Population Studies
A Journal of Demography

Routledge
Taylor & Francis Group

ISSN: 0032-4728 (Print) 1477-4747 (Online) Journal homepage: http://www.tandfonline.com/loi/rpst20

The demography of words: The global decline in non-numeric fertility preferences, 1993–2011

Margaret Frye & Lauren Bachan

To cite this article: Margaret Frye & Lauren Bachan (2017): The demography of words: The global decline in non-numeric fertility preferences, 1993–2011, Population Studies, DOI: 10.1080/00324728.2017.1304565

To link to this article: http://dx.doi.org/10.1080/00324728.2017.1304565

Population Studies, 2017
http://dx.doi.org/10.1080/00324728.2017.1304565

Routledge
Taylor & Francis Group
Check for updates

The demography of words: The global decline in non-numeric fertility preferences, 1993–2011

Margaret Frye[1] **and Lauren Bachan**[2]
[1]Princeton University, [2]Pennsylvania State University

This paper examines the decline in non-numeric responses to questions about fertility preferences among women in the developing world. These types of response—such as 'don't know' or 'it's up to God'—have often been interpreted through the lens of fertility transition theory as an indication that reproduction has not yet entered women's 'calculus of conscious choice'. However, this has yet to be investigated cross-nationally and over time. Using 19 years of data from 32 countries, we find that non-numeric fertility preferences decline most substantially in the early stages of a country's fertility transition. Using country-specific and multilevel models, we explore the individual- and contextual-level characteristics associated with women's likelihood of providing a non-numeric response to questions about their fertility preferences. Non-numeric fertility preferences are influenced by a host of social factors, with educational attainment and knowledge of contraception being the most robust and consistent predictors.

Supplementary material for this article is available at: http://dx.doi.org/10.1080/00324728.2017.1304565

Keywords: fertility transitions; fertility preferences; non-numeric responses

[Submitted January 2016; Final version accepted November 2016]

Introduction

When women are asked how many children they would want to have under ideal conditions, they sometimes provide answers using words rather than numbers, for example, 'it's up to God', 'as many as possible', or simply, 'I don't know'. Such *non-numeric* answers to questions about ideal family size (IFS) have long captivated researchers studying the cultural and developmental processes underlying fertility change (e.g., Caldwell 1976; Morgan 1982; Olaleye 1993; Castle 2001; Hayford and Agadjanian 2011) and have played a central role in classical theories of the fertility transition (Coale 1973; Van de Walle 1992). Yet despite general consensus that non-numeric responses are meaningful, demographers' understanding of how they cohere with broader fertility paradigms remains limited. Using over 90 surveys that span 19 years and three world regions, this paper provides the first comprehensive analysis of non-numeric responses to the IFS question. Combining a detailed examination of aggregate-level trends in fertility rates and non-numeric IFS with a multi-pronged investigation into the correlates of these types of response among individual women, our results provide insights into the demographic and social processes underlying non-numeric fertility preferences across much of the developing world.

Our analysis centred on three research questions. First, we asked: *Which countries and world regions report the highest levels of non-numeric response, and how has the prevalence of non-numeric IFS changed over time?* We harnessed the full analytic potential of the Demographic and Health Surveys (DHS) to describe geographic and temporal trends in non-numeric fertility preferences.

Second, we built on fertility transition theory to ask: *To what extent do aggregate-level patterns of non-numeric response cohere with trends in national fertility rates?* Non-numeric IFS responses are typically conceptualized in relation to Coale's (1973) preconditions of fertility decline, specifically that fertility reductions happen when childbearing decisions enter the 'calculus of conscious choice' (p. 65). When survey questions about IFS yield high levels of non-numeric response, demographers often assume that a country has not yet entered the fertility transition

(Caldwell 1976; Castle 2001). A decline in non-numeric IFS has been said to foreshadow widespread fertility decline within countries—that is, fertility is expected to fall shortly *after* women develop a numeric understanding of their fertility (Van de Walle 1992). Yet the relationship between these types of response and cross-national fertility trends has not yet been examined empirically. We compared aggregate patterns and trends in total fertility and non-numeric IFS, and investigated whether the timing of fertility transitions is related to country-level changes in non-numeric IFS.

