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FERTILITY REGIMES, WOMEN'S WELL-BEING, AND GENDER GAPS IN WELL-BEING: A CROSS-NATIONAL TIME-SERIES ANALYSIS

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The second half of the 20th century witnessed dramatic declines in fertility especially in poor countries (Bongaarts, 2008) and increasing ages at first birth (Frejka, Jones, & Sardon, 2010; Frejka & Sardon, 2006; Westoff, 2003).[1] In the 1950s, the median person in the world's population was living in a country in which total fertility was 5.4 births per woman of reproductive age, and by 2000, the median person was living in a country in which total fertility was 2.3 (Wilson, 2001).

Demographers, for decades, have studied the reasons for these shifts (e.g., Bryant, 2007; Hill, 1992; Mauldin, 1978, 1982; Mauldin & Segal, 1988; Tsui & Bogue, 1978), including changes in women's opportunities and gender relations (e.g., Adamchack & Ntseane, 1992; Folbre, 1983; London, 1992; Malhotra, Vanneman, & Kishor, 1995; Mason, 1984, 1987; Sanderson & Dubrow, 2000; Weinberger, Lloyd, & Blanc, 1989). Yet, the reciprocal influences of changing fertility regimes on women's lives are understudied (See Mason [1997], Huber [1991], McDonald [2000] and Brewster and Rindfuss [2000] for important theoretical discussions of these reciprocal influences and Engelhardt, Kögel, & Prskawetz [2004], Engelhardt & Prskawetz [2004], Kögel [2004], and Matysiak & Vignoli [2008] for empirical investigations in wealthier Western countries.). Still, dramatic shifts in fertility regimes in recent decades are likely to have had marked influences on women's lives (Das Gupta & Bhat, 1997; Das Gupta & Shuzhuo, 1999; Mason, 1997; McDonald, 2000).

This paper examined, cross-nationally in poorer countries, how declines in total fertility and increases in women's age at first birth have predicted changes in women's well-being (see Malhotra, 2009) and gender gaps in well-being. Underpinning the analyses were three hypotheses, that *declining fertility and increasing ages at first birth should predict* (1) *widespread increases in women's well-being mainly because of reductions in women's reproductive stress,* (2) *improved birth outcomes for all children and a greater tendency to invest in children, including daughters, and* (3) *potentially competing changes in gender gaps in well-being that depend on the normative environment* (Das Gupta & Bhat, 1997; Das Gupta & Shuzhuo, 1999). We tested our hypotheses by leveraging data from as many as 185 national Demographic and Health Surveys (DHS) undertaken in as many as 75 lower-income countries over more than a quarter century (1985 to 2011) (Measure DHS, 2011). This source provided comparable national time-series measures of total fertility and women's mean ages at first birth, coverage (or not) of their basic and intermediate needs for well-being (girls' mortality at ages 1 – 4 years, nutrition, vaccinations, and schooling attainment, as well as women's nutrition and prenatal and delivery care), and gender gaps in the coverage (or not) of most of these needs. We linked these data with other sources of information on changes in national socioeconomic conditions for the same period. We used OLS time-series regression with country-time fixed-effects and adjustments for concurrent national socioeconomic changes to examine (a) how changes in national fertility regimes predicted changes in women's met and unmet needs for well-being and gender gaps in these met and unmet needs and (b) to what extent concurrent changes in socio-economic conditions accounted for and conditioned these associations (e.g., Brewster & Rindfuss, 2000). We tested the robustness of our findings with alternative estimation strategies (random-effects modeling) and alternative samples that compensated for country attrition in the DHS.

In the next sections, we define the components of well-being analyzed here and outline the theoretical arguments for our hypotheses. We then describe the sample, data sources, variables, and methods. Third, we present the results, including (a) univariate statistics and trends in our main variables; and (b) estimates from country-time fixed-effects and random-effects linear regressions of how changes in total fertility and women's mean age at first birth predict changes in women's met and unmet needs for well-being as well as changes in gender gaps in these met and unmet needs. We end by discussing the implications of our findings for theory, research, and policy.

HUMAN NEEDS, THEIR SATISFACTION, AND WOMEN'S WELL-BEING

Doyal and Gough's (1991) *Theory of Human Need* informs our conceptualization of women's *well-being* and the *basic* and *intermediate human needs* that are foundational to it. *Well-being* refers to "a state of being with others, where human needs are met, where one can act meaningfully to pursue one's goals, and where one enjoys a satisfactory quality of life" (Economic and Social Research Council, Research Group on Wellbeing in Developing Countries, 2007, p. 1). Well-being, thus, is enabled through the fulfillment of certain universal *human needs*, or common "preconditions" that, if met, avoid serious objective harm and enable successful social participation (Gough, McGregor, & Camfield, 2007). These preconditions include most essentially *survival*, and beyond that, some measure of *physical health*. They also include *autonomy of agency*, or the "capacity to make informed choices about what should be done and how to go about doing it" (Gough et al., 2007, p. 14). Autonomy of agency can be constrained by mental or cognitive impairments and by blocked opportunities to engage in social participation. The needs for survival, health, and autonomy of agency arguably can be satisfied by meeting a range of *intermediate needs*, which have material foundations or are pursued through social relationships. These intermediate needs include adequate nutrition and water, adequate housing, non-hazardous work and physical environments, appropriate health care, security in childhood, significant primary relationships, physical and economic security, and appropriate basic and cross-cultural education. The outcomes in this paper capture changes in (a) selected preconditions (or met needs) for women's well-being, (b) the burden of harms to women from unmet needs, and (c) gender gaps in met needs and in harms associated with unmet needs.

TOTAL FERTILITY, AGE AT FIRST BIRTH, AND WOMEN'S WELL-BEING

With these definitions in mind, how might increases in women's mean age at first birth and declines in total fertility enhance *well-being* and reduce *harm* among women and girls? To answer this question, our conceptual argument has two parts. First, increases in the mean age at first birth and reductions in total fertility should diminish the aggregate reproductive toll on women, reducing the prevalence of maternal depletion. Improved maternal health and nutrition should directly improve birth and early-childhood outcomes for all children. Second, the above changes in fertility regimes should provide an environment that encourages mothers (and parents) to invest more in existing children. In other words, declining fertility and rising ages at first birth create an environment that encourages trade-offs from a higher quantity to a higher quality of children. Girls, to some extent, should benefit from this tradeoff (Figure 1).

[Figure 1]

The first part of our argument focuses on the aggregate nutritional and physiological benefits to mothers of later ages at first birth and lower total fertility. Populations of women with later first births and lower fertility may experience a lower average physiological toll, both from child birth and child rearing, and such women should be better nourished and less often underweight (Koski-Rahikkala, et al., 2006; Rah et al., 2008). Although some studies in energy-rich environments have shown that higher parity predicts higher body mass and age-adjusted body mass (e.g., Nenko & Jasienska, 2009), other reviews and studies have shown that a later first birth predicts lower risks of maternal depletion (King, 2003; Rah et al., 2008). Pregnant adolescents in Bangladesh, for example, have had lower weight, BMI, mid-upper arm circumference, upper-arm muscle area, and percent body fat six months post-partum than their never-pregnant counterparts, suggesting depletion in energy stores resulting from pregnancy at a young age (Rah et al., 2008). In retrospective and prospective cohort studies, higher parity has been negatively associated with post-reproductive survival (Gagnon, et al, 2009; Smith, Mineau, & Bean, 2002) and positively associated with the adjusted risks of mortality from vascular complications (Koski-Rahikkala, et al., 2006). Thus, we argue that populations of women will experience, on average, less maternal depletion and will less often be underweight as the mean age of first birth increases and the total fertility rate declines. Healthier and better nourished mothers should have, on average, new-born boys *and* girls who are better nourished and more likely to survive (e.g., Imdad, Yakoob, & Bhutta, 2011; Haider, Yakoob, & Bhutta, 2011).

The second part of our argument concerns the well-being of *girls* and adapts general theories originated by Becker and colleagues of the quantity–quality tradeoff that occurs with fertility decline (Becker, 1960; Becker & Lewis, 1973. Specifically, *child quality* can be defined as a function of the time and resources that parents devote to each child (Willis, 1973). With fewer children, parents can invest more time and resources into each pregnancy and birth (Becker, 1960, 1973 Hanushek, 1992), including female fetuses and girls. In the aggregate, an environment characterized by fewer children and later ages at first birth should encourage parents to invest more in each pregnancy and child. These increased investments enable parents to fulfill more of each child's needs, increasing the likelihood of avoiding objective harms and of enhancing the child's overall well-being. Empirical support at different levels of analysis is available for a range of settings and preconditions for well-being. In North-Eastern Libya, lower fertility has predicted lower probabilities of child mortality (Bhuyan, 2000), and in the U.S., higher birth-order children have been less likely than first births to have ever been breastfed (Hirschman & Butler, 1981). In a national sample of women 15 – 24 years in India, child marriage (before the age of 18) has predicted higher adjusted odds of stunting and underweight in the next generation (Raj et al., 2010). In national samples of children in the U.S., large family size has predicted higher odds of vaccination delay and lower odds of full coverage (Dombkowski, Lantz, & Freed,, 2004), and a cross-national study in 15 countries has shown a significant difference in immunization coverage between infants born to adolescent versus older mothers (Reynolds, Wong, and Tucker, 2006). Studies also have documented an inverse association between measures of fertility and children's schooling, suggesting that children in smaller families with less (sibling) competition for resources are more likely to have better access to education (Adamchak & Ntseane, 1992; de la Croix & Doepke, 2003). In a study of parents' age at first birth and children's educational achievements in the British Household Panel Survey,[2] the children of parents who were older at their first birth had higher average schooling attainments (Booth & Kee, 2009). Family size also has been inversely associated with children's educational performance (e.g., Hanushek, 1992).TOTAL FERTILITY, AGE AT FIRST BIRTH, AND GENDER GAPS IN WELL-BEING

The *relative* benefits accrued to girls versus to boys from the "pro-quality norms" that emerge with declining fertility are likely to depend on prevailing gender norms (e.g., Das Gupta & Bhat, 1997; Das Gupta & Shuzhuo, 1999). In their study of the effects of fertility decline on gender bias in India, Das Gupta and Bhat (1997) described two potentially competing effects on girls' excess mortality in populations with strong preferences for sons. We extend their arguments here to a general discussion of how declines in fertility may influence gender gaps in well-being in these and other contexts.

In populations with parents who prefer an equal investment strategy, as fertility falls, sons and daughters should benefit similarly, and any pre-existing gender gap in well-being should remain stable (unless parents initially compensate for past inequities). In populations having stronger preferences for sons, smaller family sizes may affect the gender gap in well-being through two channels. First, if girls are disadvantaged relative to boys at higher parities, then declines in fertility should improve girls' well being ceteris paribus. Das Gupta and Bhat (1997) have called this pattern a *parity effect*, and we call it here a *gendered parity effect* to distinguish it from the general improvements arising from reductions in family size. This typology stems from South Asian data showing that girls' excess mortality has concentrated in the higher parities (e.g., Das Gupta 1987; Muhuri & Preston 1991; Pebley & Amin 1991).

Although the gendered parity effect is a purely structural effect of falling fertility, the actual distribution of newly available resources will likely depend on cultural norms. In populations having stronger preferences for sons, an *intensification effect* occurs when boys gain a disproportionate share of these resources. Such effects are based on observations in some countries, where girls' excess mortality at a given parity has amplified as total fertility has fallen (Hull, 1990; Zeng Yi, Gu

Baochang, Li, & Li, 1993). Das Gupta and Bhat's explanation for this effect is that norms favoring lower total fertility change more rapidly than do norms about the preferred number of sons. The differential pace of these normative changes results in greater "pressure" at each parity to invest in sons. Das Gupta and Bhat (1997) have highlighted evidence from India showing that the pace of fertility decline has exceeded declines in women's desired number of sons.

As fertility declines in populations having stronger son preference, the gendered-parity and intensification effects are counter-balancing forces, and their net effect on gender gaps in well-being is an empirical question. Scenarios (a) – (d) in Figure 2 depict four possible trajectories of the net effects of these competing forces as well as likely scenarios in populations lacking strong son preference but still exhibiting some gender gaps in well-being. In all four scenarios, we assume that some gender gap in well-being exists at the outset, with boys having an advantage over girls in some outcomes (e.g. schooling attainment).

[Figure 2]

Scenario (a) depicts what would happen if boys and girls accumulated the benefits of fertility decline at the same rate. In this case, outcomes are improving for boys and girls, but the gender gap remains constant. In populations with stronger preferences for sons, this plot would be evidence that the gendered-parity and intensification effects balanced each other out. In populations with more balanced gender preferences, this same scenario could be evidence of a biological advantage of boys. Scenario (b) depicts a predominant intensification effect, in which boys accumulate the benefits of lower fertility more rapidly than do girls. In Das Gupta and Bhat's (1997) study of child mortality in India, the intensification effect dominated the gendered parity effect in the 1980s, leading to an increasing number of excess deaths among women during this decade. Because son (male) preference is more common than daughter preference in poorer countries (Fuse, 2010; World Values Survey, 2011) and fertility-norms may change more rapidly than gender norms, an intensification of gender gaps in met needs is possible even where initial levels of son preference are less extreme.

