Horn of Africa Journal of Business and Economics (HAJBE), 2018, 1(2), PP: 1 – 18

ISSN: 2617-0078 (Print), 2617-0086 (Online))

Explaining Inter-regional Differentials in Child Mortality in Rural Ethiopia: A Count Data Decomposition Analysis

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Abstract

Using data from the Ethiopian Demographic and Health Survey, 2016 for a total of 1,295 number of under-five child deaths, this study examined the major determinants of inter-regional differentials in under-five child mortality in rural Ethiopia. An extended detailed Oaxaca-Blinder decomposition technique to negative binomial regression model was employed to examine the relative contribution of various factors to regional differentials in under-five child mortality. Findings of decomposition analysis indicated that large portion of the regional differentials remained unexplained, being the lowest between Tigrai and Benshangul-Gumuz (12 percent) and the highest in Tigrai-Gambella regions (37 percent). The explained regional gap was due to differences in the distributions of measured factors across regions mainly attributable to differences in short birth-spacing, higher birth-order, antenatal visits, women without education, home delivery, large household size, and poorest households' economic status. Hence, understanding inter-regional differentials in under-five child mortality and developing appropriate policies and strategies could further reduce the rate of under-five child mortality. On top of strengthening the health extension program in rural Ethiopia, this study suggests that more sustained efforts focused on improving households' economic status and women's education should be a prior agenda of the country.

Keywords: *child, decomposition, determinant, Ethiopia, mortality, region, under-five*

1. INTRODUCTION

Child mortality is one among the key indicators of the well-being of population and society, as measured by life expectancy and is considered as one of the Human Development Index's (HDI) dimensions used by the ñUnited Nations Development Programò (UNDP) (Aigbe & Zannu, 2012; NIMS et al., 2012; Patel & Sharma, 2013; UN, 2010). Reducing child mortality can significantly increase the life expectancy and hence, human capital, which is highly required for the overall development of one's nation (MOFED, 2004). The globe has made substantial improvement in overall under-five child mortality reduction. Overall, under-five child mortality rate (U5MR) has fallen dramatically from 12.7 million per year in 1990 to 5.9 million per year in 2015 (UNIGME, 2011, 2012, 2013, 2014, 2015). Despite the progress that the globe has made in reducing the overall child mortality, the rates of progress differ substantially across countries and regions (Shyama et al., 2014). For example, East Asia and the Pacific have exceeded the ñMillennium Development Goalò (MDG-IV) target of a two-thirds reduction in U5MR between 1990 and 2015, whereas sub-Saharan Africa has had only a 24 percent decline over the same period (UNIGME, 2015). Despite the progress the Sub-Saharan Africa made, the region remains with the highest in under-five child mortality rate in the world (Demombynes & Trommlerová, 2012; UNIGME, 2011, 2012, 2013, 2014, 2015). Most of the global under-five child deaths still occur in this region, where one child in every twelve dies before reaching five years of age (UNIGME, 2015). Also, evidence indicates that there is a substantial difference in the rate of progress within sub-Saharan Africa (UNIGME, 2015), where one child in every nine dies before celebrating his or her fifth birthday when compared to the death of one under-five child in every 152 in developed countries (UNIGME, 2012).

Ethiopia is a Sub-Saharan African country experienced sizeable progress in under-five child mortality reduction at the national level, dropping from 211deaths in the 1990s to 88 deaths per thousand births in 2016 (CSA & ICFInternational, 2012), however, the country remains among the highest number of under-five child deaths in the world (UNICEF, 2015b). Although Ethiopia has already achieved its under-five child mortality by two-thirds (68 deaths per thousand births) in 2012 (UNIGME, 2013, 2014) and dropped by 71 percent with average annual rate of reduction of 5 percent between 1990 and 2015 (UNICEF, 2015a), previous studies indicated the existence of substantial variations in the rate of progress across regions of the country (the regions are Afar, Amhara, Benshangul-Gumuz, Gambella, Harari, Oromia, Somali, Southern Nations Nationalities and People (SNNP) (Abebaw, 2013; CSA & ICFInternational, 2012; CSA & ORCMacro., 2006; UNDP, 2012). Oftentimes, the observed differences in the rate of progress across regions have been masked by the overall rate of reduction in under-five child mortality at the national average. Moreover, in Ethiopia, the inter-regional distribution of under-five child mortality indicate the marked regional disparities (Abebaw, 2013; CSA & ICFInternational, 2012; UNDP, 2012). In 2000, for example, the under-five child mortality rate varied from as low as 169 deaths in Tigrai to as high as 233 death per thousand births in Gambella (CSA & ORCMacro., 2000). Similarly, in 2016, the U5MR also varied as low as 85 deaths in Tigrai to as high as 169 deaths per thousand births in Benshangul-Gumuz. The rates of decline in under-five mortality for all regions except Tigrai (85 deaths per thousand births) were significantly lower than the national average rate (88 deaths per thousand births) in 2016, indicating there was a disproportionate inter-regional gain in under-five child mortality rates across times (CSA & ICFInternational, 2012).