Third, moving from aggregate trends to individual-level responses, we asked: *Which individual- and contextual-level characteristics are associated with women providing a non-numeric response to the IFS question?* According to demographic transition theory, women who provide a non-numeric IFS response approach their fertility from a 'pre-transition mindset' rather than envisioning and pursuing a particular family size (Van de Walle 1992), and this mindset is thought to be related to a lack of awareness that fertility can be controlled intentionally (Coale 1973; Johnson-Hanks 2007). A small body of research has found that non-numeric IFS responses are associated with low educational attainment (McCarthy and Oni 1987; Riley et al. 1993) and uncertainty stemming from high mortality (LeGrand et al. 2003; Sandberg 2005; Hayford and Agadjanian 2011). However, this literature is limited to cross-sectional analyses with narrow geographic coverage, and thus we know little about the experiences and characteristics that are most salient in predicting non-numeric responses to this question. Using both country-specific and multilevel regression models, we examined several individual and contextual factors that previous research suggests could be associated with non-numeric IFS response. We organized this part of our analysis around three theoretical perspectives that other scholars have used to understand non-numeric IFS: perceived ability to limit family size, exposure to formal schooling, and mortality-related uncertainty.

Previous research on non-numeric IFS

Before describing our data and methodological approach, we introduce the central theoretical paradigms and empirical findings from previous research related to non-numeric fertility preferences. We outline the roles that non-numeric IFS responses have played in fertility transition theories. This research motivated how we approached our second research question. Next, we outline previous research that has examined the attributes and experiences that predict whether individual women provide a non-numeric IFS response. This research motivated a set of alternative theoretical perspectives that we examined in the third stage of our analysis.

Non-numeric IFS and the fertility transition

The fertility transition refers to a shift from a fertility regime characterized by an absence of parity-specific control to a system of deliberate family size limitation (Henry 1961; Knodel 1977, 1979). The onset of this shift is typically defined as a net 10 per cent reduction in a country's total fertility rate (TFR); once this threshold has been crossed, no country has ever recovered to pre-transition fertility levels (Knodel 1977; Dyson and Murphy 1985; Kirk 1996; Bongaarts and Casterline 2013).

Scholarly interest in the fertility transition has often centred on cognitive orientations and culturally mediated systems of ideals and aspirations around childbearing. Such research focuses on variation across time and space in whether these systems of meaning construe fertility as requiring careful planning and management or, alternatively, as something that unfolds inevitably (Cleland and Wilson 1987; Hammel 1990; Mason 1992; Bongaarts and Watkins 1996; Bachrach 2014). To these scholars, non-numeric IFS responses are particularly pertinent, as these responses may suggest an alternative perspective according to which childbearing cannot (or should not) be conceptualized in quantitative terms (Coale 1973; Caldwell 1976; Castle 2001; Hayford and Agadjanian 2011). Indeed, Caldwell (1976) explicitly acknowledges that in high-fertility countries, 'up to God' and 'don't know' responses to IFS questions are likely to be more truthful than numeric responses, as pronatalist cultural norms engender preferences for 'many' children rather than encouraging women to select a specific number as their ideal (Jensen 1985; Olaleye 1993).

Some scholars view the onset of the fertility transition as an indication that women have begun to construct specific plans for childbearing; from this perspective, non-numeric responses are an indication of women's perceived lack of control over their fertility and a sign that the transition has not yet begun (Caldwell 1976; Morgan 1982; Van de Walle 1992; Hayford and Agadjanian 2011). Van de Walle (1992, p. 501) finds that a numeric understanding of fertility was absent from pre-transition European populations and predicts that a decline in non-numeric IFS will immediately precede the onset of a country's fertility transition, writing,

> I hypothesize that numeracy about children and the norm of an ideal family size appear not long before the fertility transition. Fertility decline is not far away when people start conceptualizing their family size, and it cannot take place without such conceptualizing.

Critics of this perspective claim that women in high-fertility settings *do* think numerically and deliberately about childbearing, and interpret non-numeric IFS as revealing a disinclination to verbalize these conceptions, either because of discomfort with the interview setting (Olaleye 1993) or concern about the supernatural risks such statements might incite (Castle 2001). According to these alternative perspectives, a decline in non-numeric IFS would not usually be expected to occur shortly before the onset of the fertility transition.

The correlates of non-numeric IFS response among individual women

We focused our analysis of the individual- and contextual-level predictors of non-numeric fertility preferences around three theoretical perspectives: perceived ability to limit family size, a woman's exposure to formal schooling, and mortality-related uncertainty. These perspectives are complementary rather than competing, and offer a set of theoretically motivated alternative explanations that guided our investigation into the factors associated with women offering words rather than numbers when describing their IFS.