Scenario (c) depicts a situation wherein girls accumulate advantages at a faster rate than do boys. In populations with stronger preferences for sons, this effect could arise because the gendered parity effect outweighs the intensification effect. More likely, this scenario arises because gender norms shift, resulting in improvements in the status of women and girls. The crossover of the gender gap in well-being in Scenario (c) shows how changing norms could lead to a long-run advantage in well-being for women or girls. The emergence of greater schooling enrollments and attainments for women than man exemplify this crossover in the gender gap (Knodel, 1997; Grant & Behrman, 2010). Finally, Scenario (d) depicts a likely trajectory for a society where son preference is strong initially but diminishes over time. In this scenario, the intensification effect dominates at first, resulting in a widening of the gender gap in well-being. Later, the gap narrows as changes in gender norms result in improvements for girls outpacing those of boys. Trends in the sex ratio at birth in South Korea have followed this trajectory, and Chung and Das Gupta's (2007) explanation for this phenomenon is that urbanization and industrialization (rather than declining fertility) eventually "unraveled" the population's preference for sons.

Three summative expectations follow from the foregoing discussion. First, lower fertility and especially increasing ages at first birth should predict better aggregate maternal nutrition and health, both universal needs for women's well-being. Second, an environment of lower fertility and later first birth should encourage women to invest more in each pregnancy and child, which would manifest in both higher levels of met intermediate needs for well-being (e.g., prenatal care, trained attendance at delivery, child vaccinations, and schooling) as well as reductions in the objective harms associated with unmet needs (e.g., mortality and malnutrition in children). Third, although girls' met needs should rise with declining fertility and later first births, the *relative* benefits accrued to girls versus boys will depend on prevailing gender norms. A preference for equal investments would result in stable gender gaps; a dominant gendered-parity effect would result in diminished gender gaps; an intensification effect would result in rising gender gaps, and an initial intensification effect followed by changing gender norms would result in rising then diminishing gender gaps.

SAMPLE AND DATA

For this analysis, the country was the unit of observation, and its primary sources of data were the Demographic and Health Surveys (DHS) (Measure DHS, 2011) and the World Bank's World Development Indicators (WDI) database. The maximum possible sample size for this analysis included all countries in which at least two DHS had been conducted (*n* = 75).

The outcomes were derived from the DHS and included three sets of variables that operationalized (a) harms to girls/womens' associated with unmet needs (mortality, malnutrition), (b) girls' and women's intermediate needs for well-being (nutrition, access to health care, schooling), and (c) gender gaps therein. The measure for mortality in early childhood captured the number of deaths to girls 1 – 4 years per 1,000 girls 1 – 4 years in the 10 years before the DHS survey.[3] Four measures of (mal-) nutrition for girls less than 36 months at the time of each DHS captured the median height-for-age (*haz*) and weight-for-age (*waz*) z-scores with respect to the WHO/CDC/ NCHS international reference population (Rutstein and Rojas, 2006), the percentage stunted or below minus two standard deviations (SD) from the median *haz* in the reference population, and the percentage underweight or below minus two standard deviations from the median *waz* score in the reference population. One measure of women's malnutrition captured the percentage of non-pregnant women 15 – 49 years who were *underweight*, or with a body-mass index (BMI, in kilograms per meters squared) below 18.5. This measure included women who had had a birth in the prior three years and were more than three months postpartum. The measure of girls' access to health care captured the percentage of those 12 – 23 months who had received (according to the child's vaccination card or mother's report) all specific vaccines by the time of the survey. Specific vaccines included BCG, DPT 1 – 3, Polio 0 – 3, and Measles. Two measures of women's access to health care captured the percentages of those 15 – 49 years with: any use of antenatal care and any professional attendant at delivery for births in the three years before each survey. Professional attendants at delivery included medically trained and licensed professionals, such as doctors, nurses, midwives, and auxiliary health personnel. Finally, the measure of schooling captured the percentage of the household population aged 11 – 15 years attending school. Measures of *gender gaps in well-being* captured the difference between girls and boys in their: risks of mortality at 1 – 4 years; *haz* scores, *waz* scores, and percentages stunted and wasted at 0 – 36 months; percentages fully vaccinated at 12 – 23 months; and percentage of 11 – 15 year olds attending school.

The *explanatory variables* also were derived from the DHS and included two aggregate measures of the fertility regime. The total fertility rate (TFR), or the total number of births per woman of reproductive age, was estimated from age-specific fertility rates for women who were 15 – 49 years in the period 0 – 4 years before each DHS. The mean age at first birth was estimated for women who were 25 – 49 years at the time of each DHS.

The main *control variables* included country- and time-fixed effects, which captured, respectively, unobserved time-invariant national characteristics (such as culture or language) and unobserved time-variant national attributes (such as political regime) as captured by the years of each DHS for a given country. Four other time-varying national characteristics were included to capture socioeconomic changes that may have been correlated with changes in fertility regimes and either changes in women's well-being or changing gender gaps in well-being (see Chung and Das Gupta, 2007). Data for these control variables were obtained from the World Development Indicators produced by the World Bank (World Bank, 2011). One measure of technological innovation captured mobile cellular subscriptions per 100 people.[4] One measure of urbanization captured the percentage of the total population that was living in urban areas, as defined by the national statistical offices.[5] .

Two time-variant measures of national economic conditions captured five-year averages of the Gross Domestic Product (GDP) per capita and the net Official Development Assistance (ODA) per capita.[6] Values for both indicators were computed by averaging annual figures for the 0 to 4 years preceding each DHS, which matched the time period for which the TFR was calculated.

METHODS

First, we examined univariate distributions of all outcomes, explanatory variables, and covariates to assess their completeness and distributions. We then explored within-country trends in all outcomes, explanatory variables, and covariates to ensure sufficient change over time to permit time-series analyses. Finally, we examined bivariate plots of all outcomes and explanatory variables to explore potential non-linearities in their associations.

Preliminary multivariate models for each outcome were estimated using linear regression with country- and time-fixed effects. In general, fixed-effects models explore the relationship between an explanatory variable and an outcome variable within an entity, in this case a country. Each country is assumed to have unique, time-invariant attributes that may influence the explanatory and outcome variables, confounding their estimated relationship. Fixed-effects models remove these effects of unobserved time-invariant attributes so the "net influence" of the explanatory variable can be assessed. The general equation for the country fixed-effects model is:

$$Y_{it}= \beta_1 F_{it}+ \alpha_i+ u_{it} \qquad (1)$$

where Y_{it} is the dependent variable (such as the percentage of girls 11 – 15 years attending school) in country i at time t, F_{it} denotes the explanatory variable of interest (such as the total fertility rate) for country i at time t, β_1 denotes the coefficient for that explanatory variable, α_i (I = 1….n) is the unknown intercept for each country (n country-specific intercepts), and u_{it} is the error term. To control for unexpected time-variant effects or special events that may affect the outcome of interest, we then estimated three other models that adjusted the base model reflected in equation (1) for: (2)

time fixed-effects, (3) time-variant national socioeconomic conditions, and (4) both time fixed-effects and time-variant national socioeconomic conditions, as follows:

$$Y_{it} = \beta_1 F_{it} + \beta_T T_t + \alpha_i + u_{it} \quad (2)$$

$$Y_{it} = \beta_1 F_{it} + \beta_E E_{it} + \alpha_i + u_{it} \quad (3)$$

$$Y_{it} = \beta_1 F_{it} + \beta_T T_t + \beta_E E_{it} + \alpha_i + u_{it} \quad (4)$$

where T_t is time as binary design variable and t-1 time periods entered into the model and E_{it} denotes a vector of national socioeconomic conditions for country i at time t. F-tests for the joint significance of the design variables for time indicated that their inclusion was typically warranted. Estimated variance inflation factors (VIFs) ranged from 1.2 to 2.0 (full results available upon request), below the standard cutoff of 10 indicating that multicollinearity is influencing the least square estimates (Hair et al., 1995; Marquardt, 1970; Neter, Wasserman, & Kutner, 1989; O'Brien, 2007) and suggesting that each structural variable is more than a linear combination of the others. To explore variation in the relationship between F_{it} and Y_{it}, equations (1) – (4) were estimated separately for subsamples of countries that were stratified both by region (within versus outside of Sub-Saharan Africa) and according to their baseline sex ratio at birth (> 1.045 versus ≤ 1.045).[7] The estimated coefficients for measures of fertility did not differ systematically across strata for most outcomes, and so the results for the full sample of countries are presented. Where appropriate, the results from these stratified models are discussed. In all models, robust standard errors were estimated accounting for clustering at the county-level, and the population sizes for each country averaged over the period of analysis were used as analytic weights (Dorius, 2008).

Notably, the fixed-effects model assumes that time-invariant attributes are unique to the entity under analysis (e.g., a given country), so the country's error term and the constant capturing the country's attributes should not be correlated with those for other countries. If the error terms across countries are correlated, then fixed-effects modeling is not suitable, and the relationship may need to be modeled using random effects. To explore this possibility, we estimated random-effects models following the same sequential model-fitting strategy as that depicted in equations (1) – (4), and we estimated the relative fits of fixed-effects and random-effects models using the Hausman test (Hausman, 1978). A rejection of the null hypothesis would lead one to conclude that the random-effects models were preferable to the fixed-effect models. In this analysis, only 4 of the 34 Hausman tests were significant at $p \leq 0.05$, and in only one of these four cases did the inference for fertility differ; therefore, the random-effects estimates are presented in the main results, and the fixed-effects estimates are presented in appendices and discussed where appropriate.

RESULTS

Univariate Descriptives

Table 1 shows univariate statistics (mean, sd, min, max) for the outcomes, explanatory variables, and covariates in the analysis. For each variable, we present the number of surveys (N) with data for each variable, the number of countries represented by these observations, and the average number of observations per country. An extended version of Table 1 stratified by period (1985–9, 1990–4, 1995–9, 2000–4, and 2005–11) is available in Appendix 1.

[Table 1]

The top panel of Table 1 shows descriptive statistics for selected measures of women's met and unmet needs for well-being and gender gaps therein. The risk of dying in early childhood for girls averaged 45.8 deaths per 1,000 girls and ranged from 2.0 to 231.8. The mean risk of dying in early childhood was similar for boys and girls across countries and over the period, as shown by the near-zero difference in their mortality risks (-0.3). This difference, however, initially was positive for 24 countries, indicating higher early-childhood mortality for girls than boys, which tended to decline over time within these countries (results available upon request). On average, high percentages of girls 0 – 3 years in this sample were stunted (28%) and underweight (22%); yet, girls typically were not nutritionally disadvantaged in comparison to same-aged boys within country. Rather, girls held a slight advantage over boys in terms of the average percentages who were stunted or underweight (by 2.3% and 1.3% respectively). In contrast, young men in this sample seem to have had at least an initial advantage over young women in school attendance. Overall, 5.9% more men 11 – 15 years were attending school compared to women the same age (among whom the average percentage attending school was 68.1%). The highest gender gap indicating a male advantage was observed in Yemen in 1997 (45.2%), and the highest gender gap indicating a female advantage was observed in Brazil in 1991 (9.8%).

Overall, a majority (or 79%) of women of reproductive age had ever used antenatal care for births in the prior three years, but this figure varied widely across countries and years, from 27% in Ethiopia in 2000 to almost 100% in the Dominican Republic in 1999. The mean prevalence of having had a trained attendant at delivery for births in the prior three years was both lower (56%) and more variable (8.6% - 100%). The mean percentage of recently delivered women who were considered to be underweight (BMI<18.5) was 11.6% but varied widely, from over 50% of women in Bangladesh in 1996 to only 0.6% of women in Egypt in 2000.

The average TFR in our dataset was 4.6 births and ranged from 1.6 to 7.5. The mean age at first birth among women 25 – 49 years was 20.4 but ranged from 17.2 to 24.0.

National Trends in Women's Well-being and Gender Gaps in Well-being: 1990 - 2009

[Figures 3a and 3b]

Figures 3a and 3b show national trends in measures of fertility, women's and girl's met and unmet needs for well-being, and gender gaps therein. In these graphs, trends for countries in Sub-Saharan Africa are depicted with solid lines while countries from other regions are represented with dotted lines. In the graphs depicting gender gaps, red lines indicate the countries in which girls initially have a disadvantage in the indicator of well-being. These graphs are based on DHS data (as described earlier) and feature all variables in our analysis except for measures of socioeconomic change.

Figure 3a includes graphs of trends in our two explanatory variables of interest, the TFR and mean age at first birth, as well as trends in the percentage of women receiving antenatal care, the percentage of births with a skilled attendant, and the percentage of recently delivered women considered to be underweight. On average, the level of fertility in Sub-Saharan African countries is higher than in other regions and the age of first birth is lower. Most countries show a decline in TFR over the period of analysis (1985 – 2011) while trends in the average age at first birth are more variable. Although, on average, there appears to be a trend toward a slight increase in the age at first birth across countries, this pattern does not hold in countries where the mean age at first birth is lowest; in these countries, trends largely remain flat. In most cases, women's access to maternal health care improved over the period, with increases observed in most countries in the percentage of women using antenatal care and the percentage of births with a skilled attendant. In a few countries, the nutritional status of recently delivered women seems to have improved remarkably; however, in general, there are just slight reductions in the percentage of these women considered underweight.

