Explaining Areal Variations in Contraceptive Use in East Africa

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Abstract

Preliminary research findings are presented for the determinants of the use of modern contraception in three East African countries (Kenya, Malawi and Tanzania) and the importance of these determinants in accounting for the areal variation in contraceptive use. This study analyses Demographic and Health Surveys data for each country using multilevel logistic regression models. The findings show that there are similarities in the factors associated with modern contraceptive use in each country. The individual / household factors do account for some areal variation in contraceptive use, but significant variation remains. There is evidence that this unexplained variation is accounted for by unobserved contextual factors.

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Explaining Areal Variations in Contraceptive Use in East Africa

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Introduction

Many developing countries contain substantial geographic variations in modern contraceptive use (Amin, Basu and Stephenson 2002: National Research Council, 1993). The application of multi-level modelling techniques has often found that areal (sub-national geographic) variations in contraceptive use remain after controlling for individual, household and community factors (Amin, Basu and Stephenson 2002). These variations could be attributed to a number of unobserved contextual factors, such as cultural beliefs, reproductive health service provision, the physical characteristics of the area, macro-economic factors, or the presence of transport routes. However, there is a lack of detailed research examining the possible impact of such factors.

The main sources of contraceptive use data for developing countries are Demographic and Health Surveys (DHS). Recently these surveys, especially in sub-Saharan Africa, have collected a global positional system (GPS) locator for the primary sampling units (PSU) in the survey. This now allows for the linking of other contextual data sources to the DHS data to further explain areal variations in modern contraceptive use. This research aims to advance the methodology used to explain areal variations in contraceptive use in developing countries through combining multilevel modelling and Geographic Information System techniques. Furthermore, detailed maps of the modelling results and contextual data can be plotted in order to better inform researchers and local policymakers, by highlighting the characteristics of those areas with unusually high or low levels of contraceptive use.

The overall aim of this project is to explain areal variations in modern contraceptive use in three East African countries using a combination of DHS data and contextual data sources. The research detailed in this paper is from the initial phase of this work. This had the following specific objectives:

1) To quantify, using data from the DHS, the determinants of modern contraceptive use in three East African countries.

2) To identify the importance of these determinants in accounting for areal variation in contraceptive use
3) To identify communities of unusually high or low contraceptive use within each of these countries after controlling for a range of demographic and socio-economic variables.
4) To map the outlying communities within each country and to examine the variations in modern contraceptive use both within and between the countries.

Three East African countries were selected for this study, Kenya, Tanzania and Malawi. The selection of these countries was restricted to countries with DHS data that contains the global positional system (GPS) location identifier necessary to allow the mapping of PSUs. The selection of neighbouring countries also allows the identification patterns of areal variations that may transcend political boundaries.

Background

East Africa is an area where modern contraceptive use was historically low but is now increasing (DHS reports – see *Data and Methodology*). However, there has been little examination of the factors influencing variation in the use of modern contraceptive methods in this setting. Figure 1 shows the current use of modern methods by women in each of the study countries. Contraceptive use varies from 23.6% in Kenya to 15.6% in Tanzania, with injectibles and the pill being the main methods used.

Research concerning the use of modern methods of contraception has typically concentrated upon the effect of individual and household level factors, plus service provision. There is limited evidence as to how community contextual factors may influence variation in the use of contraceptive services (Stephenson and Tsui 2002). Furthermore, in sub-Saharan Africa, research has typically concentrated on the use of any contraceptive method rather than the use of modern methods or any examination of areal (sub-national) variations in contraceptive use. This is probably because modern contraceptive use has typically been very low and increasing uptake has only occurred recently.

Demographic factors that influence contraceptive use include age, parity and marital status (DHS reports; Clements and Madise, 2002). These may be mitigated by behavioural and biological factors such as sexual activity, the desire for children and fecundity. Furthermore, women in poor socio-economic circumstances are less likely to use contraception (National Research Council 1993; Curtis and Nietzel 1996). For example, in some parts of sub-Saharan Africa women who have attended secondary education are ten times more likely to use contraception than those with no education (Curtis and Nietzel 1996). Education is typically used as a measure of socio-economic status, otherwise indicators of work status or quality of household amenities (water, sanitation etc.) tend to be used. Consequently, any spatial variation in the above factors would contribute to areal variation in modern contraceptive use.

