**58**

Table 2A: Regression models predicting CPR for modern methods, CPR for temporary methods, and CPR for public sector temporary methods (n=34)

Independent variable	CPR for modern methods				CPR for temporay methods				CPR for public sector temporary methods			
	Unweighted		Weighted		Unweighted		Weighted		Unweighted		Weighted	
	Coef.	**(SE)**	**Coef.**	**(SE)**	**Coef.**	**(SE)**	**Coef.**	**(SE)**	**Coef.**	**(SE)**	**Coef.**	**(SE)**
	Model 1		*Model 2*		*Model 3*		*Model 4*		*Model 5*		*Model 6*	
Trend (1999 vs. 1995)	1.01	(0.84)	0.09	(1.08)	1.12	(0.60) *	0.55	(0.37)	-0.30	(0.59)	-0.64	(0.82)
Wanted TFR	-0.55	(1.09)	-1.43	(1.46)	-0.45	(0.87)	-1.02	(0.68)				
log (GDP PPP)	5.76	(6.92)	7.93	(8.22)	-5.32	(4.83)	-3.05	(3.59)				
Female education	-0.10	(0.17)	-0.02	(0.15)	-0.01	(0.07)	0.02	(0.05)				
Female labor force	-0.85	(0.65)	-0.03	(1.61)	-0.80	(0.37) *	-0.55	(0.42)				
Population assistance	0.13	(0.05) **	0.10	(0.03) ***	0.14	(0.02) ***	0.13	(0.01) ***	0.13	(0.03) ***	0.13	(0.02) ***
Logistics systems	0.11	(0.03) ***	0.12	(0.03) ***	0.07	(0.02) ***	0.07	(0.02) ***	0.05	(0.02) ***	0.08	(0.03) **
FPE	-0.12	(0.06) *	-0.03	(0.11)	-0.08	(0.02) ***	-0.05	(0.03)	-0.07	(0.03) **	-0.08	(0.04) *
Constant	21.99	(53.93)	-31.35	(67.21)	86.78	(35.94) **	61.43	(24.89) **	6.74	(1.35) ***	8.10	(1.91) ***
Goodness-of-fit statistics												
Adjusted Wald's test												
Model	F(8, 9)	22.75 ***		1,348.03 ***		317.80 ***		3,132.27 ***	F(4, 13)	15.24 ***		192.8 ***
Fixed-effect	F(16, 9)	266.07 ***		427.46 ***		971.58 ***		419.80 ***	F(16, 13)	42.39 ***		105.30 ***
Adjusted R-squared		0.99		0.99		0.99		1.00		0.97		0.98