Figure 3b depicts trends in measures of girl's met and unmet needs for well-being and the corresponding gender gap. Considering measures of girl's health, there is evidence of improvements in girl's met needs, with general trends of declining mortality among girls 1 – 4, increasing vaccination coverage among girls 12 – 23 months, increasing average *HAZ* and *WAZ* scores, and corresponding reductions in the percentage of girls stunted and underweight, respectively. Levels of and trends in gaps in these measures are more variable across countries. For instance, in some countries, boys have an advantage over girls in terms of lower mortality among 1-4 year olds, but in other countries, girls have the advantage. In countries where boys have an advantage initially, there does seem to be a trend toward a narrowing of the gap in mortality levels over the period of analysis. In terms of vaccination coverage, again there are some countries where boys have an advantage and others where girls have the advantage; in general, trends are flat for this variable indicating no change in the gap. The figures depicting gaps between the percentage of girls and boys under-nourished and stunted suggest that in most countries girls are less likely to be undernourished and stunted in comparison to boys. Trends in gaps in these measures vary across countries.

The graph depicting trends in school attendance among young women 11 – 15 years indicate increases in attendance over the period. In most countries, young men 11 – 15 years more often are attending school than their female peers. In general, the gap in school attendance appears to decline in most countries over the period of analysis; however, this pattern is not universal.

Random-Effects Regression Models of Women's Well-being

Table 2 presents the results of the random-effects models exploring to what extent changes in total fertility and the mean age at first birth predict changes in women's and girl's met and unmet needs. Column (1) depicts the results of the first series of these random-effects models, which account only for country effects. These results suggest that declines in total fertility and increases in the age at first birth improve women's and girl's met needs for well-being. For women, these changes in fertility predict increasing access to reproductive healthcare (as indicated by the use of antenatal care and skilled attendant at birth). Increases in the mean age at first birth predict improvements in nutritional status among women who had recently given birth. In contrast, declines in total fertility predicted an increase in the percentage of these women considered underweight. For girls, declines in the total fertility rate and increases in the mean age at first birth predict declines in the risk of 1 – 4 mortality and the percentage stunted or underweight at 0 – 3 years as well as increases in vaccination coverage at 12 – 23 months, school attendance at 11 – 15 years, and mean *HAZ* and *WAZ* scores at 0 – 3 years. All of these associations were significant at $p \leq 0.05$ except for that between the total fertility rate and the percentage of recently delivered women who were considered underweight.

[Table 2]

Controlling separately for time effects or socioeconomic changes (as measured by trends in cell-phone usage, urbanization, GDP per capita, and ODA per capita) diminishes somewhat these associations, although in most cases they remain statistically significant (Table 2, Columns 2 and 3). The series of random-effects models with all controls added (Table 2, Column 4) underscores that declining total fertility and increasing mean ages at first birth still predict increases in women's and girl's met needs for well-being and reductions in the harms reflective of unmet needs. Namely, for reproductive age women, declines of one birth in total fertility and increases of one year in women's mean age at first birth predict 6.5% and 5.2% higher use of antenatal care respectively (as well as a 4.2% and 7.0% increase in the percentage of births with a skilled attendant present). Counter-intuitively, the results also suggest that a one-birth reduction in total fertility predicts a 5.9% increase in the percentage of recently delivered women who are underweight; whereas, a one year increase in the age at first birth predicts a 3.8% decrease in the same measure. Similar changes in total fertility and the mean age at first birth also predict 18 and 10 fewer deaths per 1,000 girls 1 – 4 years, 8.3% and 5.8% increases in girls' vaccination coverage at 12 – 23 months, and 3.8% and 3.5% increases in the percentage of young women 11 – 15 years attending school. Associations between the total fertility rate and the measures of girls' nutrition were not significant; however, these associations were significant for models with mean age at first birth as the explanatory variable. The results of these models indicated that a one-year increase in the mean age at first birth predicts increases of 0.12 and 0.20, respectively, in the mean HAZ and WAZ scores among girls 0 – 3 years as well as 2.1% and 3.8% reductions in the percentage of young girls stunted and underweight.

The results of fitting the fixed-effects models of these same relationships (Appendix 2) largely mirror those in Table 2. Hausman tests indicated a preference for the fixed effect models only in the case of modeling the relationship between the fertility measures and vaccination coverage; however, the results do not vary substantially between the fixed and random effects models, and the random effects models indicate a weaker effect. Overall, these results provide strong evidence that declines in fertility have been accompanied by increases in the basic and intermediate needs that are foundational to women's well-being.

Random Effects Regression Models of Gender Gaps in Well-being

Table 3 presents the results of the random-effects models exploring to what extent changes in total fertility and the mean age at first birth predict changes in gender gaps in met and unmet needs. Column (1) depicts the results of the first series of these models, which account only for country effects. These results suggest that declines in total fertility and increases in the mean age at first birth predicted changes in most but not all gender gaps in met and unmet needs. Namely, these changes in fertility predicted at least marginally significant declines in the gender gap in school attendance among 11 – 15 year-olds (assuming an initial male advantage). Surprisingly, declines in total fertility and increases in the age at first birth have opposing effects on gender gaps in nutritional measures. Assuming that girls were nutritionally advantaged at the start of the period (Figure 3), a decline in total fertility predicts a narrowing of the gap between boys and girls; conversely, an increase in the age at first birth predicts a widening of the gap between boys and girls, indicating a growing advantage for girls in this scenario. Increases in the mean age at first birth also predict a narrowing of the gender gap in child mortality and vaccination rates assuming an initial male advantage in both of these measures; these measures are not significantly associated with total fertility.

[Table 3]

Controlling separately for time effects or socioeconomic changes diminished some of these associations and elevated others (Table 3, Columns 2 and 3). The series of random-effects models with all controls (Table 3, Column 4) shows that declines in total fertility predicted increases in the gender gap in child mortality (assuming an initial male advantage) and a narrowing of the gender gap in mean height and weight as well as the proportion stunted and underweight (assuming an initial female advantage) (see Table 4 for a visual interpretation of the results for the full model). Similar to the results of Model 1, the results for the models with age at first birth as the explanatory variable produce seemingly contradictory results, with increases in the age at first predicting declines the gender gap in mortality (assuming initial male advantage) and a widening of the gender gap in nutrition (assuming an initial female advantage). Note that in the models of girl's well-being increases in the age at first birth predicted improvements in nutrition, and these associations were significant; however, these same associations were not significant when total fertility was the explanatory variable. We return to this issue in the Discussion section. The results of fitting the fixed-effects models of these same relationships (Appendix 3) revealed weaker associations than those in Table 3. Formally, the Hausman test revealed a preference for the fixed-effect model only in the case of modeling the relationships between child mortality and the fertility measures. With total fertility as the explanatory variable, the interpretation of the results differs as the direction of the association changes; for both fertility measures, the associations estimated using the fixed-effects models are not significant while the associations are significant in the random-effects models. Overall, these results suggest that changes in fertility and the age at first birth can have seemingly contradictory effects on gender gaps in mortality and nutrition. This counterintuitive result is discussed in more detail below.

DISCUSSION (TO BE ELABORATED)

In this paper, we have examined whether national changes in fertility regimes (from high total fertility and an early average age at first birth to lower total fertility and a later average age at first births) predict: (1) aggregate increases in women's well-being as a result of reductions in women's reproductive stress; (2) improvements in girl's well-being as a result of mother's increased biological capacity and broader normative changes encouraging "higher quality" children; and (3) changes in gender gaps in well-being between girls and boys based on the broader gender-normative environment. Table 4 and the paragraphs below summarize the results of testing these three hypotheses.

[Table 4]

Summary of Findings

Improvements in women's met needs for well-being: We proposed that national declines in fertility and increases in the mean age at first birth would result in improvements in women's health because of population-level reductions in maternal depletion. In our analysis, we tested this hypothesis by examining the relationship between trends in our fertility measures and trends the percentage of recently delivered women who were underweight. Surprisingly, in models with the total fertility rate as the explanatory variable, we did not find the associations that we were expecting. Both the fixed and random effects model with full controls suggested that declines in total fertility predicted an increasing percentage of women who were underweight, and this association was significant in the random-effects models. Notably, the coefficient for total fertility was not robust (e.g., changed direction) to alternative specifications using fixed-effects estimation (Models 1 – 4, Appendix 2). Thus, further investigation of these findings is needed. Still, estimates of the relationship between the mean age at first birth and the percentage of recently delivered women who were underweight were in the expected direction. In fully adjusted models, increases in mean age at first birth predicted declines in the percentage of these mothers being underweight, and this association was significant in the random-effects model). Both fertility reductions and increases in the age at first birth predicted improvements in meeting women's intermediate needs for well-being in terms of improvements in access to antenatal care and skilled attendant at delivery (although the associations with skilled attendant at delivery were not significant in the fixed effects models).

Improvements in girls' met needs for well-being: Our results overwhelmingly supported our second hypothesis, that aggregate declines in fertility would predict improvements in measures of girls' met needs for well being. Declines in fertility and increases in the age at first birth predicted increases in vaccination coverage among girls 12 – 23 months and increases in school attendance among women, suggesting that girl's intermediate needs for well-being are better met in countries characterized by low fertility regimes. Similarly, in countries with lower fertility and higher age at first birth, there is a reduction in the burden of harms felt by girls from unmet needs, as these same changes in fertility predict declines in mortality among girls 1 – 4 years. Higher ages at first birth also are associated with improvements in nutrition among girls less than 3 years.

Changes in gender gaps in well-being: While we find strong evidence that declines in fertility and increases in the mean age at first birth are associated with improvements in women's and girl's well-being, the relationship between these changes in fertility and gender gaps in well-being are more complex. We illustrate the seeming discrepancies in our results related to the gender gap in child mortality in Figure 4. In this set of graphs, we depict predicted relationships among our fertility measures and early childhood mortality (for girls 1 – 4 years and the gender gap at 1 – 4 years) based upon the results of the full random-effects models of these relationships (Model 4, Tables 2 and 3). To make these predictions, we set the values of our control variables (GDP per capita, percent urban, mobile cellular subscriptions per 100 people, and net ODA per capita) at their mean values for the periods 1990 – 4, 1995 – 9, and 2000 – 4 (Appendix 1), and we also account for unobserved time-varying effects for these periods using the full model results. Thus, these predictions illustrate possible trajectories of women's met needs for well-being and gender gaps therein for various fixed socioeconomic environments.

While both reductions in total fertility and increases in the mean age at first birth predict substantial improvements in girls' mortality, reductions in total fertility are associated with an increase in the gender gap in mortality (assuming an initial male advantage) while increases in the mean age at first birth are associated with a decrease in the gender gap in mortality. If we assume that declines in total fertility and increases in the age at first birth occur simultaneously, our results are nonsensical. The results for total fertility suggest an intensification effect (scenario (b), Figure 2), while the results for mean age at first birth suggest a gendered parity effect (scenario (c), Figure 2).

However, these changes in fertility do not necessarily occur simultaneously. Instead, initial declines in fertility might be the result of women limiting their fertility at older ages with reductions in young women's fertility and thus postponement of first births occurring later in the fertility transition (Knodel, 1977).

If the temporal ordering is such that total fertility declines before the mean age at first birth increases (which is the case in our sample, results available upon request), the gender gap in mortality may follow a trajectory similar to that presented in scenario (d), Figure 2. In the initial stage of fertility decline, women limit their fertility at older ages and thus have more resources to invest in their children as a result of the quantity-quality tradeoff. Both the widening of the gap in child mortality (assuming initial male advantage) and the narrowing of the gap in nutritional status (assuming initial female advantage) indicate that these newly available resources are disproportionately invested in boys (signs of an intensification effect). Our results indicate that increases in vaccination coverage and school attendance among young adults 11 – 15 years accrue equally to girls and boys suggesting that these disproportionate investments in boys are occurring in the private sphere rather than the public sphere.

Postponement of fertility associated with an increase in the mean age at first birth may indicate a broader shift in the normative environment. As the status of women and girls rises, more equal investments occur and thus the girls are able to catch up with boys (in the case of the gender gap in mortality) or regain their natural biological advantage (in the case of nutritional status).

Limitations of the Analysis

Our analysis had some notable limitations, which suggest promising avenues for further research. First, the period of observation for this analysis was limited to 26 years spanning the years 1985 to 2011. Thus, we did not have an opportunity to observe the full trajectory of changes in met and unmet needs for well-being that may be associated with fertility change. As Demographic and

Health Surveys continue to be undertaking, the period for observing the effects of further fertility change may be extended. Second, this study was a cross-national time series study, and thus, the results are limited to interpretations at the aggregate level. A complimentary analysis might examine how macro-level changes in fertility and son preference manifest in couple's decisions about investments in the well-being of their sons and daughters. Including in these analyses measures for the desired number of children or average expenditures on children would be the first step to examining how declines in total fertility and increases in the mean age at first birth might lead to improvements in child well-being through the quantity-quality tradeoff.