Independent of socio-economic factors, lack of knowledge of modern methods of contraception is clearly a key reason for non-use (Bongaarts and Bruce, 1995; Curtis and Nietzel, 1996). In Tanzania, the success of media campaigns have been linked with the increased used of modern methods (Jato et al., 1999; Rogers et al., 1999), and access to media is likely to vary. An individual woman's attitudes, beliefs or religion can also influence her contraceptive use directly or indirectly through her desire for children. More traditional beliefs can support the demand for large families and limit the uptake of contraception, particularly non-traditional methods (Caldwell and Caldwell, 1987; Clements and Madise, 2002). Clearly, any variation in knowledge and attitudes could potentially create areal variations in modern contraceptive use.

Women living in poorer households tend to use modern methods least (National Research Council 1993, Clements and Madise, 2002). As women in poorer households tend to have less autonomy this will impact upon their contraceptive use through familial disapproval of contraception (Bongaarts and Bruce 1995). Consequently, as household poverty varies this is likely to effect areal variation in contraceptive use. For similar reasons, other research has shown instead that women whose partners are in poor socio-economic circumstances, or who have received less education, are less likely to use contraception (National Research Council 1993; Curtis and Nietzel 1996; Clements and Madise 2002).

Evidence from a number of countries has pointed towards the partner's disapproval as a key factor for non-use of contraception (Bongaarts and Bruce, 1995). Effective communication with partners and other important household members may help to reduce barriers to contraceptive use (Salway 1994). However, it is not known if such factors influence areal variation in modern contraceptive use.

Data and Methodology

The contraceptive use, individual and household data were obtained from the latest available Demographic and Health Surveys (DHS) conducted in each of the study countries. For Tanzania, the 1999 interim DHS data were used because the survey was conducted in a similar time period to that of the other surveys. Furthermore, GIS data were not collected for the last full Tanzania DHS in 1996. The surveys used are as follows:

Kenya 1998: (National Council for Population and Development, Central Bureau of Statistics and Macro International Inc. 1999)
Malawi 2000: (National Statistical Office and ORC Macro. 2001)
Tanzania 1999: (National Bureau of Statistics and Macro International Inc. 2000)

For the analysis of modern contraceptive use, only those women considered 'at risk' of conception and therefore potential contraceptive users were included. A conservative measurement of the number of women 'at risk' of conceiving in each survey was calculated by excluding, from all women interviewed, those women who were currently pregnant or who had not had previous sexual intercourse. The individual and household factors selected from the relevant DHS were chosen from those highlighted by past research as potential explanatory factors. The factors analysed are shown in Table 1.

The DHS collect data for a number of primary sampling units (PSU) within sub-national administrative areas. Consequently, and given that contextual data are likely to be measured both at a small area (PSU) and large area level (administrative area), there are three levels of hierarchy in each dataset: individual / household, PSU and administrative

area or ‘district’. There are too few women per household to include household as a separate level in the analysis. The location of the primary sampling units were obtained from ORC Macro. They were collected using global position system locators (Montana and Spencer 2001). International and sub-national boundary data were obtained from the African Population Database (National Center for Geographic Information and Analysis, University of California).Data were plotted using ArcView GIS (© ESRI International).

The PSUs are determined by the design of each survey. However, in some cases there is a choice in the boundaries to take as the ‘district’ level. In Kenya the pre-1993 districts were chosen because of the lack of appropriate GIS boundary data and because the study design was based upon these areas. There were also fewer districts in 1993 which meant individual district values could be estimated more precisely. In Malawi the current district structure was chosen. In Tanzania the DHS region was chosen. This combines the five regions in Zanzibar into two regions, otherwise the regions are the same as the administrative regions. This was chosen because the study was designed using the DHS regions and because of the small sample size in some regions of Zanzibar. A summary of the data hierarchy is given in Table 2.