***p<.01; **p<.05; *p<.10

Table 3A. The data used for the study

Country	Year	CPR	CPR_temp	CPR_pub_temp	Logistics system performance score						wtfr	GDP_PPP	secondary	labor	assist	pop
					Total	Distribution	Forecasting	LMIS	Procurement	Warehousing					(US4 000)	(million)
Bangladesh	1995	38.4	29.3	16.1	85.3	80.6	87.5	100.0	75.0	83.3	2.2	1,230	41.8	42.1	39.6	123.1
Benin	1995	3.4	3.0	1.3	17.8	29.6	0.0	19.4	0.0	22.2	5.0	810	29.2	48.3	1.7	5.6
Cameroon	1995	5.5	4.2	1.2	51.7	33.3	37.5	50.0	50.0	91.7	4.8	1,380	65.0	37.5	3.1	13.6
Dominican Republic	1995	57.7	17.2	3.8	35.3	36.1	25.0	12.5	31.3	66.7	2.5	4,990	91.4	29.0	3.5	8.0
Ghana	1995	11.4	10.0	4.3	44.0	47.2	75.0	41.7	37.5	25.0	4.1	1,850	65.0	50.7	6.6	18.0
Guatemala	1995	26.9	11.1	1.6	25.0	27.8	0.0	4.2	12.5	66.7	4.0	3,940	71.7	26.2	7.3	10.9
Haiti	1995	13.2	9.8	1.5	27.6	11.1	25.0	0.0	37.5	75.0	3.0	1,830	64.4	43.1	2.3	7.3
Jordan	1995	34.6	29.9	6.3	24.1	11.1	12.5	33.3	25.0	41.7	3.3	3,770	84.7	21.3	1.6	5.7
Kenya	1995	29.0	23.1	14.9	78.4	72.2	87.5	79.2	87.5	75.0	3.4	990	82.1	46.1	16.9	29.1
Malawi	1995	14.4	11.4	8.4	19.0	11.1	12.5	16.7	0.0	50.0	5.6	520	58.0	49.1	2.4	11.4
Mali	1995	4.5	4.2	2.1	53.4	50.0	79.2	27.8	75.0	52.8	6.0	650	19.0	46.4	6.5	11.1
Nepal	1995	26.0	8.6	5.3	53.4	43.3	45.0	56.7	60.0	66.7	2.9	1,090	20.0	40.4	6.7	22.5
Peru	1995	41.3	31.6	21.0	50.0	44.4	37.5	37.5	62.5	70.8	2.1	4,230	93.9	29.6	7.4	24.2
Philippines	1995	25.6	13.6	10.0	77.6	77.8	87.5	75.0	87.5	66.7	2.9	3,470	97.8	37.2	15.9	69.0
Senegal	1995	6.5	6.0	3.9	34.5	38.9	50.0	16.7	62.5	16.7	5.1	1,230	27.0	42.5	3.8	8.5
Tanzania	1995	11.6	9.8	7.7	66.8	66.7	81.3	50.0	75.0	68.8	5.4	450	71.4	49.4	8.3	30.5
Zambia	1995	13.0	10.9	6.8	36.2	22.2	37.5	41.7	50.0	41.7	5.3	720	85.0	45.4	3.7	9.7
Bangladesh	1999	44.0	35.5	21.4	78.8	75.7	76.6	87.5	76.6	77.6	2.2	1,430	53.6	42.3	93.1	129.2
Benin	1999	6.4	5.6	2.7	57.8	55.6	43.8	58.3	62.5	66.7	4.6	890	36.0	48.3	5.8	6.1
Cameroon	1999	7.1	5.6	1.8	45.7	36.1	43.8	25.0	68.8	66.7	4.3	1,520	71.9	37.9	6.6	15.1
Dominican Republic	1999	64.1	19.9	5.7	52.6	38.9	37.5	37.5	56.3	95.8	2.0	6,340	97.4	30.4	6.8	8.5
Ghana	1999	14.4	12.4	5.9	59.9	61.1	37.5	72.9	56.3	62.5	3.6	2,060	70.8	50.5	16.1	20.2
Guatemala	1999	30.9	13.4	3.2	52.2	48.6	50.0	47.9	59.4	58.3	4.1	4,230	74.7	28.4	5.6	11.4
Haiti	1999	20.9	17.2	3.1	81.0	83.3	100.0	41.7	100.0	91.7	2.8	1,880	71.1	42.9	16.1	8.2
Jordan	1999	39.1	34.1	9.2	87.9	91.7	75.0	95.8	100.0	75.0	2.9	3,720	90.9	23.9	7.9	6.7
Kenya	1999	31.8	25.7	14.2	91.4	94.4	92.5	86.7	95.0	88.3	3.5	980	88.5	46.1	29.3	30.1
Malawi	1999	23.8	19.0	14.2	75.0	75.0	62.5	70.8	93.8	75.0	5.2	570	73.0	48.7	22.7	10.9
Mali	1999	6.5	5.2	2.7	58.6	45.4	83.3	48.6	75.0	61.1	6.1	740	20.0	46.2	12.8	11.2
Nepal	1999	33.5	12.8	8.8	83.6	80.6	87.5	87.5	93.8	75.0	2.5	1,190	28.0	40.5	16.9	23.9
Peru	1999	50.4	37.0	28.6	79.3	83.3	75.0	70.8	93.8	75.0	1.8	4,410	94.8	31.0	29.6	25.7
Philippines	1999	28.2	17.6	13.5	74.7	65.7	83.3	76.4	85.4	73.6	2.7	3,610	98.4	37.7	47.9	76.0
Senegal	1999	8.2	7.6	5.2	74.1	83.3	75.0	50.0	100.0	66.7	4.6	1,360	33.4	42.6	9.6	9.5
Tanzania	1999	16.9	14.8	10.6	72.6	67.4	81.3	62.5	84.4	77.1	4.8	470	72.8	49.2	35.0	33.5
Zambia	1999	18.5	16.5	10.5	56.0	44.4	75.0	50.0	56.3	66.7	4.9	720	88.0	44.9	20.0	9.2

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