A third limitation of this analysis was that it was restricted to the countries in which DHS are conducted. In some cases, countries that were surveyed in earlier years did not have surveys in subsequent years (e.g., were lost to follow-up). If the reason for this loss to follow was associated with the country's level of fertility and our outcomes, then the relationships estimated here may be confounded. In sensitivity analyses not shown here (results available upon request), we tried to account for loss to follow-up by imputing observations for selected outcomes using data from the Multiple Indicator Cluster Surveys (MICS) (UNICEF, 2011). These robustness checks indicated no meaningful differences between the DHS only and DHS-MICS samples.

Fourth, while we have shown strong associations between our fertility measures and indicators of well-being, these relationships could be conditional on other co-occurring national socioeconomic changes (e.g., Chung & Das Gupta, 2007; Das Gupta & Shuzhuo, 1999). To assess this possibility, we tested for interactions between our measures of fertility and the socioeconomic measures that we included as controls. These checks did not reveal any systematic conditional influences of socioeconomic change on the fertility-well-being relationships presented here.

Finally, in the current analysis, we did not have direct measures of changes in national norms pertaining to fertility and gender preferences. In sensitivity analyses not shown here (available upon request), we stratified the sample by each country's initial sex ratio at birth to see if the relationship between changes in fertility and changes in other gender gap in well-being varied by the initial level of son preference in each country (as captured in the sex ratio at birth). Only 18 countries, however, had initial sex ratios at birth of 1.05 or greater, and so we were not able to distinguish countries with initially high son preference. In the future, researchers might apply our analytical approach to study district-level changes in fertility with our outcomes in countries with highly variable sex ratios at birth and reliable panel census data for districts (e.g., India).

Conclusions and Policy Implications

Together, our findings suggest that fertility decline predicts improvements in women's and girls' intermediate needs for well-being (e.g., child vaccination, schooling, prenatal care, and access to a skilled attendant at birth) and declines in the objective harms associated with unmet needs (e.g., child mortality and malnutrition). Fertility decline also appears to accrue equal benefits for boys and girls with respect to some intermediate needs for well-being (e.g., vaccination coverage and school attendance). Our analyses suggest some potential for an intensification effect of fertility decline on the harms associated with unmet needs (e.g., child mortality and malnutrition). However, increases in women's mean age of first birth, perhaps indicative of a larger shift in gender norms, predict greater improvements in well-being for girls relative to boys on these same measures. Thus, the effects of fertility decline on gender gaps in well-being are likely to vary across the fertility transition.

OTHER POINTS UNDER CONSIDERATION BY THE AUTHORS:

Include and analyze mortality rates for the period 0 – 4 years before each survey (current measures reflect average rates for the 10 years prior, creating problems with the temporal ordering of outcomes and explanatory variables).

Consider other measures for women's well-being: % of all women with any, mild, moderate, severe anemia.

Questions regarding comparability of samples, ever-married versus all women – need to include a control variable for the sample.

Need to discuss:

Extent to which there are interaction effects between explanatory variables (contraception, fertility) and other time-varying covariates.

Allow for variation in the relationship between fertility, contraceptive use, and outcomes across regions by including a region dummy variable (SSA=0, not SSA=1) (Kögel, 2004).

Estimates random-effects models and conduct Hausman test to assess when fixed or random effects more appropriate modeling strategy for each outcome.

Figure 1. Hypothesized Effects of Lower Fertility and Higher Ages at First Birth on Women's and Girls' Well-Being

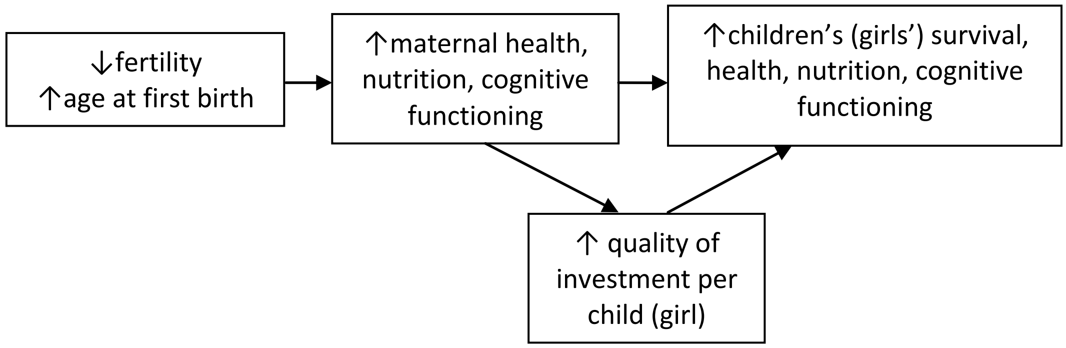
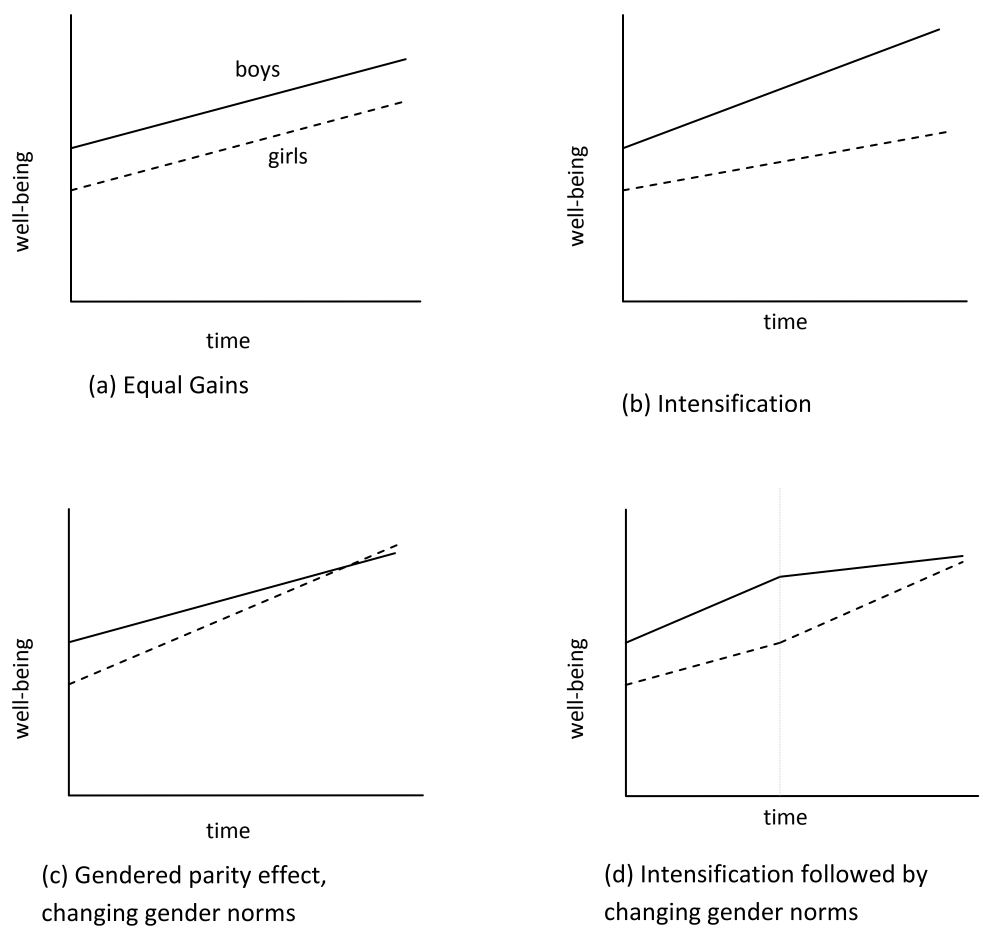


Figure 2. Four scenarios depicting likely trajectories of gender gaps in well-being following declines in fertility



Note. Adapted from Das Gupta and Bhat (1997).

Figures 3 and 4 here

Tables 1 – 4 here

Appendices 1 – 4 here.

(Currently all of these tables and figures can be found at the end of the paper)

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ENDNOTES

[1] Dorius (2008) persuasively reveals, however, that trends toward convergence in total fertility between rich and poor countries began only around 1995.

[2] In Wave 13 of this panel survey, respondents were asked about family background characteristics.

[3] A measure for early-child mortality averaged over a shortened interval of time was not available from STAT-COMPILER, the online national statistics database for the DHS.

[4] Mobile cellular subscriptions were defined as subscriptions to a public mobile telephone service using cellular technology that provides access to the public switched telephone network. Postpaid and prepaid subscriptions were included, and WDI sources for subscription data were taken from the International Telecommunication Union, World Telecommunication/ICT Development Report and database, and World Bank estimates.

[5] Values were included for the same year or up to six years before that of the DHS using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects.

[6] For the average GDP per capita, WDI sources included World Bank national accounts data and OECD national accounts data files. The WDI sources for ODA were taken from the Development Assistance Committee of the Organisation for Economic Co-operation and Development, Geographical Distribution of Financial Flows to Developing Countries, Development Co-operation Report, and the International Development Statistics database.

[7] The median sex ratio at birth in this sample of countries was 1.045, and only 18% of the observations in this analysis had initial sex ratios equal to or greater than 1.05. So, it was not possible to conduct separate multivariate analyses for those countries with very high baseline sex ratios at birth.

Table 1: Descriptive Statistics for Measures of Women's Well-being, Gender Gaps in Well-being, and Explanatory and Contextual Variables, National Demographic and Health Surveys for 1985 - 2011

	Unit	Mean	(SD)	Min	Max	Obs.
Women's and Girls' Well-Being						
	Overall		(39.41)	2.00	231.80	184
Deaths to girls 1–4 y per 1,000 1–4 y	Between	45.77	(36.26)	3.10	189.83	74
	Within		(12.53)	-8.57	98.49	2.49
	Overall		(20.90)	1.10	92.40	176
% 12–23 m with specified vaccinations[a]	Between	51.42	(18.53)	11.00	84.60	73
	Within		(11.71)	11.34	101.24	2.41
	Overall		(0.43)	-2.30	-0.10	152
Mean height-for-age (HAZ) z-score < 3 y	Between	-1.13	(0.41)	-1.93	-0.10	67
	Within		(0.15)	-1.61	-0.68	2.27
	Overall		(10.85)	4.50	56.70	152
% < 3 y stunted, HAZ < -2SD below median reference	Between	27.61	(10.30)	4.50	47.10	67
	Within		(3.49)	17.83	37.81	2.27
	Overall		(0.50)	-2.00	0.20	152
Mean weight-for-age (WAZ) z-score < 3 y	Between	-0.91	(0.48)	-1.87	0.00	67
	Within		(0.13)	-1.35	-0.59	2.27
	Overall		(12.69)	2.10	52.70	152
% < 3 y underwgt, WAZ < -2SD below median reference	Between	22.03	(12.35)	3.90	48.90	67
	Within		(2.56)	14.90	29.86	2.27
	Overall	68.09	(22.03)	12.80	99.10	125
% 11-15 y attending school	Between		(21.34)	19.90	98.20	60
	Within		(6.71)	48.09	93.26	2.08
	Overall		(19.07)	27.00	99.80	175
% with any antenatal care, births in 3 y prior	Between	78.89	(17.63)	27.40	99.10	71
	Within		(7.04)	60.21	103.19	2.46
	Overall		(24.13)	8.60	99.60	175
% with trained attendant at delivery, births in 3 y prior	Between	55.74	(24.22)	13.48	99.50	73
	Within		(7.22)	33.51	82.14	2.40
	Overall		(9.87)	0.60	52.00	124
% non-pregnant, > 3 m post-partum with BMI <18.5	Between	11.56	(9.20)	0.90	42.08	60
	Within		(1.84)	2.29	21.49	2.07
Gender Gaps in Well-Being (A Positive Value Reflects Girls' Disadvantage)						
	Overall		(6.26)	-24.70	20.20	184
Gap (girls–boys 1–4 y) in risk of mortality	Between	-0.29	(4.87)	-18.70	12.07	74
	Within		(3.81)	-14.62	12.31	2.49
	Overall		(4.09)	-12.00	28.50	176
Gap (boys–girls 12–23 m) in % with specified vaccinations	Between	0.38	(2.98)	-7.00	11.50	73
	Within		(3.24)	-11.44	27.16	2.41
	Overall		(0.11)	-0.50	0.30	152
Gap (boys–girls < 3 y) in mean HAZ scores	Between	-0.10	(0.10)	-0.50	0.10	67
	Within		(0.07)	-0.30	0.10	2.27
	Overall		(2.40)	-7.40	3.60	152
Gap (girls–boys < 3 y) in % stunted	Between	-2.27	(2.17)	-7.40	2.70	67
	Within		(1.41)	-6.57	1.93	2.27

Table 1 (continued)