Furthermore, despite the overall rate of reduction in under-five child mortality, the magnitude of mortality rate inequalities has significantly varied between regions and over time. For example, the under-five mortality rate of the Ethiopian Somali and Benshangul-Gumuz regions have increased from 93 deaths in 2005 to 122 deaths per thousand births in 2016, and from 157 deaths in 2005 to 169 deaths per thousand births in 2016, respectively. Similarly, the U5MR for the Benshangul-Gumuz region has increased from 157 deaths in 2005 to 169 deaths per thousand births in 2016, a statistic (CSA & ICFInternational, 2012) even higher than for Angola with an under-five child mortality of 167 deaths per thousand, the highest in the world (UNICEF, 2014). This evidence shows that although most regions have reduced the under-five child mortality with different levels of reduction, some of them (Afar, Somali, and BG regions) have found to increase the U5MR instead from 2005 to 2016 (CSA & ICFInternational, 2012; CSA & ORCMacro., 2006). Moreover, compared to many other developing countries the improvement that Ethiopia has made in overall child mortality reduction remains very low. The country has been ranked 37th and is one among the ten top countries with highest absolute umber under-five children deaths (184 deaths per thousand). Hence, Ethiopia accounts for three percent of the share of global under-five child deaths in 2015 (UNICEF, 2015a; UNIGME, 2015). More importantly, about 59 of every one thousand children in Ethiopia are still dying before celebrating the age of five years (UNICEF, 2015a; UNIGME, 2015). Like in many developing countries, in Ethiopia mortality of under-five children in rural areas are considerably higher than in urban areas (CSA & ICFInternational, 2012; CSA & ORCMacro., 2006; Regassa, 2012). A child born in rural areas has 38 percent higher probability of dying than a child of urban counterparts (FMOH, 2014b). Previous studies have also noted that one child in every 11 Ethiopian children under-five dying before reaching the fifth births anniversary (CSA & ICFInternational, 2012; CSA & ORCMacro., 2006). Furthermore, most of the Ethiopian population is still primarily rural. Out of the total population (94 million), more than 15 percent (14.245 million) of them are under-five children (UNICEF, 2014). Since the share of rural population in Ethiopia is huge, combating under-five rural child mortality could further speed up the overall U5MR reduction both at the national and regional levels. The overall rate of progress that Ethiopia has made in under-five child mortality rate (59) is considerably lower than infant mortality (41 deaths per thousand births) (UNIGME, 2015).

Furthermore, in Ethiopia, the regional disparities in under-five child mortality rates were twice higher than in infant mortality rates (UNDP, 2012). This suggests that the importance of addressing disparities in mortality of under-five children to further reduce the overall child mortality of the country. More importantly, much less is known about which factors explaining the regional variations in under-five mortality rates, while majority of previous studies have instead focused on factors influencing infant and under-five child mortality rates in Ethiopia (Amouzou et al., 2014; Dejene & Girma, 2013; Regassa, 2012; Tesfa & Jibat, 2014). These are the rationale as to why this study is carried out and focused on U5MR in rural areas of Ethiopia. This study, therefore, aims at identifying the major factors responsible for inter-regional differentials in under-five child mortality levels in rural settings of Ethiopia.

The remaining of the paper is systematised as follows: review of previous studies is presented in section two. In section three, data source and methodologies are described followed by analysis of results in section four. Section five discusses the findings. The chapter concludes the study in section six.

2. REVIEW OF PREVIOUS LITERATURE

A substantial number of previous studies have evaluated the factors affecting infant and under-five child mortality rates (Caldwell, 1979; Dejene & Girma, 2013; Kabir et al., 2001; Khadka et al., 2015; Shyama Kuruvilla et al., 2014; Srinivasan, 2000). However, despite the overall improvement in under-five child mortality rates across countries, the rate of progress was varied not only across countries or between developing and developed countries, but within a country. In Sub-Saharan Africa where Ethiopian is located, the marked disparities in the rate of under-five child mortality remain very high across the countries (UNIGME, 2012, 2013, 2014, 2015). Hence, within demographic and development economics literature, currently, substantial interest has been observed in identifying and quantifying the separate relative contribution of specific determinants on how each explains the observed regional under-five child mortality differentials across states or regions within a country and across countries. In developing countries, there have been substantial regional, provincial or cross- state differences in infant and under-five child mortality. Hence, reducing the variations in child mortality within and between countries could considerably contribute to the overall health of the population (Houweling & Kunst, 2010). A study by Adedini et al. (2015) examined the sources of regional differentials in infant and under-five child mortality in Nigeria using 2008 demographic and health survey data. The study has applied Cox-proportional hazard regression model to identify the determinants of the regional differentials in child mortality (infant and under-five child mortality) in Nigeria. The findings simply indicated that differences in community infrastructure, households' wealth index, households' poverty status, place of delivery and residence distributions across the regions were the major factors of regional differentials in under-five child mortality while difference in birth-order, birth-spacing, mother's level of education, and mother's age at marriage distributions across regions were the most key factors explaining the regional disparities in infant mortality rate in Nigeria. The study concluded that to substantially reduce the overall child mortality of the country, much efforts should be exerted in addressing the sources of regional variations in these important health indicators by focusing on the disadvantageous regions of the country, however, the authors could not explain the percentage relative contribution of each covariate to the explained regional gap. A study by Jhamba (1999) indicated that despite the dramatic decline in child mortality among district of Zimbabwe, there have considerable disparities across districts. Hence, mother's education, the percentage of households with access to improved water and toilet facility was among the major determinants of regional variation in child mortality in Zimbabwe. Other factors such as malaria epidemic, religious and cultural determinants were also explained the district differentials in child mortality rates in Zimbabwe. Similar regional differences in under-five child mortality have been reported in many other developing countries (references). For example, In Libya, a study by Ghaffar and Bhuyan (2000) examined the factors explaining the regional differentials in child mortality in North-eastern Libya. The study was based on the seven localities and then these localities have developed into three regions namely, Benghazi, Darna, and Tobruk, where five out of the seven localities are found in Benghazi.

