

Maternal Mortality in Ghana: An Econometric Analysis

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Abstract

Sub-Saharan Africa has the highest ratio of maternal deaths in the world. Despite some progress, it is uncertain if Ghana (like other sub-Saharan countries) can reduce, by three-quarters, the maternal mortality ratio (MMR) by the year 2015. Therefore, the primary purpose of this study was to determine the predictors of MMR in Ghana. The study utilized data from the Demographic and Health Survey (DHS) reports on Ghana from 2002 to 2009. The variables used from the survey reports included: MMR (response variable), Doctor Population Ratio (DPR), Nurse Population Ratio (NPR), Antenatal Coverage (ANC), Postnatal Coverage (PNC), Skilled Delivery (SKD) and Family Planning Acceptors (FPA). Data were analyzed using descriptive and inferential statistics. Line graphs were used to describe MMR trends. Two Panel Data Econometric models, the Pooled Ordinary Least Squares (Pooled OLS) and the Least Squares Dummy Variable (LSDV) regressions, were used to analyze the data. MMR declined by 16.93% from 2002 to 2005. It increased by 35.57% from 2005 to 2007; then declined again by 26.15% from 2007 to 2009. The LSDV regression model indicated that only SKD ($p < 0.01$) significantly predicted MMR. The OLS regression models showed SKD significantly predicted MMR in only three regions. The OLS regression also revealed that DPR significantly predicted MMR in two regions; and NPR and FPA in two and one region respectively. Policy makers in Ghana would do well to identify and target region specific response variables for the efficient allocation of resources in reducing MMR.

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1 Introduction

The United Nations Commission for Africa Millennium Development Goals (MDG) 2013 Report indicates that sub-Saharan Africa has the highest ratio of maternal deaths in the world [1]. Despite some progress, it is uncertain if Ghana (like other sub-Saharan countries) can reduce, by three-quarters, the maternal mortality ratio (MMR) by the year 2015. Colonial (see [2] and [3]) and postcolonial (see [4] and [5]) policies have resulted in regional disparities in the educational, social and economic, and health sectors of the country.

Ghana introduced a free delivery policy in the three northern regions and central region in 2003 on a pilot basis. The exemption was extended to the rest of the country in 2005. Then in 2008, the government introduced the free maternal health insurance policy through the National Health Insurance Scheme ([6]). The national target was to reduce MMR from 214 (1990) to 54 in 2015 ([7]). However, the skilled delivery coverage for poor women has remained stagnant or is declining ([8]).

The aim of this paper was to determine the predictors of MMR in Ghana. The secondary aim was to examine disparities in MMR among the 10 regions of Ghana. The specific objectives were to investigate: (a) the prevalence of MMR in Ghana, (b) the significant predictors of MMR in Ghana, and (c) the significant predictors of MMR in each of the 10 regions of Ghana. These would assist policy makers in Ghana to identify critical predictors of MMR at the national level, and target region specific predictors for the efficient allocation of resources in reducing MMR.

2 Method

The study utilized data from the Demographic and Health Survey (DHS) reports on Ghana from 2002 to 2009 (see [9] and [10]). The variables used from the survey reports included: MMR, Doctor Population Ratio (DPR), Nurse Population Ratio (NPR), Antenatal Coverage (ANC), Postnatal Coverage (PNC), Skilled Delivery (SKD) and Family Planning Acceptors (FPA). The MMR was used as the response variable, while the rest were predictors of MMR. . The 10 regions of Ghana were used as the subjects. These included: Ashanti (AR), Brong Ahafo (BA), Central (CR), Eastern (ER), Greater-Accra (GA), Upper East (UE), Upper West (UW), Volta (VR), and Western (WR).

Data were analyzed using descriptive and inferential statistics. Line graphs, averages and standard deviations were used to identify trends and also to describe the variables. Panel Data Econometric models were used to identify significant predictors for MMR at the national level. In the next section, we discuss the two models.

Panel Data Econometric models employed in the considered were the Pooled Ordinary Least Squares (Pooled OLS) and the Least Squares Dummy Variable (LSDV) or Fixed Effects regressions. The Chow test helped in comparing the two models as to which provided a better fit. The combination of Durbin-Watson's test and Ordinary Least Squares (OLS) method helped in identifying regional disparities relating to significant predictors of MMR.