In order to analyse the data multilevel modelling techniques are employed because of the hierarchical nature of the data set and in order to analyse the factors accounting for the areal variation in the reproductive health outcomes. The dependent variable in the analysis is binary (use or non-use of a modern method of contraception).A multilevel logistic model is the most appropriate to fit to binary outcome data as the model parameters can easily be interpreted as odds ratios[1]. The models are estimated using the MLwiN software package (Goldstein et al. 1998). The design of each survey is accounted for by including the factors used in stratifying the sample as either covariates or levels in the model. However, the analysis is not weighted as this can potentially bias random effects in multilevel level models (Brown, Madise and Steel, 2002). Instead, in all three countries, the design of each survey was accounted by the levels of the multilevel model and by urban-rural residence.

Results

Figure 2 shows the variation in modern contraceptive use for at risk women in the three study countries. All three countries show substantial variation. For ‘at risk’ women in Kenya, modern contraceptive use varies from 5% in Kirinyaga district to 56% in Nyeri district. For ‘at risk’ women in Malawi, modern contraceptive use varies from 8% in Dowa district to 38% in Blantyre district. Whereas, for ‘at risk’ women in Tanzania, modern contraceptive use varies from 6% in Mara region to 43% in Kilimanjaro region.

The results from modelling individual / household factors are shown in Table 3. All the demographic and biological factors are significant predictors of modern contraceptive use in all three countries. In general, women aged under 40, higher parity women and those formerly or never married are more likely to be using modern methods. Not surprisingly fecund women are more likely to use modern contraception than non-fecund women, whilst the latter women are significantly more likely to use modern contraceptive methods more than those currently breastfeeding, except in Malawi.

There was evidence of an association between women’s educational attainment and modern contraception use in Malawi and Tanzania, where the more educated were more likely to use modern methods. Similarly, there was also an association with occupation, but only in Kenya and Malawi. However, the significance of both these factors in Tanzania may be explained by the fact that this model was unable to account for partner’s occupation and education.

Factors shaping knowledge and attitudes towards fertility and contraception are also shown to be determinants of contraceptive use in the presence of other factors. Those women who wanted a child in the next 12 months were much more likely not to be using a modern method. Meanwhile, those who had heard of family planning through media messages were more likely to use modern methods, except in Tanzania. However, the association between modern contraceptive use and religion is weak. It is only significant in Malawi.

The results in Table 3 also show the importance of the women's partner and household in determining modern contraceptive use. If her partner currently lives with her, is educated to secondary level or the household has more basic amenities (except in Tanzania), then she is more likely to use a modern contraceptive method. There is also some evidence a limited spousal age difference encourages use in Kenya. However, partner's occupation and the respondent's autonomy in financial decision making are not significant predictors of use. Otherwise, the partner's approval of family planning plus discussion of family planning with her partner are strongly associated with modern contraceptive use. The household amenities index is included in each model, as opposed to the household assets index, as it was found to best reduce the unexplained areal variation across the three countries.

Overall, these factors reduce the initial unexplained district variation by 43%, 29% and 36% in Kenya, Malawi and Tanzania respectively. The initial unexplained PSU variation is reduced by 56%, 25% and 78% in Kenya, Malawi and Tanzania respectively. The large amount of PSU variation explained in Tanzania is possibly partly due to the variation in survey design, between PSUs within districts, that is unique to Tanzania of the three countries. The individual / household factors that notably account for the district variation are household amenities, husband's approval of family planning and marital status. However, significant unexplained variation remains. Meanwhile, the individual / household factors that primarily account for the PSU variation are marital status, household amenities, discussion of family planning with partner and exposure to family planning messages in the media. However, the amount of PSU variation accounted for varies by country and significant unexplained variation remains, except in Kenya.