In Nepal, the disparities in child mortality by ecological region was examined by Goli et al. (2015). To examine the determinants of regional variation in child mortality, they used an Oaxaca-blinder decomposition technique based on Cox-Proportional hazard regression model using demographic and health survey data. The results of Cox proportion regression indicated that children of Mountainous areas had the highest probability of dying than children of the same cohort living in the other two areas (Hill and Terai). The results of the decomposition analysis revealed that differences due to the proportional differences in children of four birth-order or higher, mother's working status, place of residence, households' economic status, and father's level of education were reported to significantly explained the regional under-five child mortality disparities. The decomposed covariates altogether explained 40 percent of the regional variations in under-five child mortality between the mountain and the combined Hill and Terai regions while the larger 60 percent of the components of the gap remained an unexplained part. Findings of the decomposition analysis revealed that the differences in the proportional distribution of parental educational levels (mother's and father's education) contributed 34 percent of the regional variations in under-five child mortality. However, 30 percent of the explained gap by parental education was attributed to father's level of education, the largest contributor to the ecological differentials in under-five child mortality. The results further indicated that households' wealth status, households' place of residence, higher birth-order along with short spacing (less than 24 moths), and mother's employment status have contributed significantly to 25, 16, 11, and 5 percent of the explained ecological regional differences in under-five child mortality, respectively. In addition, mother's religion and motherœs liberty on healthcare decision have contributed 3 percent each to the explained regional gap in under-five child mortality. Although its relative percentage contribution of the explained gap is very small, mother's exposure to mass media has also contributed to under-five child mortality differences between the two ecological regions. Furthermore, the study indicated that female under-five children are in a les advantageous situation in terms of the survival rate in the country compared to male cohort counterparts. The study has concluded that though Nepal has made a remarkable progress and achieved the ñMillennium Development Goalò four (MDG-IV) in under-five child mortality reduction by two-third, there has been variations in rate of progress in child mortality across its ecological regions. Hence, the disparities in rate of progress of under-five child mortality should be addressed from an ecological region outlook (Goli et al., 2015).

In Mozambique, the geographic disparities in child mortality have been examined using the Mozambican demographic and health survey data of 2003 (Macassa et al., 2012). The ten provinces have been geographically classified into three regions; North, Central and South regions. The study has applied Cox regression analysis to identify the factors explaining the regional differences in under-five child mortality. An under-five child whose mother was living in the North and the central regions had higher mortality risks than a child of a mother who was living in the South regions. The study has also indicated that there have been significant differences in levels of under-five child mortality within the regions (among provinces of the same region). However, although the authors have attempted to indicate why the regional variations occurred in child mortality in Mozambique through discussing the reviewed literature, empirically; the authors have nor explored which factors and how much each did contribute to explain the geographic-specific variations in under-five child mortality. Employing the Iranian demographic and health survey data of 2000, a study by Hosseinpoor et al. (2006) examined the contribution of determinants differentials in infant mortality. The analysis was made using the concentration index based on logistic regression to compute the contribution of specific socioeconomic determinants inequalities in infant mortality. The magnitude of differences in households' economics status (36 percent), and mother's education level (21 percent) were the largest contributors to the regional infant mortality differences in Iran. The paper further indicates that risky or short birth-spacing (13 percent), place of residence (14 percent) and access to improved toilet facilities (12 percent) contributed significantly to the regional disparities in infant mortality rates in Iran. The findings have finally noted that provinces had different levels of inequalities in infant mortality rates (Hosseinpoor et al., 2006).