3 Models

3.1 The LSDV Regression Model

A Panel Data regression with one-way error components disturbances is given by

$$y_{it} = \alpha + X'_{it}\beta + u_{it} \quad i = 1, \dots, N; t = 1, \dots, T \quad (1)$$

$$u_{it} = \mu_i + \vartheta_{it} \quad (2)$$

The i and t denote the cross-section and time-series dimensions respectively. α is a scalar, β is $K \times 1$ and X_{it} is the it th observation on K predictor variable. u_{it} denotes the one-way error components disturbances where μ_i is the unobserved heterogeneity across individuals that is fixed over time. ϑ_{it} denotes the stochastic term which is independent, identically distributed (i.i.d.) with mean 0 and variance σ_{ϑ}^2 . Also, $E(X_{it}\vartheta_{it}) = 0$, $E(u_i u'_i) = \Sigma$ and $E(X_{it}\mu_i) \neq 0$. This model is useful if we are considering a specific set of N regions and the inference is restricted to the behaviour of these set of regions. Putting (2) into (1), one can obtain the LSDV then conduct OLS to estimate α, β and μ . This is known as the LSDV regression or Individual-specific fixed effects model. Note that, the Pooled OLS method is where (1) is estimated by the OLS approach ignoring the individual-specific fixed effects. The estimated parameters and their corresponding standard errors for both models are obtained by solving the following:

$$\beta = (\sum_{i=1}^N \sum_{t=1}^T X'_{it} X_{it})^{-1} (\sum_{i=1}^N \sum_{t=1}^T X'_{it} Y_{it}) \quad (3)$$

$$\sigma^2 = \frac{(Y_{it} - X_{it}\beta)'(Y_{it} - X_{it}\beta)}{NT - N - K} \quad (4)$$

where X_{it} is a matrix stacking together ones and the predictors, X'_{it} is the transpose of X_{it} and Y_{it} is a vector of responses.

In an event that the individual-specific fixed effects are statistically significant, the estimated parameters for the pooled method will be biased and inconsistent as pointed out by [11] and [12]. The procedure for the choice of either the Pooled OLS or the LSDV regression model is the simple chow test. The μ_i 's

are treated as $N - 1$ dummy variables then a joint significance of these dummies are tested. The steps for the hypothesis testing are as follows:

$$H_0: \mu_1 = \dots = \mu_{N-1} = 0$$

$$H_a: \mu_i \neq 0 \text{ for some } i \neq j$$

The test statistics is obtained by:

$$F = \frac{RSS_{Restricted} - RSS_{Unrestricted}/N - 1}{RSS_{Unrestricted}/NT - N - K} \sim F_{N-1, NT-N-K}$$

where $RSS_{Restricted}$ is the residual sum of squares for the restricted model (Pooled OLS), $RSS_{Unrestricted}$ is the residual sum of squares for the unrestricted model (LSDV) model. $F_{N-1, NT-N-K}$ is the usual F-distribution with $N - 1$ and $NT - N - K$ degrees of freedom for the numerator and denominator respectively (K is the number of predictor variables). Details are well presented in [13] and [14], [15] and [16]. [17], [18] and [19] are among known references of early applications of error components in economics.

3.2 The Durbin-Watson Test for Autocorrelation

The Durbin-Watson (DW) Test checks whether the individual regional data are autocorrelated. Autocorrelation indicates a systematic relationship between the residuals measured at different points in time.

Consider the model

$$y_t = a + bx_t + \epsilon_t \quad (5)$$

The idea is that $cov(\epsilon_t, \epsilon_{t-1}) \neq 0$.

The systematic relationship is captured using a simple linear regression model with errors following an autoregressive process of order 1.

$$\epsilon_t = \rho\epsilon_{t-1} + e_t \quad (6)$$

where ϵ_t and ϵ_{t-1} are the errors from (5) at time t and $t-1$ respectively. ρ is the correlation coefficient and e_t is white noise.

From (6) we test the following hypotheses.

$$H_0: \rho = 0$$

$$H_a: \rho \neq 0$$

The test statistic is given by:

$$D = \frac{\sum_{t=2}^n (\epsilon_t - \epsilon_{t-1})^2}{\sum_{t=1}^n \epsilon_t^2}$$

The test rejects H_0 if $D < d_L$ where d_L is the lower limit of the DW critical value. Similarly, the test fails to reject H_0 if $D > d_U$ where d_U is the upper limit of the DW critical value. However, we say the test is inconsistent if $d_L \leq D \leq d_U$ ([20]).

4 Results

4.1 Prevalence of MMR

The first objective of the current study was to determine the prevalence of MMR in Ghana. The results indicated a downward trend in MMR. Figure 1 shows that MMR for the country declined by 16.93% from 2002 to 2005. However, it increased by 35.57% from 2005 to 2007; then declined again by 26.15% from 2007 to 2009.