The district residual variation in modern contraceptive use, after controlling for individual and household factors is plotted in Figure 3. As three separate models were fitted, standardised comparative residuals were calculated to allow for comparison of the remaining unexplained variation across the three countries. They show a cluster of high and low residual areas. Parts of southern Malawi, coastal Tanzania and central Kenya

typically have higher use than predicted by the model. Conversely, parts of western Kenya and northern Tanzania have lower use.

Discussion

The findings have shown that there are similarities in the factors associated with modern contraceptive use in each country. Most factors are significant and the findings conform to those previously suggested by earlier research. The individual / household factors do account for some areal variation in contraceptive use, but significant variation remains. This indicates that unobserved contextual factors could account for the remaining areal variation. This is also highlighted by the geographic pattern of district residual variation.

The individual / household factors noted as important for accounting for variation are likely themselves to vary across each country, hence their importance. For example, the household amenities index is likely to vary because of sub-national variation in water and sanitation provision. Consequently, such factors could also be considered as contextual and indeed their significance may reflect similar unobserved contextual factors. The relevant contextual factors can be considered as health or non-health related factors.

Clearly, a key health related factor is the provision of family planning services. Research evidence has tended to show that the presence of family planning services increases contraceptive use (Bongaarts and Bruce, 1995; Tsui and Ochoa, 1992). Provision of contraception will vary within countries, dependent upon policy, the funding available and any specific targeting of services. Residual variation could be due to variation in health service policies and interventions in specific areas such as the Dar es Salaam urban health project (Few et al. 2003). A poor communications infrastructure to access those services that do exist, plus limited access to the mass media which may promote family planning and less traditional ways of life (National Research Council 1993; Nazzar et al. 1995) may also influence use. Indeed, exposure to family planning messages is important in accounting for PSU variation.

Situation analyses conducted in Nigeria, Tanzania and Zimbabwe have shown that family planning services can vary widely in their content and quality (Mensch et al. 1994). However, this variation was only weakly associated with the use of the contraceptive services. Contrary to this, other research has found the opposite. Stephenson and Tsui (2002) in an analysis of reproductive health service use in India also find that the uptake of services is related to certain characteristics such as the number of contraceptive methods available. They emphasize the importance of choice in improving the uptake of family planning.

Thus, there is much evidence of areal variation in the quality and characteristics of contraceptive services. However, whether this effects contraceptive use is less clear. It may depend more specifically upon the setting and characteristics involved, or the degree of areal variation that exists. Furthermore, research has also noted that perceptions of contraceptive services can influence their utilization (Basu, 1990; Obermeyer 1993). For example, in rural areas of Tanzania, community level perceptions of family planning services have been found to influence contraceptive use (Mroz et al., 1999). It is also important to consider the effect of HIV/AIDS on reproductive decision making. Variation in the levels of HIV infection may impact upon the areal variation in contraceptive use. However, there is limited information relating to this at a sub-national level.

Across sub-Saharan Africa, areal variation in contraceptive use has been partially attributed to levels of development and infrastructure as well as the variation in the socio-economic characteristics of residents (National Research Council 1993). This is also highlighted by the importance of the household amenities index which as it uses water, sanitation provision is likely to vary contextually. Furthermore, economic development may influence contraceptive use indirectly through access to health services (Diez-Roux 1998), or through its relationship with female autonomy and positive attitudes towards health service use (Alan Guttmacher Institute 1998). The importance of partner's approval of family planning and discussion of family planning in accounting the areal variation in the models may be reflecting such contextual factors.

The contraceptive decision-making process is known to be influenced by socio-cultural norms and behaviour (Bongaarts and Bruce, 1995; Nsemukila et al 1999), as shown by the importance of the demand for more children indicator. Both demographic and socioeconomic determinants of contraceptive use are mediated by cultural influences that shape the way an individual perceives their own health and the health services available (Stephenson and Tsui 2002). In general, across sub-Saharan Africa, the persistence of traditional cultural values tends to enhance the demand for large families (and especially sons in certain cultures), whilst restricting the use of contraception. Religious beliefs and customs may constrain women's autonomy, promote a traditional lineage system and reject the uptake of western lifestyles and products (Caldwell & Caldwell 1987; Nazzar et al.1995; Casterline et al. 2001). Consequently, some of the factors highlighted by the models, plus the remaining areal variation in contraceptive use may be attributable to such community level socio-cultural factors.