Similarly, the study of Assi (2014) has attempted to assess the factors explaining regional variations in under-five child mortality in Cote d'Ivoire based on 2016-2012 Cote d'Ivoire demographic and health survey data using logistic regression model. Findings indicated there were considerable variations in child mortality across the region of Cote d'Ivoire. Mother's education at least who completed secondary education was associated with under-five child mortality risk and was found to be statistically significant. However, the study failed to identify the sources of the observed regional variations in under-five child mortality in Cote d'Ivoire rather it has identified the factors affecting under-five child mortality not the regional variations in under-five child mortality rate. More importantly, the study suggested further research be carried out explaining the sources of regional differences in child mortality. Similarly, a study by Akuma (2013) has evaluated regional differentials in infant mortality using the 2009 Kenyan DHS. For analyses purpose, the author has examined the regional differences in infant mortality by classifying provinces of the country into two regions (groups) as low and high infant mortality regions based upon the magnitudes or levels of infant mortality that the provinces had and applied logistic regression model to analysis the data. Hence, the results of the regression analysis revealed that there were regional disparities in infant mortality across regions. The mother's low level of educational attainment, poor socioeconomic status, and short birth spacing were the major determinants of infant mortality for the region of high mortality category that causes the regional variations in infant mortality between the mortality regions (high and low mortality regions). Finally, the author has concluded that the sources of infant mortality differentials across provinces of Kenya are due to differences in households' economic status and social development. However, the study did not consider other important demographic and other socioeconomic factors while examining the regional differentials in infant mortality that. More importantly, findings of the study might not really indicate the sources the regional differentials in infant mortality in Kenya Akuma (2013).

In Asia, a study by Khosravi et al. (2007) evaluated the mortality differentials among the Iranian provinces. Child mortality rates varied among the provinces from 25 to 47 per thousand births. The findings indicated that important sources of variations in child mortality among the Iranian provinces. These are the GDP per capita, life expectancy, and health care accessibility. Provinces having a high GDP per capita and high life expectancy had the lowest rate of child mortality. The Iranian study concluded that variations in child mortality were worse in the rural areas than the urban areas of the country. However, in Iran, the extent of variations in child mortality is lower than the child mortality differentials for other developing countries. Another study evaluating ñinter-district variations in infant mortality in Sri Lankaò indicated that access to health care services, (33 percent); safe drinking water, (16 percent); low childbirth weight, (13 percent); and health care utilization (8 percent) explained infant mortality differences across districts of the country. Findings of the study noted that a unit increment in health care service accessibility and utilization reduces infant mortality rate by 4.3 and 7.1 percent, respectively (Chaudhury et al., 2006).

The reviewed literature revealed that there have been several factors affecting regional differentials in infant and under-five child mortality; however, prior studies available on this domain in Ethiopia have not given due emphasis on examining determinants of regional disparities in infant and under-five child mortality. Therefore, given the lack of empirical evidence on the relative individual contribution of determinants to regional differentials in under-five child mortality, there is a need to systematically examine the major drivers of inter-regional differences in under-five child mortality in Ethiopia. The present study, therefore, aims at quantifying and identifying the major factors responsible for inter-regional differentials in under-five child mortality levels in rural settings of Ethiopia.

3. DATA AND METHODS

3.1. Data source

The study uses data from the Ethiopian ñDemographic and Health Surveyò 2016. The data are a cross-sectional and large-scale health survey carried out in nationally representative sample households across all regions of the country. The survey employed a multistage cluster sampling procedure to select sample households that are nationally representative. Altogether, a total 8,881 households were selected. However, the present study was delimited to a total of 5,481 households from nine administrative regions of rural Ethiopia. There were a total of 5,437 under-five children ever born at the national level. In this study, about 1,295 number of rural under-five deaths were considered for further analysis after excluding those missing values for the variables included in the regression analysis. Details of sampling procedure, data collection tools, and sample design are available in the report of the CSA and ICFInternational (2016).

3.2. Outcome variable

Analysis of this study was limited to rural children whose age is between 0-59 months as a primary health outcome variable (dependent variable), defined as the probability of a child dying by age under-five years per thousand births (CSA & ICFInternational, 2016). While examining the association between under-five child mortality and explanatory variables, the unit of analysis was number of under-five child deaths.

3.3. Explanatory variables (covariates)

Several previous studies have indicated that the importance of various determinants that affects infant and under-five child mortality across various countries (Akuma, 2013; Caldwell, 1979; CSA & ICFInternational, 2012; CSA & Macro, 2006; Dev et al., 2016; Gupta, 1997; Hong et al., 2009; Khadka et al., 2015; Mosley & Chen, 1984; Negera et al., 2013; Regassa, 2012). Hence, the inclusion of a set of explanatory variables in the analyses was mainly guided by these previous studies and availability of data on these potential explanatory variables. In the analytical framework employed in the study analysis, these covariates are grouped into three distinct classifications: I) proximate determinants such as the age of the child, gender of the child, multiplicity of birth, birth-order, birth size, birth spacing, and mother's age at birth. II) socioeconomic determinants such as mother's use of modern contraceptives, antenatal visits, mother's working status, mother's and father's education level, sex and age of household head, household size, and household's wealth index as a proxy measure for household's economic status. III) Environmental determinants such as place of delivery, access to toilet facilities, electricity facility, safe drinking water and household's region of residence.

3.4. An Oaxaca-Blinder decomposition model

Since the response variable is a count data variable, application of linear regression models based O-B decomposition could not be an appropriate technique of decomposition (Bauer et al., 2006). Thus, this warrant to use an extended nonlinear decomposition technique to count data modeling approach (Bauer & Sinning, 2008; Park & Lohr, 2010; Yun, 2004). The differences in the average rate of under-five child mortality for any two groups (regions is in the present context) can be explained by a set of independent variables (O'Donnell et al., 2008) and then are decomposed into two components. Namely, i) the ñexplained componentò is the part of the outcome measure disparity due to differences in the magnitude of observable determinants across the two regions (characteristics or covariates effect), labeled as EC). ii) the ñunexplained componentò is the part of the outcome measure due to differences in estimated effects of theses determinants across the two regions (coefficients effect), labelled as UC) (Blinder, 1973; Fairlie, 2005; Oaxaca, 1973; Powers et al., 2011; Sen, 2014; Wagstaff et al., 2007).