Perceived ability to limit family size. Coale's (1973) seminal treatise posits that fertility will fall only when people are aware that family size can be the subject of intentionality and choice, are knowledgeable about methods of fertility limitation, and are convinced of the advantages of smaller families. This triumvirate sparked a wellspring of 'ideational' theories of fertility change, which, unlike those emphasizing 'structural' factors, centred around changing knowledge and attitudes about future fertility (Cleland and Wilson 1987; Mason 1992). Some scholars have suggested that Coale's preconditions are interrelated: awareness of new contraceptive technologies can awaken a 'latent demand' for small families through the realization that fertility can be consciously controlled (Easterlin and Crimmins 1985; Van de Walle 1992; Freedman 1997). Ideational theorists have also championed the idea that women may not want to limit their fertility until they see others doing so, articulating fertility decline as a process of social diffusion (Montgomery and Casterline 1993; Rosero-Bixby and Casterline 1993; Bongaarts and Watkins 1996; Cleland 2001b). Considerable empirical support exists for ideational theories. Evidence from 1991 in rural Pakistan, where a majority of women expressed non-numeric IFS, suggests that women who were familiar with a modern method of contraception were more likely to express a desire to limit their fertility (Mahmood and Ringheim 1997). In Kenya between the 1960s and late 1990s, messages promoted by the international family planning movement, interpreted through local discussions and debates, led to the increasingly widespread belief that fertility control is 'a legitimate choice' (Watkins 2000). In Ghana in 1999, women were more likely to express a desire to limit childbearing if their communities received an experimental intervention that introduced women to modern methods of contraception (Debpuur et al. 2002). Likewise, participation in family planning through the use of contraception signals that women are managing their reproductive futures. Unsurprisingly, use of contraception has been linked to the desire to stop childbearing in a variety of pre- and post-transition societies (Westoff 1990). Together, this research suggests that as women become aware of methods enabling them to control their fertility, and as they see other women limiting their childbearing, women will begin to think of their own family size as something to approach with a numeric mindset (Coale 1973; Rosero-Bixby and Casterline 1993; Hayford and Agadjanian 2011). Given these findings, we expected that knowledge of modern contraception, ever use of contraception, and contextual-level total fertility would be negatively associated with the level of non-numeric IFS response.

Formal education. Across contexts, educated women report smaller IFS, though the magnitude of this association varies widely across world regions (Martin 1995; Cleland 2002; Bongaarts 2003). Recent research from Malawi documents this relationship using longitudinal data and shows that when women attend an additional year of school, they reduce their IFS on average (Yeatman et al. 2013). Additionally, evidence from Costa Rica and Mozambique shows that educated women are more likely to respond numerically to IFS questions (Riley et al. 1993; Hayford and Agadjanian 2011).

The mechanisms through which education influences fertility preferences are contested (Martin 1995; Basu 2002). Some scholars suggest that education provides women with the mathematical and conceptual knowledge necessary to state their fertility preferences numerically (Levine et al. 1994; Diamond et al. 1999). An alternative perspective posits that the effect of schooling is cultural rather than academic: schools transmit Western values that emphasize nuclear families and intensive investment in children, leading to preferences for smaller families and more conscious deliberation about IFS (Caldwell et al. 1985; Caldwell and Caldwell 1987; Thornton 2001, 2013). Others suggest that population-level increases in educational attainment result in quantity–quality economic trade-offs that favour smaller families, leading women to shift their fertility goals from maximization to limitation (Becker and Lewis 1973; Becker 1991). While it was beyond the scope of our analysis to identify which mechanism links education with numeric IFS responses, the previous research collectively suggests that exposure to formal schooling would be negatively associated with non-numeric IFS response.

Mortality-related uncertainty. A growing body of literature, particularly focused on sub-Saharan Africa, documents how situational uncertainty shapes actions and decisions (Johnson-Hanks 2004, 2005, 2006; Trinitapoli and Yeatman 2011). Everyday life in less developed countries presents multiple sources of uncertainty, including spiritual insecurity (e.g., resulting from witchcraft), social vulnerability caused by poverty, and existential uncertainty resulting from child and young adult mortality.

Mortality-related uncertainty is particularly salient to the phenomenon of non-numeric fertility preferences. Witnessing repeated incidents of infant and child mortality leads women to question whether their children will survive to adulthood, making the task of choosing an 'ideal' number of children considerably more complex (Cleland 2001a; Lee 2003; Doepke 2005). Indeed, localized, cross-sectional studies have demonstrated that child mortality is positively associated with non-numeric IFS response (LeGrand et al. 2003; Sandberg 2005; Hayford and Agadjanian 2011). Adult mortality is another important dimension of uncertainty in these settings. In particular, the AIDS epidemic in sub-Saharan Africa strongly influences both men's and women's fertility preferences, especially when the perceived risk of infection is high (Yeatman 2009a, 2009b; Hayford et al. 2012). Drawing from this research, we expected both child mortality and HIV prevalence to be positively associated with the level of non-numeric IFS.