Further research is naturally required to investigate whether such contextual factors do account for the remaining unexplained variation in modern contraceptive use. Consequently, in the next phase of this project, information on the contextual characteristics of PSUs and districts will be collected and investigated as potential determinants of areal variations in contraceptive use.

NOTES

1: The multilevel logistic model is written as:

$$Y_{ijk} = \pi_{ijk} + \varepsilon_{ijk} Z_{ijk}$$

where: $\log_e (\pi_{ijk}/(1- \pi_{ijk})) = \alpha + \beta \mathbf{X}^T_{ijk} + U_{jk} + V_k$

Y_{ijk} is the binary response (use of contraception, use of health facilities for childbirth) for individual i in PSU j in district k. Y_{ijk} are assumed to be independent Bernoulli random variables with the probability of contraceptive use or use of health facilities for childbirth $\pi_{ijk} = Pr (Y_{ijk}=1)$. Consequently, to correctly specify the binomial variation, Z_{ijk} denotes the square root of the expected binomial variance of π_{ijk} and the variance of the individual residual term ε_{ijk} is constrained to be one. The outcome variable $\log_e (\pi_{ijk}/(1- \pi_{ijk}))$ fitted in the model is the $\log_e$ odds of use versus non-use. This constrains the predicted values from the model to be between zero and one. α is a constant, whilst β is the vector of parameters corresponding to the vector of potential explanatory factors defined as $\mathbf{X}_{ijk}$. The PSU (level 2) residual term is defined as $U_{jk} \sim N(0,\sigma^2_u)$ and the district (level 3) residual term is defined as $V_k \sim N(0,\sigma^2_v)$.

2: The fecundity measure uses the standard DHS variable (V623) for fecundity, itself derived from survey responses, that differentiates between pregnant women, postpartum amenorrheic women, menopausal or infecund women, and fecund women. It is recoded to classify all non-fecund categories into one group. However, an additional category is added for those who currently state they are breastfeeding.

3: The measure of exposure to family planning media messages was derived from five possible media sources. In the surveys the respondents are asked whether they have heard about family planning through either television, radio, newspapers, posters or brochures. Exposure to any one of these family planning messages is contrasted against no exposure. In Kenya and Malawi, the respondents were not asked about family planning messages on posters or brochures, and so the measure here is restricted to the other three mediums.

4: Two measures of household wealth were created. A simple measure based upon the provision of basic amenities and a more sophisticated measure based upon a range of household assets. Three variables were included in the simple household amenities score: source of drinking water; toilet facilities and the type of floor material. The factors were grouped into three categories so that a limited amenity was given a zero score, a moderate amenity was given a score of a half, and those with a good amenity were given a score of one. The household amenity score was created by summing the scores for the three countries.

Ten measures were used to create the assets index: source of drinking water, toilet facility, type of floor material, provision of electricity and ownership of a radio, television, refridgerator, bicycle, motorbike or car. The first three variables were transformed into binary indicators by identifying whether the household had access to piped drinking water, a flush toilet or finished flooring. In each of the ten measures the provision of the asset was given a score of one. A weight was then attached to each asset to indicate its importance, where assets rare in each setting were given a higher weight. These weights were derived from the inverse proportion of households having the specific asset in the relevant urban or rural setting of each country. Thus, having a flush toilet in a rural setting typically obtains a higher weight than for a urban setting. The index was then created by adding together the weighted number of assets. For each country the score was then categorised into five groups with roughly equal numbers of 'at risk' women in each group. In Malawi, the index was based upon nine assets, as the question on ownership of a refridgerator was not asked.