Assume there are N number of under-five child deaths ($U5MR_{ih}^{r}$) (indexed, i = 1., ,., N_r) belonging to h household (h=1,. ,. ,. H) in R mutually exclusive and collectively exhaustive regions, r = 1,.,.,R, each region containing N_r, X_{jr} is a vector of j observable explanatory variables (as explained above), α_{jr} represents a vector of regression parameters to be estimated, and ε_{jr} denotes the error term. Thus, following Bauer et al. (2006); Bauer and Sinning (2008); Park and Lohr (2010); Yun (2004) and Sinning et al. (2008), the O-B decomposition of two regions, continuing with TG as a reference category and HR as a comparison regions for example is computed by:

$$\hat{\Delta}_{NBR}^{TG,HR} = ln(U5MR_{ih}^{r=TG}) - ln(U5MR_{ih}^{r=HR}) = \left[E_{\hat{\alpha}_{jTG}^{NBR}}(U5MR_{ih}^{r=TG}|X_{jTG} - E_{\hat{\alpha}_{jTG}^{NBR}}(U5MR_{ih}^{r=HR}|X_{jHR}\right] + \left[E_{\hat{\alpha}_{TG}^{NBR}}(U5MR_{ih}^{r=HR}|X_{jHR} - E_{\hat{\alpha}_{jHR}^{NBR}}(U5MR_{ih}^{r=HR}|X_{jHR}\right] \quad [1]$$

The first bracketed segment on the right-hand side of equations [1] represents the ñexplained componentò, the differences in under-five child mortality rate due to differences in the magnitude of observable characteristics across the two regions (ñcharacteristics effect or covariates effectò). The second bracketed segment represents the ñunexplained componentò, the regional differences in under-five child mortality rates due to effects of the estimated coefficient of the observable attributes across the two regions (ñcoefficients effectò).

A separate decomposition analysis was performed for the nine regions continuing with Tigrai region as a reference category to examine how much of the overall regional disparity or the relative regional differentials specific to one of the covariates (X_{jr}) is attributable to differences in covariates (covariates effect) and differences in returns of these covariates (coefficients effect). The present discussion focused only on explained part of the components gap (covariates effect) because influencing the behavioural responses to the characteristics (captured by the coefficient effects) is more complicated (Jann, 2008; O'Donnell et al., 2009; Oaxaca & Ransom, 1999). The statistical analyses are computed using Stata version 14 by adopting the ñuser-written mvdcmp Stata commandò on nonlinear regression-based detailed decomposition technique of average outcome differentials proposed by Powers et al. (2011) and O'Donnell et al. (2008).

4. EMPIRICAL RESULTS

The results of decomposition analysis show that of the regions being compared with a benchmark of Tigrai region, Somali region seems exceptional in that its aggregate, characteristics, and coefficients effects were significantly smaller than in the case of the other regions. The results of detailed decomposition analysis indicated that the relative contribution of determinants to the regional differentials in under-five child mortality rates differ significantly across groups of regional comparisons of Ethiopia (Table 1). The relative contribution of a determinant (factor) reflects the differences between the groups of regional comparisons distributions of that covariate (variable) and the differences in the magnitude of the association of the variable with under-five child mortality (Van de Poel et al., 2009). Therefore, among the socioeconomic determinants, the most important relative contributions come from antenatal health care visits, maternal education, households' economic status, household size, and use of modern contraceptive. The differences in the proportion of children born to mothers have received antenatal healthcare services contributed a substantial 12, 9, 26, 55, 13, 37, and 32 percent to the explained Tigrai-BG, Tigrai-Harari, Tigrai-Amhara, Tigrai-Oromia, Tigrai--Somali, Tigrai-Afar, and Tigrai-SNNP regional gaps in under-five child mortality, respectively. On the contrary, the antenatal visit has been found to reduce 8 percent of Tigrai-Gambella regional under-five child mortality difference. Similarly, results of decomposition analysis revealed that the differences in under-five child mortality for Tigrai-BG, Tigrai-Somali, Tigrai-Afar, and Tigrai- Gambella regions were explained by the proportional differences in children to mothers with no education, which accounts for 3, 23, 6, and 21 percent of the total explained regional differences. However, this covariate contributed significantly to a 79 and 3 percent reduction of the Tigrai-Oromia and Tigrai-SNNP regional differentials in under-five child mortality, respectively. In the present study, households' economic status measured in households' wealth index was the most important socioeconomic determinants of the regional gap. The differences in the proportion of children to households in the poorest third index category contributed significantly to a 4, 12, 3, and 10 percent of the explained Tigrai-Harari, Tigrai-Amhara, Tigrai-Oromia and Tigrai-SNNP regional gaps in under-five child mortality, respectively. However, this factor has also been found to significantly reduce 8 percent of the explained Tigrai-Gambella regional gap.