	Unit	Mean	(SD)	Min	Max	Obs.
	Overall		(0.10)	-0.40	0.20	152
Gap (boys–girls < 3 y) in mean WAZ scores	Between	-0.08	(0.09)	-0.40	0.10	67
	Within		(0.06)	-0.28	0.12	2.27
	Overall		(2.24)	-8.60	4.30	152
Gap (girls–boys < 3 y) in % underweight	Between	-1.34	(1.94)	-8.60	3.13	67
	Within		(1.44)	-7.09	3.01	2.27
	Overall	5.90	(8.53)	-9.80	45.20	125
Gap (men–women 11-15 y) in school attendance	Between		(9.43)	-8.40	45.20	60
	Within		(2.33)	1.02	14.77	2.08
National Fertility Regime						
	Overall		(1.45)	1.60	7.47	184
Total Fertility Rate, women 15–49 y 0–4 y before survey	Between	4.59	(1.40)	1.60	7.27	74
	Within		(0.44)	3.30	6.01	2.49
	Overall		(1.47)	17.20	24.00	183
Mean age at first birth, Women 25 – 49 y	Between	20.43	(1.47)	17.60	24.00	74
	Within		(0.35)	18.68	21.93	2.47
National Economic Conditions						
	Overall		(878.18)	131.44	5565.98	184
Avg GDP[b] per capita 0-4 y prior, current US$	Between	902.42	(988.23)	132.64	5565.98	74
	Within		(277.91)	-340.56	1931.55	2.49
	Overall		(18.36)	5.20	80.10	184
Urban population as a % of total, current or prior year	Between	38.62	(18.00)	5.20	80.10	74
	Within		(3.02)	29.22	51.22	2.49
	Overall		(14.14)	0.00	84.08	184
Mobile cellular subscriptions per 100 people 0–4 y prior	Between	7.05	(8.48)	0.00	39.17	74
	Within		(11.95)	-25.64	63.80	2.49
	Overall		(30.99)	0.90	183.67	184
Avg net ODA[c] received per capita 0-4 y prior, current US$	Between	36.71	(30.38)	1.15	130.53	74
	Within		(9.18)	5.09	89.85	2.49

[a] Specific vaccinations include: BCG, DPT 1 – 3, Polio 0 – 3, and Measles

[b] GDP refers to Gross Domestic Product.

[c] ODA refers to Overseas Development Assistance.

Figure 3. Trends in Total Fertility Rate, women 15–49 y 0–4 y before survey, Age at First Birth, Women 25 – 49 y, and Selected Measures of Women's Wellbeing and Gender Gaps in Wellbeing, National Demographic and Health Surveys for 1985-2011. (Red lines in gender gaps figures indicate initial disadvantage in girl's well-being relative to boys.)

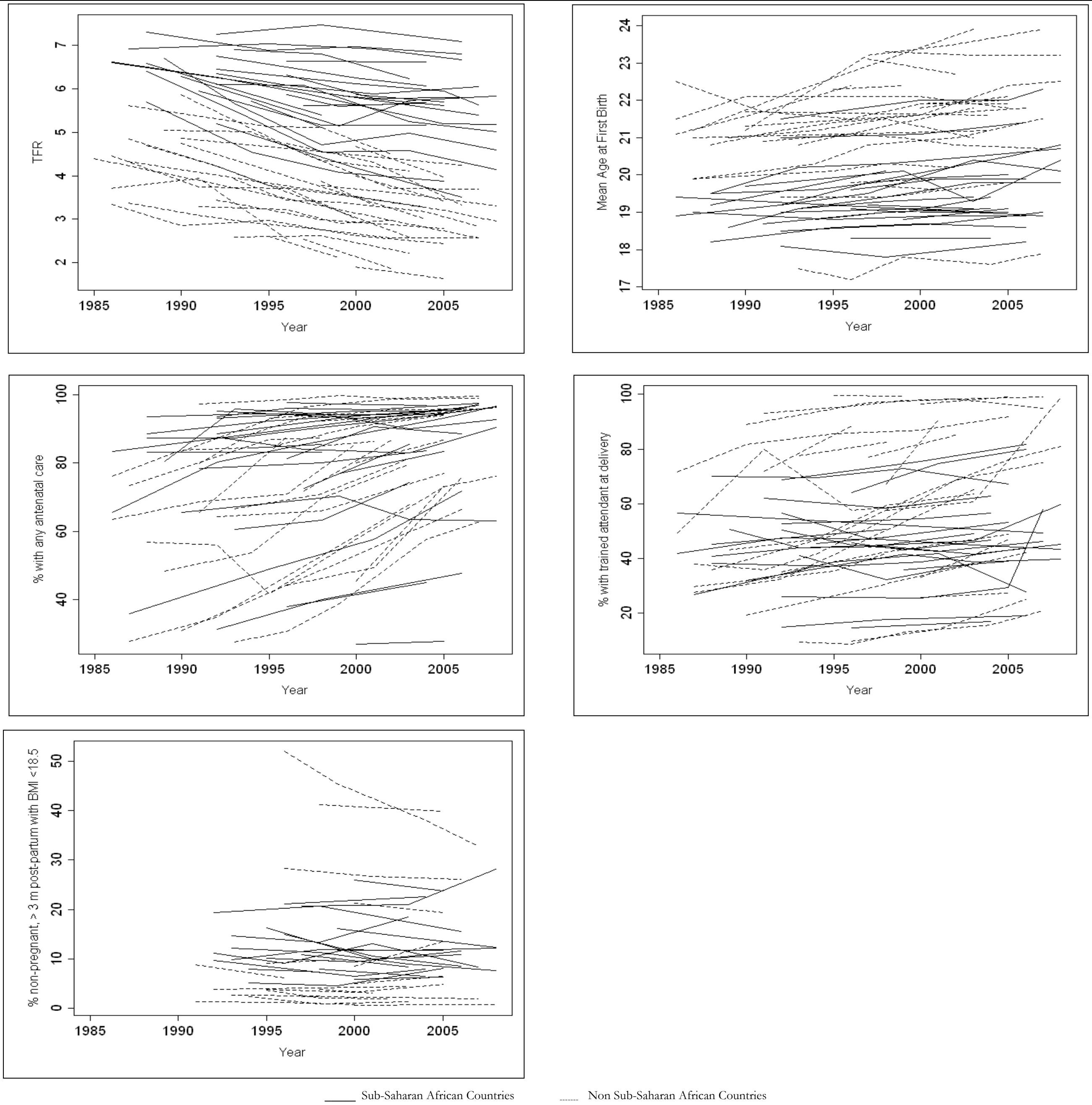
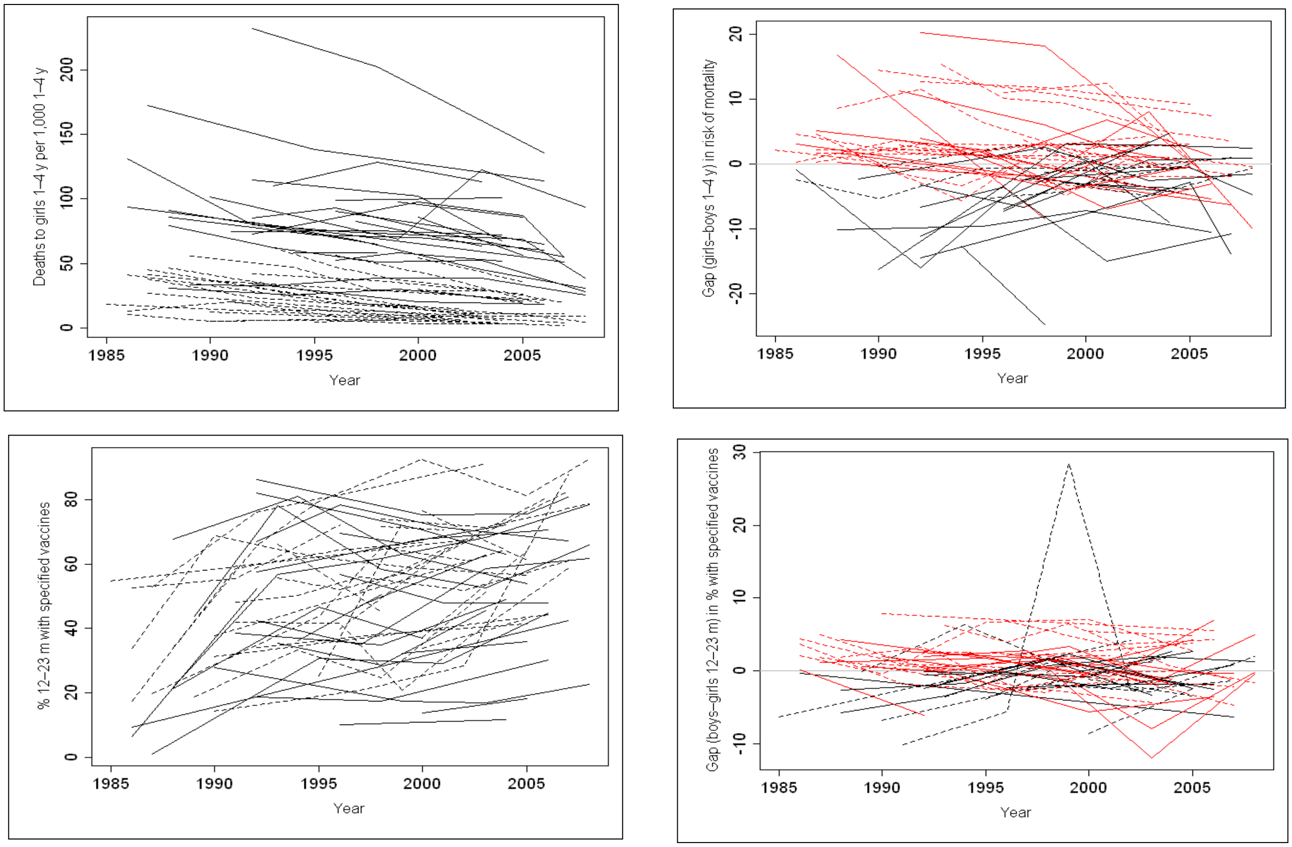
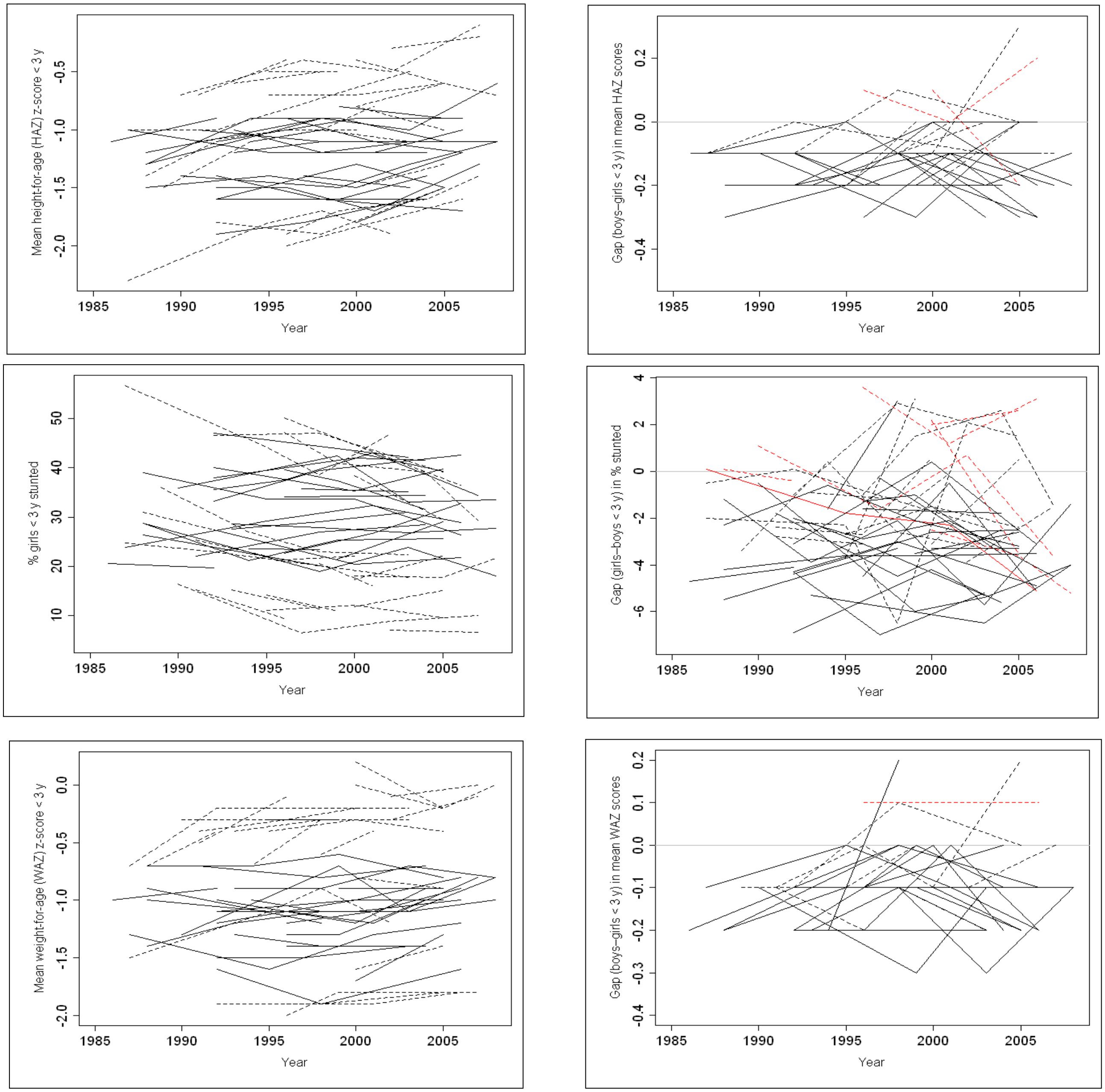