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Table 1: Potential individual / household explanatory factors for contraceptive use

Demographic & biological	**Socio-economic**	**Knowledge, attitude**	**Household**
Age	Education	Religion	Husband lives in house
Parity	Occupation	Respondent wants a child within next 12 months	Partner's education*
Marital status			Partner's occupation*
Fecundity[2]		Heard about family planning through media[3]	Who decides how to spend money?*
			Husband approves of family planning
			Discussed family planning with partner
			Spousal age difference*
			Household amenities index[4]
			Household assets index[4]

*Not available for Tanzania

Figure 1: Modern Contraceptive use by method type

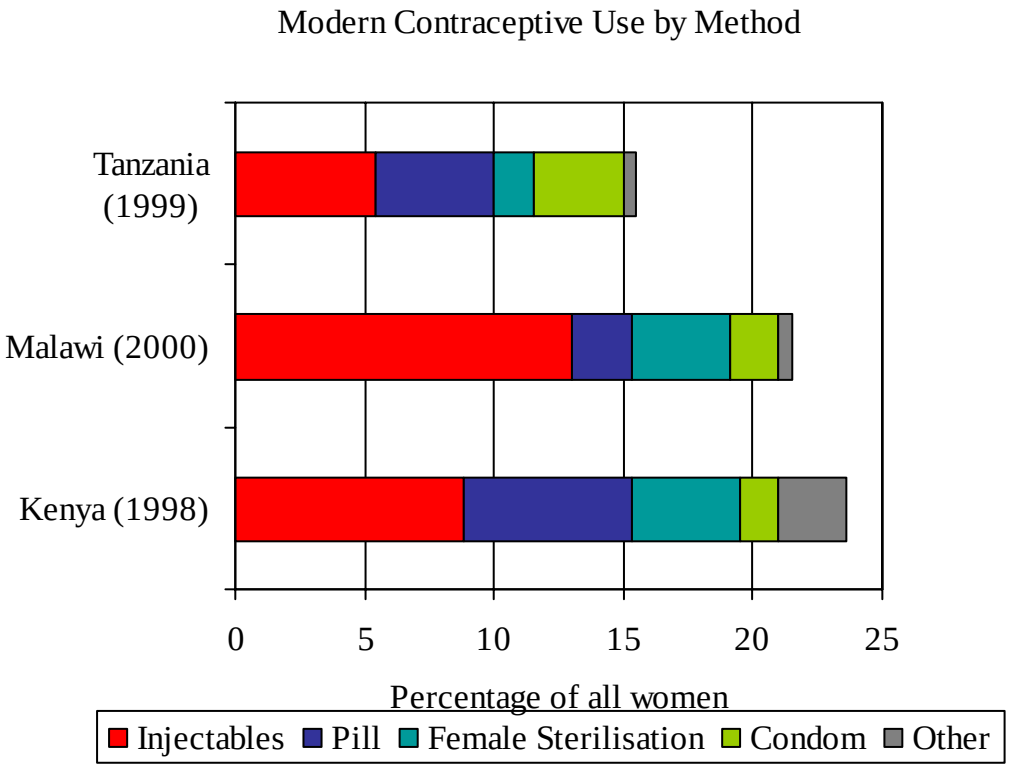

Table 2: Hierarchical structure of the datasets

Country	Survey			At risk Population		
	Women	PSUs	Districts	Women	PSUs	Districts
Kenya	7,881	530	33	6,013	530	33
Malawi	13,220	560	26	10,291	559	26
Tanzania	4,029	176	22	3,047	176	22