Furthermore, results indicated that the proportion of children to larger household size explained significantly the Tigrai-BG, Tigrai-SNNP, and Tigrai-Amhara regional gaps in under-five child mortality by about 9, 4 and 9 percent, respectively. On the contrary, the Tigrai-Harari, Tigrai-Afar, and Tigrai-Gambella regional differences in under-five child mortality were significantly narrowed down by about 10, 8, and one percent, respectively due the proportional differences in household sizes. The regional gaps were also partly explained by differences in proximate factors. The differences in the proportion of children of four or higher between regions contributed a substantial 9, 4, 29 and 12 percent, respectively to the explained Tigrai-Harari, Tigrai-Oromia, Tigrai-SNNP and Tigrai-Gambella regional gap in under-five child mortality. However, its relative effect was the reverse for the other groups of regional comparisons. The differences in the proportion of children of four or higher was found to reduce by about 13, 10, 8 and one percent of the explained Tigrai-Amhara, Tigrai-Somali, Tigrai-Afar and Tigrai-BG regional differences in under-five child mortality, respectively. Similarly, the differences in the proportion of children whose birth size are less than average constituted significantly 36 percent of the Tigrai-Gambella regional gap while it has reduced by less than one percent of the explained Tigrai-Amhara and Tigrai-Somali regional gaps in under-five child mortality rates. Interestingly, differences in children who had an average birth size contributed significantly 15 percent of the explained Tigrai-Gambella regional gaps in under-five child mortality while it has also been found to reduce or explain the Tigrai-BG regional gap by less than one percent. The differences in proportional distributions of children of short birth spacing contributed 17, 5, 53, 2, 39, and 3 percent, respectively of the covariates effect in under-five child mortality for Tigrai-BG, Tigrai-Amhara, Tigrai-Oromia, Tigrai-Somali, Tigrai-Afar and Tigrai-SNNP regions. However, unlike to the other groups of regional comparisons, short birth spacing significantly narrow down by 34 percent of the Tigrai-Harari regional child mortality differences.

Most importantly, children born to mothers with less than 20 years age at first birth contributed significantly 6 and 0.78 percent, respectively to the Tigrai-Amhara and Tigrai-Somali regional gaps while it has also been found to reduce 8 percent of the Tigrai-Gambella regional differences in under-five child mortality. Also, the differences in the proportion of children who have been delivered at home (out of health facilities) contributed significantly 3, 9, 10 and 3 percent of the Tigrai-Harari, Tigrai-Amhara, Tigrai-Somali, and Tigrai-Gambella regional differences in under-five child mortality, respectively. Furthermore, results revealed that the negative relative contribution of the male under-five child shows that female of the same cohort was in a less advantageous situation in terms of survival rate in the other comparison regions except for Harari and Somali regions. Likewise, the negative contribution of age of the child at the time of death in explaining regional gaps in under-five child mortality indicated that children of the comparison regions were relatively younger than children of the same cohort of the references category (Tigrai) except for Harari and Amhara comparison regions. However, results of detailed decomposition analysis further indicated that no statistically significant regional differences were observed due to differences in the proportional distribution of access to improved toilet facility, electricity facility, and safe drinking water across the regional comparisons (see Table 1).

Table 1: Detailed decomposition of inter-regional differentials in under-five child mortality (between Tigrai^{RC} and other regions)

	Tigrai-BG region	Tigrai-Afar region	Tigrai-Amhara region	Tigrai-Oromia region	Tigrai-Somali region	Tigrai-SNNP region	Tigrai-Gambella region	Tigrai-Harari region
Covariates	Contribution (in percentage)							
Child's age	-1.15	-1.89	2.72	-11.31	3.03	-3.50	-2.93	2.64
Child =Female	-.05	-0.06	-.01	-.12	.03***	-.39	-.01***	.51
Birth order>4	-.68	-7.60***	-13.02***	4.47***	-9.96***	29.14**	12.45**	8.63***
Birth size < average	-.08	3.90	-.53**	-.76	-.28**	-.60	36.17***	14.73
Birth size = average	-.62**	-4.44	.57	.61	.36	-.89	14.71**	-4.31
Multiple birth	.11	-0.31	-1.07	-1.52	-.33**	-.47	.13	2.85
Short birth interval	16.68***	38.88***	5.06***	53.15**	2.40**	31.27**	-1.63**	-33.76**
Maternal age at birth <20	-.05	12.63	5.78**	-5.11	.79**	-11.74	11.49	3.52
Maternal age at birth >35	.09	-6.04	-17.09**	-9.34	-2.26	-1.60	-8.31***	25.92
Contraceptive use	-.46	14.66	-8.57*	-.24	-10.14*	-5.19	.68	9.22
Antenatal visits	11.72*	36.83*	26.62**	55.48*	12.89*	32.21*	-8.12*	8.53*
Mother's education	2.85**	6.15**	-.90	-79.54**	22.97**	-3.52**	21.42***	3.08
Mother's work status	-5.63	.78	-.40	-16.31	-.17	-9.98	-12.15	9.53
Female HH head	.04	-0.66	-.21	-.55	.69	.01	-6.31	-2.96
Age of HH head	-20.96	-6.85	1.46	-1.74	-.96	-40.00***	-6.27	-14.74
Father's education	-.54	-17.57	-.28	-1.54	6.31	.67	-.54**	-8.57
Poorest third	4.15	7.37	12.51*	2.92*	-7.60***	9.98*	3.90	4.44**
Middle third	.09	-21.49	.07	17.29	-1.04	.52	-18.21**	-6.28*
Household size	8.84***	-8.45***	9.26***	6.69	5.20	4.33***	-.81***	-9.99***
Toilet facility	-.33	-32.14	-.61	-3.05	-.50	-2.37	-.16	-3.14
Electricity facility	-1.34	-0.37	-2.21	1.32	-1.69	.04	3.08	-3.20
Home delivery	-1.12	24.86	9.17***	24.10	9.6***	-5.79	3.41*	2.70***
Safe drinking water	1.74	-4.58	-1.12	-4.00	2.86	14.32	-2.09	3.84