Figure 3 (continued)



Sub-Saharan African Countries Non Sub-Saharan African Countries

Figure 3 (continued)



Sub-Saharan African Countries   Non Sub-Saharan African Countries

Figure 3 (continued)

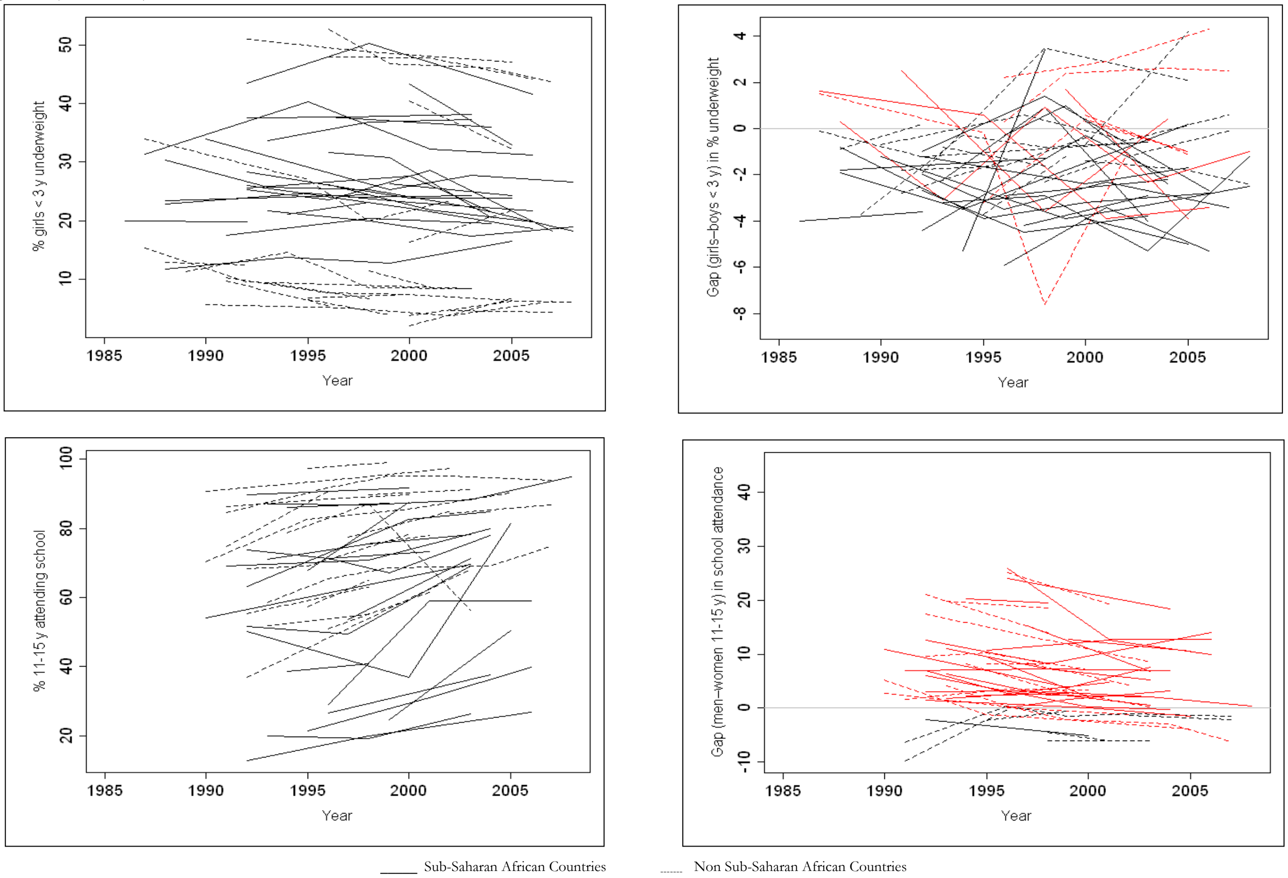


Table 2. Populated-Weighted Random-Effect Estimates of Total Fertility Rate (TFR) and Age of First Birth (AFB) on Women's Well-being, National Demographic and Health Surveys for 1985-2011

	(1)			(2)			(3)			(4)				
	B	(*se*)	*p*	B	(*se*)	*p*	B	(*se*)	*p*	B	(*se*)	*p*	R^2	N/n
Exp. Var.: TFR, women 15–49 y 0–4 y before survey														
Deaths to girls 1–4 y per 1,000 1–4 y	18.94	(1.29)	***	17.21	(1.65)	***	17.77	(1.49)	***	17.59	(1.78)	***	0.69	184/74
% 12–23 m with specified vaccines	-10.35	(1.28)	***	-6.83	(1.54)	***	-9.92	(1.43)	***	-8.31	(1.71)	***	0.27	176/73
Mean HAZ score < 3 y	-0.14	(0.03)	***	-0.08	(0.04)	*	-0.02	(0.03)		0.00	(0.03)		0.66	152/67
% < 3 y stunted	3.14	(0.79)	***	1.45	(0.90)		0.34	(0.68)		-0.40	(0.74)		0.73	152/67
Mean WAZ score < 3 y	-0.17	(0.03)	***	-0.08	(0.04)	!	-0.03	(0.03)		0.03	(0.04)		0.54	152/67
% < 3 y underweight	3.82	(0.61)	***	0.62	(0.95)		0.49	(0.69)		-1.08	(0.91)		0.61	152/67
% 11-15 y attending school	-10.56	(1.04)	***	-4.58	(1.30)	***	-8.82	(1.15)	***	-3.83	(1.35)	**	0.47	125/60
% with any antenatal care, births in 3 y prior	-11.14	(1.18)	***	-7.74	(1.47)	***	-8.31	(1.35)	***	-6.45	(1.63)	***	0.08	175/71
% with trained attendant at delivery, births in 3 y prior	-12.16	(1.36)	***	-6.84	(1.72)	***	-6.46	(1.20)	***	-4.23	(1.60)	**	0.54	175/73
% with BMI<18.5 in 3 y prior	-2.05	(1.06)	!	-3.01	(1.12)	**	-4.86	(1.01)	***	-5.85	(0.97)	***	0.71	124/60
Exp. Var.: AFB, Women 25 – 49 y														
Deaths to girls 1–4 y per 1,000 1–4 y	-15.65	(1.58)	***	-11.01	(1.74)	***	-11.70	(2.04)	***	-10.43	(1.95)	***	0.31	185/75
% 12–23 m with specified vaccines	7.39	(1.26)	***	5.27	(1.25)	***	5.89	(1.55)	***	5.80	(1.46)	***	0.24	175/73
Mean HAZ score < 3 y	0.26	(0.03)	***	0.20	(0.03)	***	0.12	(0.03)	***	0.12	(0.03)	***	0.70	152/67
% < 3 y stunted	-5.99	(0.71)	***	-4.37	(0.72)	***	-2.50	(0.71)	***	-2.09	(0.64)	**	0.75	152/67
Mean WAZ score < 3 y	0.27	(0.03)	***	0.24	(0.03)	***	0.19	(0.03)	***	0.20	(0.03)	***	0.62	152/67
% < 3 y underweight	-5.78	(0.65)	***	-3.99	(0.74)	***	-3.81	(0.70)	***	-3.77	(0.72)	***	0.67	152/67
% 11-15 y attending school	7.15	(1.32)	***	4.74	(1.10)	***	2.53	(1.63)		3.51	(1.26)	**	0.44	125/60
% with any antenatal care, births in 3 y prior	9.63	(1.18)	***	5.50	(1.22)	***	6.18	(1.54)	***	5.18	(1.44)	***	0.20	177/72
% with trained attendant at delivery, births in 3 y prior	15.74	(1.16)	***	10.62	(1.29)	***	7.94	(1.31)	***	7.03	(1.31)	***	0.67	174/72
% with BMI<18.5 in 3 y prior	-6.22	(0.89)	***	-5.93	(0.95)	***	-4.31	(1.14)	***	-3.83	(1.12)	***	0.64	124/60
Controls (of country C, time T, economic change EΔ):	C			C, T			C, EΔ			C, T, EΔ				

! $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$.

Table 3. Populated-Weighted Random-Effect Estimates of Total Fertility Rate (TFR) and Age of First Birth (AFB) on Gender gaps in Well-being, National Demographic and Health Surveys for 1985-2011

	(1)			(2)			(3)			(4)				
	B	(*se*)	*p*	B	(*se*)	*p*	B	(*se*)	*p*	B	(*se*)	*p*	R^2	N/n
Exp. Var.: TFR, women 15–49 y 0–4 y before survey														
Gap (girls–boys 1–4 y) in risk of mortality	-0.757	(0.487)		-1.125	(0.520)	*	-1.162	(0.548)	*	-1.211	(0.603)	*	0.45	184/74
Gap (boys–girls 12–23 m) in % with specified vaccines	0.047	(0.258)		-0.032	(0.282)		-0.084	(0.302)		-0.229	(0.324)		0.24	176/73
Gap (boys–girls < 3 y) in mean HAZ scores	-0.035	(0.007)	***	-0.027	(0.009)	**	-0.050	(0.009)	***	-0.048	(0.011)	***	0.47	152/67
Gap (girls–boys < 3 y) in % stunted	-1.135	(0.165)	***	-0.968	(0.189)	***	-1.549	(0.190)	***	-1.615	(0.236)	***	0.62	152/67
Gap (boys–girls < 3 y) in mean WAZ scores	-0.034	(0.007)	***	-0.024	(0.008)	**	-0.049	(0.008)	***	-0.046	(0.010)	***	0.45	152/67
Gap (girls–boys < 3 y) in % underweight	-1.130	(0.141)	***	-0.867	(0.147)	***	-1.392	(0.167)	***	-1.311	(0.190)	***	0.65	152/67
Gap (men–women 11-15 y) in school attendance	2.547	(0.755)	***	-0.113	(0.801)		2.166	(0.819)	**	0.058	(0.797)		0.29	125/60
Exp. Var.: AFB, Women 25 – 49 y														
Gap (girls–boys 1–4 y) in risk of mortality	-1.881	(0.408)	***	-1.282	(0.427)	**	-1.416	(0.519)	**	-1.168	(0.519)	*	0.40	185/75
Gap (boys–girls 12–23 m) in % with specified vaccines	-0.519	(0.223)	*	-0.252	(0.245)		-0.089	(0.292)		0.079	(0.292)		0.23	175/73
Gap (boys–girls < 3 y) in mean HAZ scores	-0.023	(0.008)	**	-0.026	(0.009)	**	-0.028	(0.011)	**	-0.038	(0.012)	**	0.24	152/67
Gap (girls–boys < 3 y) in % stunted	-0.525	(0.184)	**	-0.488	(0.200)	*	-0.334	(0.251)		-0.602	(0.274)	*	0.28	152/67
Gap (boys–girls < 3 y) in mean WAZ scores	-0.029	(0.007)	***	-0.027	(0.008)	***	-0.037	(0.010)	***	-0.041	(0.011)	***	0.33	152/67
Gap (girls–boys < 3 y) in % underweight	-0.481	(0.162)	**	-0.385	(0.163)	*	-0.406	(0.219)	!	-0.465	(0.226)	*	0.47	152/67
Gap (men–women 11-15 y) in school attendance	-2.278	(0.757)	**	-0.456	(0.680)		0.281	(0.906)		0.658	(0.733)		0.31	125/60
Controls (of country C, time T, economic change EΔ):		C			C, T			C, EΔ			C, T, EΔ			

! $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$.