Figure 2: Variation in Modern Contraceptive Use

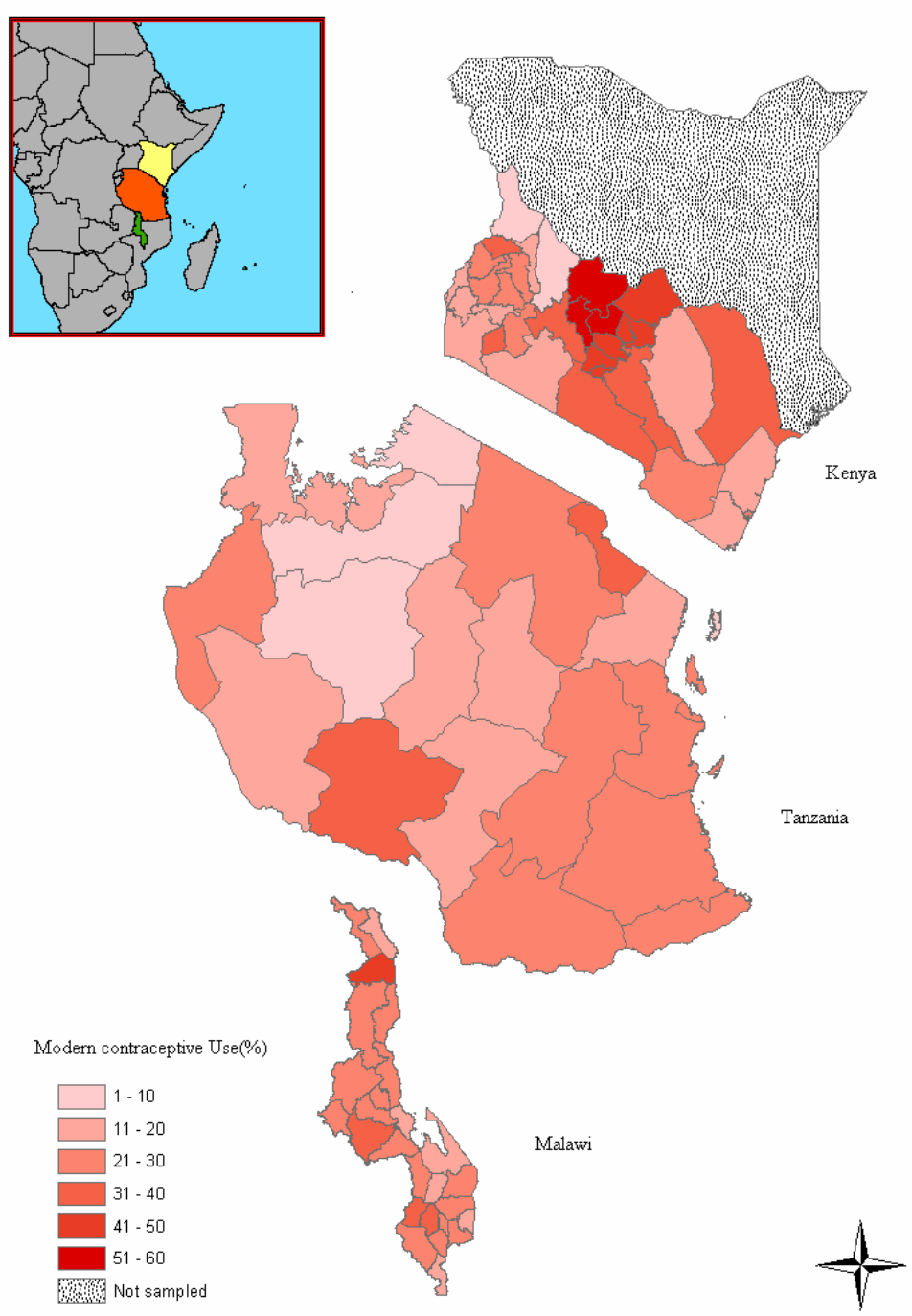

Table 3: Modelling Results

	MALAWI				KENYA				TANZANIA		
		ODDS RATIO				*ODDS RATIO*				*ODDS RATIO*	
Place of residence:											
Urban	0.089	1.09			0.147	1.16			0.567	1.76	**
(rural)											
Want to have a child in the next 12 months											
another answer	1.946	7.00	***		2.270	9.68	***		1.503	4.50	***
(yes)											
Fecundity											
Breastfeeding	-0.004	1.00			-0.398	0.67	**		-0.611	0.54	*
Fecund	0.704	2.02	***		0.987	2.68	***		0.653	1.92	**
(not fecund)											
Age group											
15-19	0.747	2.11	***		0.179	1.20			0.868	2.38	**
20-29	0.931	2.54	***		0.512	1.67	***		1.168	3.22	***
30-39	0.479	1.61	***		0.296	1.34	**		0.489	1.63	*
(40-49)											
Parity											
1-2	0.999	2.72	***		1.523	4.59	***		1.034	2.81	***
3-4	1.588	4.89	***		1.748	5.74	***		1.270	3.56	***
5+	2.053	7.79	***		2.001	7.40	***		1.412	4.10	***
(none)											
Marital status											
Nevermarried	1.025	2.79	***		0.955	2.60	***		1.280	3.60	***
formely married	0.814	2.26	***		0.474	1.61	*		1.071	2.92	***
Polygamous	-0.03	0.97			-0.115	0.89					
(monogamous)											
Respondent's education											
Primary	-0.01	0.99			0.184	1.20			0.351	1.42	*
secondary / higher	0.297	1.35	**		0.122	1.13			0.501	1.65	*
(no education)											
Respondent's occupation											
Prof./Manag./Tech./ Clerical / Sales / Services	0.144	1.15			0.383	1.47	*		0.883	2.42	***
Agriculture	0.02	1.02			0.019	1.02		Agriculture / Don't know	-0.282	0.75	
Hhdomestic	-0.308	0.73			-0.041	0.96					
Manual	0.089	1.09			0.622	1.86	**		0.117	1.12	
Other	-0.307	0.74									
(not working)											
Religion											
Ccap	-0.105	0.90		protestant christian	-0.048	0.95		protestant christian	0.083	1.09	
Anglican	0.359	1.43	*								
seven/Baptist	0.228	1.26	*								
other Christian	-0.083	0.92									