Source: Own computation, 2016 EDHS; Notes: The contribution of each covariate (characteristics) has been expressed in percentage. [RC] indicates the reference category. The relative contributions of individual covariates can be positive (>0 percent) or negative (<0 percent) and can exceed 100 percent. A positive value (sign) shows the component contributes to the greater differentials of U5MR between Tigrai and the other regional comparisons whereas a negative contribution designates the opposite. Asterisks denote the level of significance: *** p<0.01, ** p<0.05, and * p<0.1. HH represents household.

5. DISCUSSIONS

While Ethiopia has made a remarkable improvement in reducing the overall child mortality at the national level, evidence indicated that there were variations in rates of progress across its administrative regions (Abebaw, 2013; CSA & ICFInternational, 2012; CSA & ORCMacro., 2006; UNDP, 2012). To author's best knowledge, this study is the first to decompose the major determinants of inter-regional differentials in under-five child mortality into components gap (explained and unexplained parts). The results of the negative binomial regression analysis indicated that most determinant factors have the expected associations with the under-five child mortality rates and supported by previous studies (Dejene & Girma, 2013; Khadka et al., 2015; Regassa, 2012). Thus, identifying these determinant factors that explain inter-regional differentials in under-five child mortality rates could help in minimising the regional gaps and to speed up the rate of reduction in under-five child mortality both at regional and national levels of Ethiopia. According, findings of an Oaxaca-Blinder decomposition analysis indicated that there have been substantial regional variations in under-five child mortality across regional comparisons. Only small part of regional gaps in under-five child mortality was explained (28 percent), being the lowest in Tigrai and Benshangul-Gumuz regions (12 percent) and the highest in Tigrai-Gambella regional comparisons (37 percent). However, the substantial part of the regional differentials in under-five child mortality remained unexplained (72 percent), range from 62 percent (for Tigrai- Gambella regions) to 88 percent (for Tigrai-BG regions) which entails due attention. Results also indicated the substantial differences in socioeconomic, proximate and environmental determinants in explaining the regional gaps with socioeconomic factors being the major determinants of regional differentials in under-five child mortality followed by proximate. factors. The differences in the proportion of children born to mothers who have received antenatal healthcare services contributed a substantial to the explained regional gaps in under-five child mortality with different magnitude of effect and significance levels across regions. Evidence indicated that though the trends in antenatal health care coverage shows increasing rate, there has been wide disparities observed across regions of Ethiopia, ranging from the lowest 41 percent in Somali to the highest 100 percent in SNNP, Harari, Oromia and Tigrai regions (FMoH, 2014a). In low and middle-income countries, the socioeconomic disparities in child mortality are the key public health problem (Houweling & Kunst, 2010). Women education was considered as a major determinant factor of reducing under-five child mortality (Caldwell, 1979). Likewise, the contribution of the proportion of children to women with no education constituted to regional gaps in under-five child mortality for most regional comparisons. Comparable regional disparities in child mortality were reported in other developing countries. For example, in Iran, mother's level of education contributed 21 percent of the regional differences in infant mortality rates (Hosseinpoor et al., 2006), in Nepal, 4 percent of the explained regional differentials in under-five child mortality was attributed to mother's level of education (Goli et al., 2015). Also, in Nigeria, there have been regional child mortality differentials due to differences in women's education level (Adedini et al., 2015). Moreover, Jhamba (1999) and Akuma (2013) indicated that maternal education was the major determinants of regional variation in child mortality in Zimbabwe and Kenya, respectively.