Table 4 Summary of Results of Full Random-Effects Models of Well-being Outcomes on the Total Fertility Rate and Mean Age at First Birth, National Demographic and Health Surveys for 1985-2011

Explanatory variable:	TFR ↓					Age at First Birth ↑				
	Girls	Gaps		Hausman	Interpretation	Girls	Gaps		Hausmar	Interpretation
Outcome		Fem Adv	Male Adv	Girls/Gap			Fem Adv	Male Adv	Girls/Gap	
Deaths to girls 1–4 y per 1,000 1–4 y	↓	↓	↑	RE/FE	boys initially advantaged, (b) intensification	↓	↑	↓	RE/FE	boys initially advantaged, (c) gender parity effect and/or change in norms
% 12–23 m with specified vaccines	↑	NS	NS	FE/FE	(a), equal accrual of benefits	↑	NS	NS	FE/RE	(a), equal accrual of benefits
Mean HAZ score < 3 y	NS	↓	↑	RE/RE	girls initially advantaged, decreasing gap	↑	↑	↓	RE/RE	girls initially advantaged, increasing gap
% < 3 y stunted	NS	↓	↑	RE/RE	girls initially advantaged, decreasing gap	↓	↑	↓	RE/RE	girls initially advantaged, increasing gap
Mean WAZ score < 3 y	NS	↓	↑	RE/RE	girls initially advantaged, decreasing gap	↑	↑	↓	RE/RE	girls initially advantaged, increasing gap
% < 3 y underweight	NS	↓	↑	RE/RE	girls initially advantaged, decreasing gap	↓	↑	↓	RE/RE	girls initially advantaged, increasing gap
% 11-15 y attending school	↑	NS	NS	RE/RE	(a), equal accrual of benefits	↑	NS	NS	RE/RE	(a), equal accrual of benefits
% with any antenatal care, births in 3 y prior	↑			RE		↑			RE	
% with trained attendant at delivery, births in 3 y prior	↑			RE		↑			RE	
% with BMI<18.5 in 3 y prior	↑			RE		↓			RE	

Notes:

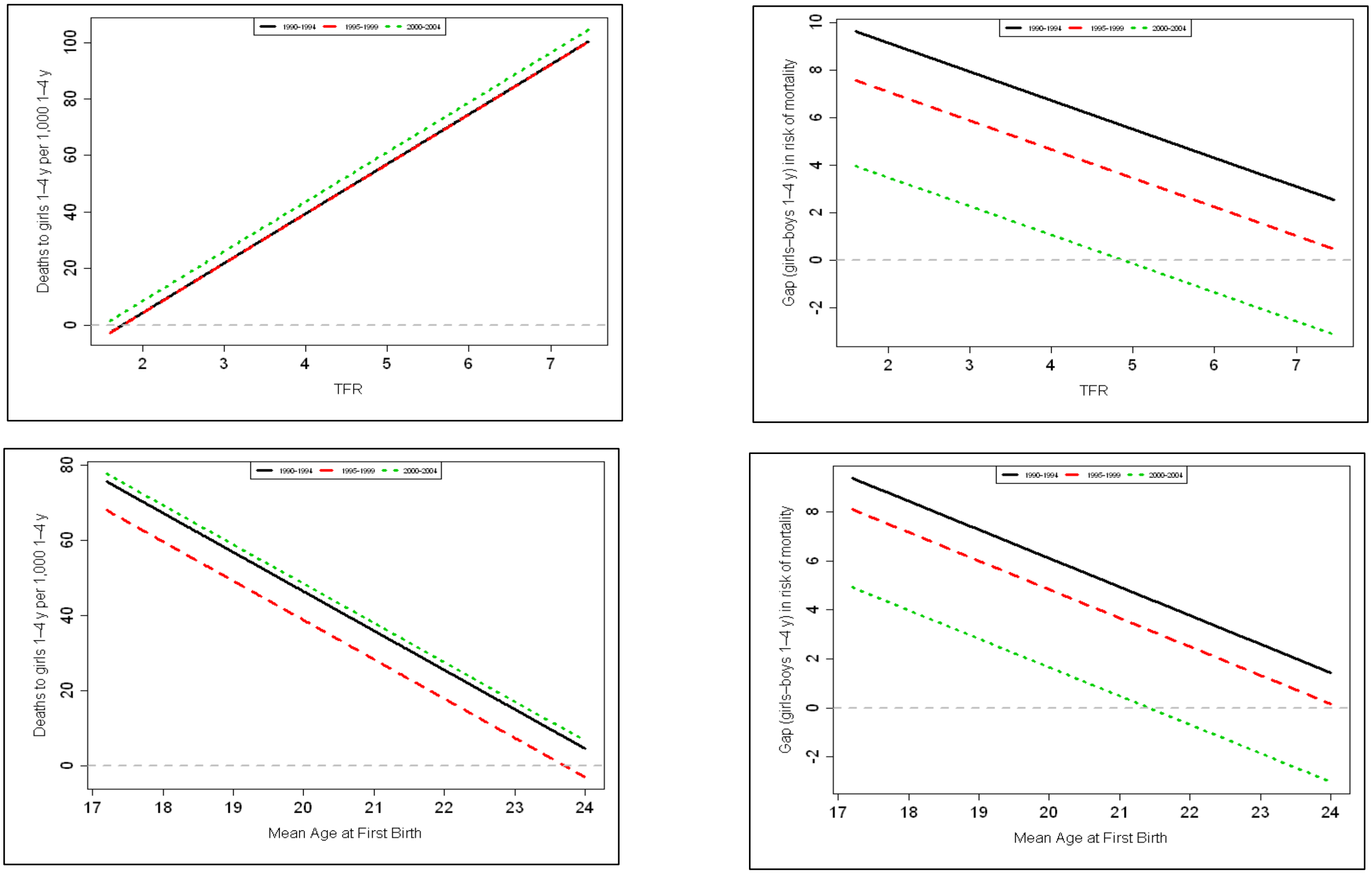
NS indicates non-significant result

↑↓ indicates direction of effect (↑ indicates widening gender gap, ↓ indicates declining gender gap; note that males are not always assumed to have the initial advantage)

Fem Adv, Male Adv indicates an assumption about whether males or females have the initial advantage in the indicator of well-being

RE, FE indicates whether the results of the Hausman Test supported using a random effects model or fixed effects model respectively

Figure 4: Predicted trends in child mortality of girls 1-4 years and gender gaps in child mortality based upon results of random effects models presented in Tables 2 and 3 (Model 4). Lines correspond to different scenarios based on average socioeconomic conditions observed in specific periods (see Appendix 1).



Appendix 1. Descriptive Statistics for Measures of Women's Well-being, Gender Gaps in Well-being, and Explanatory and Contextual Variables, National Demographic and Health Surveys for 1985-9, 1990-4, 1995-9, 2000-4, 2005-11, and total

	1985-1989					1990-1994					1995-1999				
	Mean	SD	Min	Max	N	**Mean**	SD	Min	Max	N	**Mean**	SD	Min	Max	N
Women's and Girls' Well-being															
Deaths to girls 1–4 y per 1,000 1–4 y	**50.3**	42.5	3.5	172.0	26	**54.9**	45.3	5.6	231.8	30	**47.2**	41.3	4.7	202.2	46
% 12–23 m with specified vaccines	**35.8**	21.7	1.1	74.3	22	**51.2**	19.2	14.5	86.2	30	**49.0**	19.3	10.2	80.1	45
Mean HAZ score < 3 y	**-1.3**	0.4	-2.3	-0.2	17	**-1.2**	0.4	-1.9	-0.6	25	**-1.2**	0.5	-2.0	-0.3	39
% < 3 y stunted	**28.6**	11.6	4.5	56.7	17	**28.3**	9.5	14.0	47.0	25	**28.8**	12.3	6.4	50.2	39
Mean WAZ score < 3 y	**-1.0**	0.4	-1.6	-0.5	17	**-0.9**	0.5	-1.9	-0.2	25	**-1.0**	0.6	-2.0	-0.1	39
% < 3 y underweight	**21.0**	10.3	6.9	38.0	17	**22.5**	12.1	4.7	50.9	25	**24.2**	14.5	4.0	52.7	39
% 11-15 y attending school	**.**	.	.	.	0	**61.1**	21.5	12.8	90.8	28	**67.2**	23.6	19.2	99.1	44
% with any antenatal care, births in 3 y prior	**73.1**	18.8	27.9	98.3	21	**73.6**	20.9	27.6	97.2	30	**78.0**	20.2	30.8	99.8	46
% with trained attendant at delivery, births in 3 y prior	**55.1**	21.4	19.2	98.3	25	**50.8**	21.6	9.5	93.1	30	**55.3**	26.3	8.6	99.6	46
% with BMI<18.5 in 3 y prior	**.**	.	.	.	0	**9.1**	5.6	1.3	19.4	17	**13.1**	11.9	0.9	52.0	38
Gender gap in well-being (positive value indicates girls' disadvantage)															
Gap (girls–boys 1–4 y) in risk of mortality	**1.9**	4.8	-10.1	16.8	26	**0.3**	9.2	-16.3	20.2	30	**-0.2**	6.8	-24.7	18.2	46
Gap (boys–girls 12–23 m) in % with specified vaccines	**0.8**	3.8	-7.0	8.7	22	**0.0**	3.7	-10.1	7.8	30	**1.3**	5.0	-5.7	28.5	45
Gap (boys–girls < 3 y) in mean HAZ scores	**-0.1**	0.1	-0.3	0.0	17	**-0.1**	0.1	-0.2	0.0	25	**-0.1**	0.1	-0.5	0.1	39
Gap (girls–boys < 3 y) in % stunted	**-1.6**	2.3	-5.5	2.7	17	**-2.4**	1.9	-6.9	1.1	25	**-2.4**	2.6	-7.0	3.6	39
Gap (boys–girls < 3 y) in mean WAZ scores	**-0.1**	0.1	-0.2	0.1	17	**-0.1**	0.1	-0.2	0.0	25	**-0.1**	0.1	-0.4	0.2	39
Gap (girls–boys < 3 y) in % underweight	**-0.4**	1.7	-4.0	1.8	17	**-1.8**	1.8	-5.3	2.5	25	**-1.5**	2.6	-7.6	3.5	39
Gap (men–women 11-15 y) in school attendance	**.**	.	.	.	0	**8.1**	8.5	-9.8	23.7	28	**7.3**	10.1	-6.1	45.2	44
Fertility Regime															
Total Fertility Rate, women 15–49 y 0–4 y before survey	**5.0**	1.4	2.4	7.3	26	**5.0**	1.3	2.6	7.3	30	**4.6**	1.5	2.1	7.5	46
Mean age at first birth, Women 25 – 49 y	**20.6**	1.5	18.2	24.0	25	**20.1**	1.3	17.5	22.1	30	**20.2**	1.5	17.2	23.3	46
Socioeconomic Context															
Avg GDP per capita 0-4 y prior, current US$	**967.3**	1053.0	190.9	5566.0	26	**806.0**	643.9	188.9	2613.5	30	**869.1**	882.3	166.7	3724.5	46
Urban population as a % of total, current or prior year	**36.5**	19.1	5.2	71.3	26	**38.3**	18.7	5.4	74.8	30	**38.8**	17.8	10.9	78.2	46
Mobile cellular subscriptions per 100 people 0–4 y prior	**0.0**	0.0	0.0	0.0	26	**0.0**	0.0	0.0	0.1	30	**0.8**	1.6	0.0	8.0	46
Avg net ODA received per capita 0-4 y prior, current US$	**29.1**	22.2	1.2	100.0	26	**40.7**	37.5	1.4	183.7	30	**34.1**	32.0	0.9	134.4	46