Muslim	-0.205	0.81			-0.154	0.86			-0.043	0.96	
no religion	-0.274	0.76			-0.554	0.57		no religion / other religion	-0.318	0.73	
other religion	-0.503	0.60			0.463	1.59					
(catholic)											

Partner living in household									
staying elsewhere	-0.285	0.75	**	-0.277	0.76	**	-0.658	0.52	**
(living with her)									
Partner's education									
Primary	0.054	1.06		0.174	1.19				
secondary / higher	0.364	1.44	**	0.595	1.81	**			
(none)									
Spousal age difference									
same age	-0.015	0.99		0.249	1.28				
partner 2-4 yrs older	0.018	1.02		0.244	1.28	**			
women younger	0.149	1.16		0.526	1.69				
(partner 5+ yrs older)									
Partner's occupation									
Prof./Manag./Tech./ Clerical / Sales / Services	0.012	1.01		-0.010	0.99				
household & domestic	-0.001	1.00		0.168	1.18				
skilled manual	-0.004	1.00		-0.136	0.87				
unskilled manual	-0.188	0.83		0.208	1.23				
Other	0.189	1.21							
not working				-0.215	0.81				
(agriculture)									
Partner approves of family planning									
Approves	1.326	3.77	***	1.351	3.86	***	0.895	2.45	***
don't know	-0.775	0.46	**	-0.059	0.94		-0.504	0.60	
(disapproves)									
Discuss family planning with partner									
once or twice	0.439	1.55	***	0.415	1.51	**	0.788	2.20	**
more often	0.889	2.43	***	0.694	2.00	***	1.330	3.78	***
(never)									
Who decides how to spend money?									
Partner	0.118	1.13		0.075	1.08				
Jointly	0.464	1.59		0.204	1.23				
does not earn cash	-0.067	0.94		0.185	1.20				
(respondent)									
Exposure to FP media									
Yes	0.262	1.30	***	0.237	1.27	**	0.195	1.22	
(no)									
Household amenities index									
None	-0.555	0.57	***	-1.132	0.32	***	-0.623	0.54	
Low	-0.414	0.66	***	-0.445	0.64	***	-0.438	0.65	
Medium	-0.273	0.76	**	-0.328	0.72	**	-0.025	0.98	
(hhindex=High)									

***p<0.001; **p<0.01; *p<0.05

Figure 3: District Residual Variation