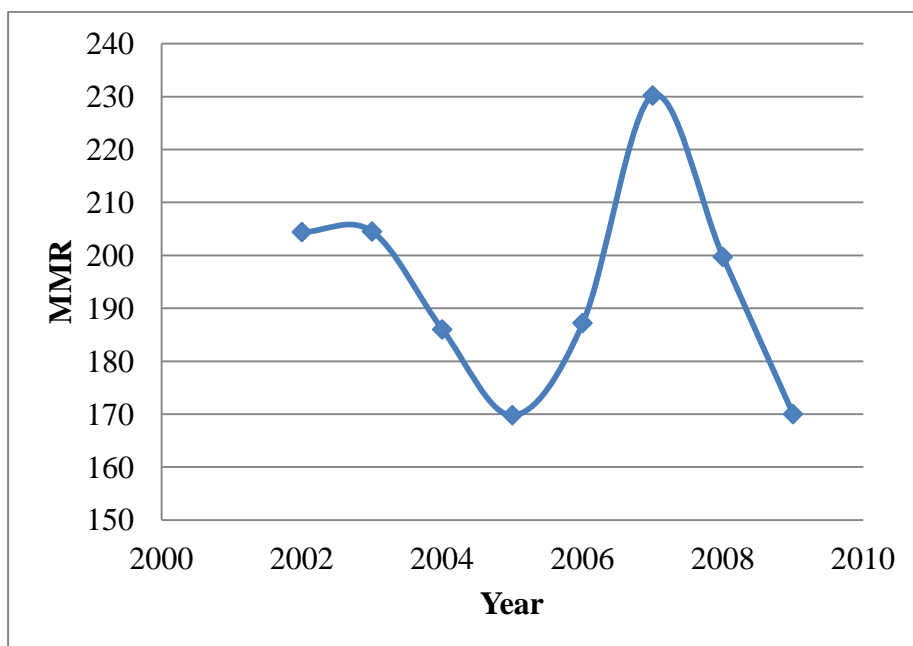


Figure 1: National Trend in MMR

Generally the trend in MMR was on the decline for all the regions except AR and UW. The MMR for AR remained consistently high but dropped by 14.89% between 2008 and 2009. That for UW increased by 121.39% from 2008 to 2009 (see Figure 2).

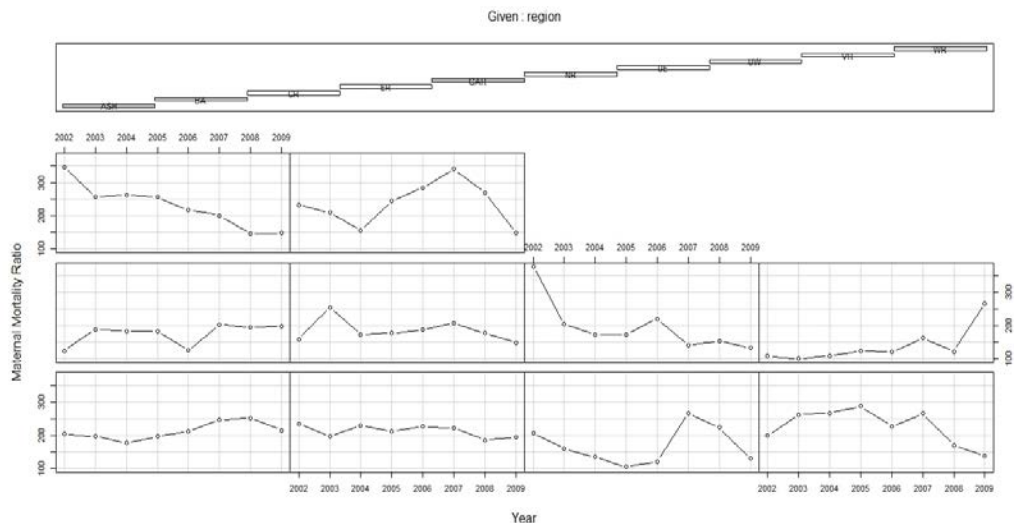


Figure 2: Regional Trend in MMR

Table 2: Panel Data Regression Models

	Pooled OLS Regression Model		LSDV Regression Model	
	Estimate	P-value	Estimate	P-value
Intercept	319.6400	0.0000***	-	-
DPR	-0.0003	0.4285	0.001653	0.1175
NPR	0.0215	0.1311	0.025604	0.2140
ANC	-0.1158	0.8642	-1.025421	0.3833
PNC	-0.7355	0.2779	-0.801439	0.3630
SKD	-1.7061	0.0007***	-2.452448	0.0000***
FPA	-0.3789	0.4406	-0.29416	0.6873
ASH	-	-	379.853855	0.0010***
BA	-	-	400.601955	0.0030***
CR	-	-	402.262675	0.0045***
ER	-	-	431.445384	0.0004***
GAR	-	-	385.574868	0.0003***
NR	-	-	283.086357	0.0801*
UE	-	-	383.160053	0.0042***
UW	-	-	310.450778	0.0181**
VR	-	-	382.486831	0.0012***
WR	-	-	354.563356	0.0069***

*** p<0.01, ** p<0.05, * p<0.1

4.2 Predictors of MMR at the National Level

Table 2 presents data on predictors of MMR at the national level. The results indicate that, after estimating both the Pooled OLS and LSDV regression functions, SKD ($p < 0.01$) significantly predicted MMR, while DPR, NPR, ANC, PNC and FPA did not in both functions. However, the simple chow test indicated that the estimated LSDV regression function provided a better fit

$$(F_0 = 2.456, df_1 = 9, df_2 = 64, p - vaue < 0.05).$$

Also, 96.0% of the variability in MMR can be accounted for by the estimated LSDV regression function as compared with 29.9% of the variability in MMR that can be explained by the estimated Pooled OLS function. This comparison confirms further the appropriateness of the estimated LSDV regression function as a better model.