	2000-2004					2005-2011					Total				
	Mean	SD	Min	Max	N	**Mean**	SD	Min	Max	N	**Mean**	SD	Min	Max	N
Women's and Girls' Well-being															
Deaths to girls 1–4 y per 1,000 1–4 y	**42.3**	36.2	3.1	124.8	44	**37.8**	33.1	2.0	135.5	38	**45.8**	39.4	2.0	231.8	184
% 12–23 m with specified vaccines	**55.9**	20.8	11.2	92.3	43	**58.9**	19.1	18.2	92.4	36	**51.4**	20.9	1.1	92.4	176
Mean HAZ score < 3 y	**-1.2**	0.4	-1.9	-0.3	39	**-1.0**	0.4	-1.7	-0.1	32	**-1.1**	0.4	-2.3	-0.1	152
% < 3 y stunted	**28.1**	10.7	7.0	46.9	39	**24.6**	9.8	6.6	42.5	32	**27.6**	10.9	4.5	56.7	152
Mean WAZ score < 3 y	**-0.9**	0.5	-1.9	0.2	39	**-0.8**	0.5	-1.8	0.0	32	**-0.9**	0.5	-2.0	0.2	152
% < 3 y underweight	**21.6**	12.6	2.1	47.8	39	**20.0**	12.4	3.9	47.0	32	**22.0**	12.7	2.1	52.7	152
% 11-15 y attending school	**73.4**	19.4	26.3	97.8	39	**70.2**	23.2	26.9	95.6	14	**68.1**	22.0	12.8	99.1	125
% with any antenatal care, births in 3 y prior	**80.7**	18.0	27.0	99.1	40	**85.4**	15.8	27.8	99.5	38	**78.9**	19.1	27.0	99.8	175
% with trained attendant at delivery, births in 3 y prior	**56.4**	24.3	14.1	98.3	38	**60.3**	25.3	19.0	99.5	36	**55.7**	24.1	8.6	99.6	175
% with BMI<18.5 in 3 y prior	**10.8**	9.6	0.6	38.1	37	**12.0**	9.3	0.7	39.9	32	**11.6**	9.9	0.6	52.0	124
Gender gap in well-being (positive value indicates girls' disadvantage)															
Gap (girls–boys 1–4 y) in risk of mortality	**-0.6**	4.8	-15.0	12.4	44	**-1.9**	4.7	-13.8	9.2	38	**-0.3**	6.3	-24.7	20.2	184
Gap (boys–girls 12–23 m) in % with specified vaccines	**-0.6**	3.7	-12.0	7.2	43	**0.5**	3.6	-6.3	11.5	36	**0.4**	4.1	-12.0	28.5	176
Gap (boys–girls < 3 y) in mean HAZ scores	**-0.1**	0.1	-0.3	0.1	39	**-0.1**	0.1	-0.3	0.3	32	**-0.1**	0.1	-0.5	0.3	152
Gap (girls–boys < 3 y) in % stunted	**-2.0**	2.5	-6.5	2.6	39	**-2.7**	2.4	-7.4	3.1	32	**-2.3**	2.4	-7.4	3.6	152
Gap (boys–girls < 3 y) in mean WAZ scores	**-0.1**	0.1	-0.3	0.1	39	**-0.1**	0.1	-0.3	0.2	32	**-0.1**	0.1	-0.4	0.2	152
Gap (girls–boys < 3 y) in % underweight	**-1.4**	1.9	-5.3	2.9	39	**-1.2**	2.7	-8.6	4.3	32	**-1.3**	2.2	-8.6	4.3	152
Gap (men–women 11-15 y) in school attendance	**3.8**	6.6	-8.4	19.3	39	**3.0**	6.5	-6.2	14.0	14	**5.9**	8.5	-9.8	45.2	125
Fertility Regime															
Total Fertility Rate, women 15–49 y 0–4 y before survey	**4.4**	1.4	1.9	7.0	44	**4.3**	1.5	1.6	7.1	38	**4.6**	1.4	1.6	7.5	184
Mean age at first birth, Women 25 – 49 y	**20.6**	1.5	17.6	23.9	44	**20.6**	1.5	17.9	23.9	38	**20.4**	1.5	17.2	24.0	183
Socioeconomic Context															
Avg GDP per capita 0-4 y prior, current US$	**940.7**	989.0	133.8	4309.3	44	**930.2**	801.4	131.4	3227.7	38	**902.4**	878.2	131.4	5566.0	184
Urban population as a % of total, current or prior year	**39.6**	20.0	12.1	80.1	44	**39.0**	17.0	12.5	78.3	38	**38.6**	18.4	5.2	80.1	184
Mobile cellular subscriptions per 100 people 0–4 y prior	**7.4**	9.9	0.0	40.2	44	**24.6**	20.7	0.5	84.1	38	**7.1**	14.1	0.0	84.1	184
Avg net ODA received per capita 0-4 y prior, current US$	**35.6**	28.7	1.7	126.1	44	**43.2**	31.7	1.3	135.5	38	**36.7**	31.0	0.9	183.7	184

Note. The countries included in each period are not identical, and so comparisons across periods should be made cautiously.

Appendix 2. Populated-Weighted Country Fixed-Effect Estimates of Total Fertility Rate (TFR) and Age of First Birth (AFB) on Measures of Women's Well-being, National Demographic and Health Surveys for 1985-2011

	(1)			(2)			(3)			(4)					Hausman	
	B	(*se*)	*p*	B	(*se*)	*p*	B	(*se*)	*p*	B	(*se*)	*p*	R^2	N/n	χ^2	$p>\chi^2$
Exp. Var.: TFR, women 15–49 y 0–4 y before survey																
Deaths to girls 1–4 y per 1,000 1–4 y	20.48	(3.27)	***	14.11	(7.23)	!	19.29	(3.80)	***	15.21	(7.25)	*	0.46	184/74	-26.39	
% 12–23 m with specified vaccines	-15.98	(2.97)	***	-13.60	(3.25)	***	-15.95	(3.76)	***	-13.95	(3.27)	***	0.27	176/73	60.23	***
Mean HAZ score < 3 y	-0.34	(0.07)	***	-0.12	(0.08)		-0.11	(0.09)		-0.11	(0.05)	*	0.42	152/67	7.18	
% < 3 y stunted	6.92	(1.78)	***	0.15	(2.20)		1.91	(1.78)		0.03	(1.72)		0.45	152/67	9.33	
Mean WAZ score < 3 y	-0.25	(0.05)	***	-0.21	(0.08)	**	-0.24	(0.08)	**	-0.22	(0.08)	**	0.05	152/67	11.93	
% < 3 y underweight	5.09	(0.52)	***	1.62	(0.93)	!	3.87	(0.64)	***	2.44	(1.12)	*	0.00	152/67	13.81	
% 11-15 y attending school	-12.83	1.14	***	-3.514	2.235		-8.375	1.867	***	-3.858	2.128	!	0.38	125/60	8.94	
% with any antenatal care, births in 3 y prior	-15.87	2.35	***	-12.63	(1.89)	***	-11.93	(2.69)	***	-10.26	(1.91)	***	0.00	175/71	15.38	
% with trained attendant at delivery, births in 3 y prior	-16.73	(3.44)	***	-5.42	(4.10)		-6.59	(2.86)	*	-3.66	(2.60)		0.34	175/73	15.99	
% with BMI<18.5 in 3 y prior	3.00	(2.85)		-1.96	(1.21)		1.02	(1.74)		-2.43	(1.66)		0.28	124/60	2.62	
Exp. Var.: AFB, Women 25 – 49 y																
Deaths to girls 1–4 y per 1,000 1–4 y	-20.15	(2.37)	***	-10.13	(4.90)	*	-17.21	(4.68)	***	-11.33	(4.72)	*	0.02	185/75	11.83	
% 12–23 m with specified vaccines	14.06	(2.94)	***	5.24	(2.83)	!	11.99	(3.89)	**	7.27	(2.84)	*	0.11	175/73	33.60	*
Mean HAZ score < 3 y	0.39	(0.10)	***	0.11	(0.07)	!	0.24	(0.10)	*	0.17	(0.06)	**	0.46	152/67	11.72	
% < 3 y stunted	-7.31	(2.83)	*	-0.47	(1.87)		-3.79	(2.60)		-1.88	(1.85)		0.50	152/67	12.71	
Mean WAZ score < 3 y	0.24	(0.03)	***	0.13	(0.05)	*	0.23	(0.04)	***	0.15	(0.03)	***	0.01	152/67	10.39	
% < 3 y underweight	-4.66	(0.86)	***	-0.84	(0.75)		-3.17	(0.81)	***	-1.79	(0.62)	**	0.02	152/67	10.55	
% 11-15 y attending school	10.59	3.445	**	3.804	2.211	!	4.276	2.354	!	4.554	2.261	*	0.32	125/60	1.72	
% with any antenatal care, births in 3 y prior	15.45	(2.80)	***	4.77	(3.27)		9.22	(1.90)	***	4.95	(2.69)	!	0.00	177/72	4.91	
% with trained attendant at delivery, births in 3 y prior	19.57	(3.15)	***	9.40	(3.73)	*	7.03	(3.43)	*	5.22	(3.60)		0.37	174/72	10.17	
% non-pregnant, > 3-m postpartum with BMI < 18.5	-3.39	(2.14)		-0.32	(1.06)		-2.02	(1.46)		-0.53	(1.14)		0.31	124/60	2.78	
Controls (of country C, time T, economic change EΔ):	C			C, T			C, EΔ			C, T, EΔ						

Notes. H_0 for Hausman test = No systematic difference between fixed-effect and random-effect coefficients.

! $p \le 0.10$, * $p \le 0.05$, ** $p \le 0.01$, *** $p \le 0.001$.

Appedix 3. Populated-Weighted Country Fixed-Effect Estimates of Total Fertility Rate (TFR) and Age of First Birth (AFB) on Gender Gaps in Well-being, National Demographic and Health Surveys for 1985-2011

	(1)			(2)			(3)			(4)					Hausman	
	B	(*se*)	*p*	B	(*se*)	*p*	B	(*se*)	*p*	B	(*se*)	*p*	R^2	N/n	χ^2	$p>\chi^2$
Exp. Var.: TFR, women 15–49 y 0–4 y before survey																
Gap (girls–boys 1–4 y) in risk of mortality	2.70	(1.55)	!	2.99	(1.40)	*	2.62	(1.79)		1.86	(1.87)		0.00	184/74	26.83	*
Gap (boys–girls 12–23 m) in % with specified vaccines	1.12	(0.78)		0.33	(0.93)		0.28	(0.89)		-0.12	(0.96)		0.01	176/73	25.02	!
Gap (boys–girls < 3 y) in mean HAZ scores	-0.02	(0.05)		0.10	(0.06)	!	-0.05	(0.10)		0.05	(0.06)		0.00	152/67	1.27	
Gap (girls–boys < 3 y) in % stunted	-0.45	(1.30)		1.35	(1.23)		-0.97	(1.89)		-0.08	(0.94)		0.03	152/67	5.03	
Gap (boys–girls < 3 y) in mean WAZ scores	-0.01	(0.06)		0.11	(0.08)		-0.02	(0.10)		0.04	(0.07)		0.00	152/67	2.96	
Gap (girls–boys < 3 y) in % underweight	-1.48	(1.51)		0.40	(1.24)		-2.28	(2.32)		-0.91	(1.13)		0.04	152/67	3.13	
Gap (men–women 11-15 y) in school attendance	4.33	(3.45)		-1.29	(2.30)		4.65	(2.88)		-1.00	(1.59)		0.05	125/60	5.92	
Exp. Var.: AFB, Women 25 – 49 y																
Gap (girls–boys 1–4 y) in risk of mortality	-2.60	(1.01)	*	-1.82	(1.73)		-2.39	(0.96)	*	-2.08	(1.86)		0.00	185/75	32.69	*
Gap (boys–girls 12–23 m) in % with specified vaccines	-0.66	(1.09)		0.41	(1.26)		0.76	(1.31)		0.71	(1.26)		0.00	175/73	16.74	
Gap (boys–girls < 3 y) in mean HAZ scores	-0.05	(0.03)	!	-0.13	(0.04)	**	-0.08	(0.02)	***	-0.11	(0.04)	**	0.01	152/67	2.85	
Gap (girls–boys < 3 y) in % stunted	-0.67	(0.69)		-2.33	(0.69)	**	-0.37	(0.68)		-1.30	(0.47)	**	0.00	152/67	14.80	
Gap (boys–girls < 3 y) in mean WAZ scores	-0.05	(0.03)		-0.14	(0.05)	*	-0.08	(0.02)	***	-0.09	(0.04)	*	0.00	152/67	5.42	
Gap (girls–boys < 3 y) in % underweight	0.33	(0.68)		-1.74	(0.79)		-0.23	(0.46)		-1.08	(0.69)		0.00	152/67	-24.53	
Gap (men–women 11-15 y) in school attendance	-1.54	2.564		2.34	1.68		0.29	2.826		1.47	1.333		0.05	125/60	5.12	
Controls (of country C, time T, economic change EΔ):	C			C, T			C, EΔ			C, T, EΔ						

Notes. H_0 for Hausman test = No systematic difference between fixed-effect and random-effect coefficients.

! $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$.

Appendix 4. Summary of Results of Full Fixed-Effects Models of Well-being Outcomes on the Total Fertility Rate and Mean Age at First Birth, National Demographic and Health Surveys for 1985-2011

Explanatory variable:	TFR ↓					Age at First Birth ↑				
	Girls	Gaps		Hausman	Interpretation	Girls	Gaps		Hausman	Interpretation
Outcome		Fem Adv	Male Adv	Girls/Gap			Fem Adv	Male Adv	Girls/Gap	
Deaths to girls 1–4 y per 1,000 1–4 y	↓	NS	NS	RE/FE	(a), equal accrual of benefits	↓	NS	NS	RE/FE	(a), equal accrual of benefits
% 12–23 m with specified vaccines	↑	NS	NS	FE/FE	(a), equal accrual of benefits	↑	NS	NS	FE/RE	(a), equal accrual of benefits
Mean HAZ score < 3 y	↑	NS	NS	RE/RE	(a), equal accrual of benefits	↑	↑	↓	RE/RE	girls initially advantaged, increasing gap
% < 3 y stunted	NS	NS	NS	RE/RE	no changes in level or gender gap	NS	↑	↓	RE/RE	girls initially advantaged, increasing gap
Mean WAZ score < 3 y	↑	NS	NS	RE/RE	(a), equal accrual of benefits	↑	↑	↓	RE/RE	girls initially advantaged, increasing gap
% < 3 y underweight	↓	NS	NS	RE/RE	(a), equal accrual of benefits	↓	NS	NS	RE/RE	(a), equal accrual of benefits
% 11-15 y attending school	↑	NS	NS	RE/RE	(a), equal accrual of benefits	↑	NS	NS	RE/RE	(a), equal accrual of benefits
% with any antenatal care, births in 3 y prior	↑			RE		↑			RE	
% with trained attendant at delivery, births in 3 y prior	NS			RE		NS			RE	
% with BMI<18.5 in 3 y prior	NS			RE		NS			RE	

Notes:

NS indicates non-significant result

↑↓ indicates direction of effect (↑ indicates widening gender gap, ↓ indicates declining gender gap; note that males are not always assumed to have the initial advantage)

Fem Adv, Male Adv indicates an assumption about whether males or females have the initial advantage in the indicator of well-being

RE, FE indicates whether the results of the Hausman Test supported using a random effects model or fixed effects model respectively