The most striking regional differentials almost across the groups of regional comparisons occurred due to differences in the proportion of children from the poorest third index households. In line with the present study, significant difference in child mortality was observed due the major difference in households' wealth index in Nigeria (Adedini et al., 2015), Nepal (Goli et al., 2015), Kenya (Akuma, 2013), and in Iran (Hosseinpoor et al., 2006). A mother who gave a birth at less than 20 years old could face delivery and pregnancy related problems due to the mother's biological immaturity. Also, a mother could not have basic knowledge on how to care babies (Pandey et al., 1998) and as a result, a child born to this mother could have more likely to significantly die than a child of a mother whose age is above 20 years (Babson & Clarke, 1983). In the present study, the differences in distribution of maternal age at first birth less than 20 years were among the major determinants of regional differentials in under-five child mortality with different magnitude of effects and level of significant. In line with the present findings, it was also evident that the proportional differences in children of mothers whose age at first birth less than 20 years across regions explained the regional variations in child mortality significantly in Nepal (Goli et al., 2015), and in Nigeria (Adedini et al., 2015). How a child birth order determines child mortality and explains regional gaps in child mortality? A child of the first order is most probably to born from a young woman who is not biologically ready to accept and care for a baby. On top of this, the young woman has very limited basic knowledge on how to care for a baby (NIMS et al., 2012; Pandey et al., 1998). A child of higher birth-order, in contrast, is most probably to born to an older woman and is likely to be influenced by competition from older siblings in terms of resources (NIMS et al., 2012). Hence, in the present study, higher birth-order was among the major proximate determinants of under-five child mortality. The differences in the proportional distribution of children of birth-order of four or higher across the regions explained the regional gaps in under-five child mortality with different magnitude of effects and levels of significant. The present finding was consistent with some previous studies from Nepal (Goli et al., 2015), and in Nigeria (Adedini et al., 2015). Prior studies have indicated that birth spacing and child mortality has a direct relationship (Srinivasan, 2000; Sweemer, 1984). A woman who experienced short birth spacing may not recover instantly her health and then can deter baby's growth. Therefore, a child born to less than 24 moths birth spacing (short birth spacing) have more likely to die than a child born to a birth spacing of more 24 months (Hobcraft et al., 1983; NIMS et al., 2012). Likewise, a child born to less than 24 months birth spacing had more likely to die. The differences in the proportional distribution of children of short birth spacing across regions explained the regional differences in U5MR for most regional comparisons with different degree of effects and levels of significant. Findings on short birth spacing were in line with some of the existing literature in Iran (Hosseinpoor et al., 2006), Nigeria (Adedini et al., 2015) and in Nepal (Goli et al., 2015). Findings of this study further indicated that birth size less than average (2500g) affects under-five child mortality across regions. The differences in the distribution of birth size less than average explained significantly to 39 percent of the regional variations in under-five child mortality for Tigrai-Gambella regions. In Sri Lanka, low birth-weight explained the inter-district disparity in infant mortality rate (Chaudhury et al., 2006). However, the present findings revealed that for most regions child size at birth less than average contributed to reducing the regional differentials in under-five child mortality with small size effect. Furthermore, the unequal distributions of children who have been delivered at home (out of health facilities) attributed significantly to the explained regional gap in under-five child mortality; however, the relative percentage contribution of this variable was small. This result was in line with previous empirical studies from Nigeria (Adedini et al., 2015).

6. CONCLUSIONS AND RECOMMENDATIONS

This paper indicated that there was an over-dominance of coefficients effect across all regional comparisons. The overall contribution of the coefficients effect (61.8 percent) outweighs the covariates effect (38.2 percent) in explaining the observed regional differentials in under-five child mortality. Overall on average, around three-quarters of the regional gap in under-five child mortality was explained by the regional differences in the distribution of socio-economic and proximate determinant factors. The aggregate decomposition analysis indicated that most of the regional gaps in under-five child mortality were constituted by returns to the observable characteristics, the coefficients effect. The major part of the overall aggregate explained regional differentials in under-five child mortality was explained by the joint effect of the proximate determinant factors (29 percent) followed by socio-economic factors (20 percent). The results of a detailed decomposition analysis revealed inter-regional differentials in under-five child mortality was due to different levels of determinants that are often associated with under-five child mortality. Findings indicated that households' economic status, mothers' levels of education, birth-order, birth-spacing, antenatal visits, household size, and place of delivery were major determinant factors affecting inter-regional variations in under-five child mortality. In rural Ethiopia, therefore; the observed under-five child mortality differentials among the regions were largely due to the reflection of the wide regional differentials of these determinant factors.

The findings of this study can help to draw a critical attention in developing specific national and regional policies based on the relative contribution of individual covariates to explained regional gaps that help in reducing child mortality disparities among regions of the country.

To reduce the national child mortality, a priority should be given to the reduction of the regional disparities in child mortality, which could finally have considerable impact on the reduction of the country's overall child mortality rate.

Addressing the regional differences mainly in households' economic status and women's education could further minimise the regional disparities in under-five child mortality and thus, enhance the overall child health status.

Further sustained efforts are also needed to minimise the inter-regional differentials and accelerate the overall rate of reduction in under-five child mortality at the national level against a certain target set, for example, a 75 percent disparity reduction goal in under-five child mortality rate among regions by 2025.

To achieve the sustainable development goal of reducing under-five child mortality rate to less than 25 deaths per thousand births by 2030 or before the deadline, Ethiopia needs to accelerate the pace of progress by addressing the already identified major determinant factors affecting the inter-regional differentials in child mortality. However, focusing only on reducing under-five child mortality rate at the national level for Ethiopia might it impossible to achieve its global sustainable development goal.

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