4.3 Predictors of MMR at the Regional Level

Table 3 shows that data on predictors of MMR at the regional level. Fitting the OLS regression models to the 10 regional data after checking for autocorrelation (see Table 4), SKD significantly predicted MMR in only three regions:

$$AR (R^2 = 0.816, p < 0.01), \quad WR (R^2 = 0.655, p < 0.05)$$

$$\text{and} \quad CR (R^2 = 0.608, p < 0.05).$$

Table 3: Estimated OLS Regression Functions

Region	SKD		DPR		NPR		FPA	
	Est.	R^2	Est.	R^2	Est.	R^2	Est.	R^2
ASH	-2.051**	0.8164	-0.009*	-	-	-	-	-
CR	-2.467**	0.6078	-	-	-	-	-	-
GAR	-	-	-0.006*	0.4443	-	-	-	-
UE	-	-	-	-	0.148*	0.4607	-9.545	0.4369
VR	-	-	-	-	0.301**	0.6934	-	-
WR	-5.321**	0.6546	-	-	-	-	-	-

** $p < 0.05$, * $p < 0.1$

Table 4: Test for Autocorrelation

Region	Lag	Estimated Rho	D	P-Value
ASH	1	-0.1896	2.2079	0.9700
BA	1	-0.1154	1.8714	0.6720
CR	1	-0.2118	1.7266	0.5820
ER	1	0.2830	0.9975	0.0840
GAR	1	-0.1780	2.0168	0.8380
NR	1	-0.2811	2.2901	0.7900
UE	1	0.1695	0.8749	0.0960
UW	1	-0.2208	1.7271	0.4540
VR	1	0.1218	1.0238	0.0760
WR	1	-0.2761	1.9676	0.7880

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, $d_L = 0.763$ and $d_U = 1.333$

Even though SKD was the only significant predictor of MMR for the panel data, the estimated OLS regression functions revealed that DPR significantly predicted MMR in

AR ($R^2 = 0.461$, $p < 0.1$) and ER ($R^2 = 0.444$, $p < 0.1$).

Similarly, NPR significantly predicted MMR in

VR ($R^2 = 0.693$, $p < 0.05$) and UE ($R^2 = 0.461$, $p < 0.1$).

Finally, FPA significantly predicted MMR only in

UE ($R^2 = 0.440$, $p < 0.1$).

5 Concluding Remarks

Results of the study suggest the LSDV as a potentially effective analytic tool for identifying significant predictors of MMR using the Panel Data. A major finding of the study was that it identified SKD as a critical predictor of MMR at the national level. There is the need for health providers in Ghana to address the constraints against skilled care delivery. [8], for example, identified underfunding of user fee exemptions as a barrier against the provision of skilled care delivery in the country [21] identified delays— in the home, accessing a health facility, and delays at the health facility as other major constraints against skilled care delivery.

Descriptive data revealed disparities in the trends of MMR for the period of evaluation among the regions. The results identified the UW region as an outlier with an unacceptably high MMR— it increased by over 121% from 2008 to 2009.

There is the need for an urgent investigation to identify effective strategies for reducing MMR in the UW region. The findings of the present study suggest that socio-cultural practices in that region be part of such investigation. For as noted, some women in the UW region prefer to deliver with their mother-in-laws ([22]).

The OLS identified predictors of MMR using the regional data. Some variables were not significant predictors of MMR in some regions. This could be a result of excessive expenditure on those variables, such that diminishing returns could have set in. Examining the distribution of government expenditure on these variables by region could help optimize the use of such resources to reduce MMR. Policy makers in Ghana would do well to identify and target region specific predictor variables for the efficient allocation of resources in reducing MMR.

The findings of the present study have implications for future research. First, the current study utilized secondary data—the use of prospective research on the determinants of MMR, especially at the regional level is warranted. Second, midwives play a very important role in skilled delivery in developing countries. Midwife population ratio was not included in the current research due to missing data for the variable. Future research needs to incorporate Midwife population ratio as a predictor variable for MMR. Third, in light of the immense contributions of women to national development, the study of the effect of MMR on GDP for Ghana is warranted.

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