Data and methods

Data

This study used DHS data from 32 countries representing three world regions: South and South East Asia, Latin America, and sub-Saharan Africa. The DHS are nationally representative household-based surveys designed to collect data on sexual and reproductive health, child health, and fertility; data that are comparable across countries and over time (ICF International 2012). To incorporate national-level information not measured consistently in the DHS, we also included data from the World Development Indicator Database corresponding to each survey in our sample (World Bank 2014).

The DHS questionnaires are revised roughly every five years, corresponding with 'phases' of the survey. Our sample was restricted to countries with at least two surveys administered between Phases III and VI of the DHS programme, resulting in a sample of 91 surveys administered between 1993 and 2011. Appendix Table A1 lists the primary years of data collection, analytic sample size, total number of years spanned for each country, and information on which surveys we excluded and why. There were very low levels of missing data for our variables of interest: only 0.65 per cent of all respondents had missing data and the survey with the largest proportion with missing values was Uganda in 2006 at only 4.5 per cent. We limited our analytic sample to surveys and respondents with valid data on all variables used in our analysis. Our analytic sample contained 1,045,897 women.

Dependent variable

The outcome of interest was whether a woman provided a non-numeric response to the question: 'If you could choose exactly the number of children to have in your whole life, how many would that be?' For women who already had children, the question was prefaced with, 'If you could go back to the time when you did not have any children … '

The wording and placement of this question remained consistent for all surveys included in our analytic sample. Starting with Phase III of the DHS surveys, interviewers were instructed to probe for numeric responses in a non-suggestive manner before recording a non-numeric response. If interviewers were unable to solicit a numeric response after probing, they were instructed to record the woman's exact response in the 'other' category. While we were unable to assess the effect of this change in protocol because we lacked information on which individuals were probed, aggregate-level analyses (see the supplementary material) suggest that the probing instructions led to lower proportions of non-numeric IFS response. Thus, we limited our sample to Phase III and later.

The majority of surveys included only one non-numeric response category for the question about IFS. We therefore treated this outcome as binary, while recognizing that non-numeric responses stem from heterogeneous motivations and perspectives. An analysis of specific non-numeric response categories reported in a minority of surveys can be found in the supplementary material.

Individual-level independent variables

A descriptive summary of all variables is provided in Table A2 and further information can be found in the supplementary material. To assess the extent to which fertility control has permeated women's 'calculus of conscious choice' and whether such choice is associated with women's likelihood of expressing numeric IFS, we used two binary measures: knowledge of a modern method of contraception and ever use of any method of contraception (for this measure, we used a subsample of sexually active women). To evaluate the role of formal schooling in predicting non-numeric IFS, we used a categorical variable specifying the highest educational level completed—no schooling, incomplete primary school, or completed primary school and above. To explore whether mortality-related uncertainty is associated with non-numeric IFS, we included a variable indicating whether a woman had experienced a child death.

In addition to these measures that correspond directly to the three theoretical perspectives described earlier, our analyses accounted for other variables that are known to be associated with fertility preferences: age, marital status, parity, whether the respondent was Muslim, and whether she resided in an urban (vs. rural) area. To control for household socio-economic status (SES), we used the DHS wealth index quintiles, which were constructed separately for each country and therefore should be interpreted as a measure of relative wealth within countries. To control for how translation of the IFS question may impact the results, we also accounted for the language in which the interview was conducted. Finally, in ancillary analyses summarized in the supplementary material, we examined interviewer effects.

Survey-level independent variables

We measured time using the year that each survey was administered. To examine whether contextual-level characteristics play a role in predicting non-numeric IFS, we used national-level estimates of several macro-demographic and socio-economic indicators in our multilevel models, corresponding with the relevant year and country for each survey in our sample. Unless otherwise noted, all contextual-level variables were constructed using data from the World Development Indicator Databank (World Bank 2014). To examine contextual-level effects of changes in the perceived ability to limit family size, we used the TFR. For investigating the contextual-level effects of mortality-related uncertainty, we used the under-five child mortality rate and adult HIV prevalence. To explore contextual-level effects of increasing educational attainment, we used a measure representing the proportion of women that had ever attended school (any level), aggregated from the DHS survey data. Finally, we also used contextual-level measures of the percentage of the population living in an urban area and gross domestic product (GDP) per head.

Analytic approach

Our analysis proceeded in three sections, corresponding to our research questions. We began with a descriptive analysis of trends over time in non-numeric IFS across countries and regions. Second, we compared proportions of non-numeric IFS response with total fertility using three different time horizons: (1) the cross-sectional relationship between non-numeric response and TFRs across the 91 surveys in our sample; (2) national-level trajectories in TFRs and proportions of non-numeric response for each country; and (3) longer-term fertility trends within countries, specifically the extent to which changes in non-numeric IFS response differed according to the timing of onset of the fertility transition.

Third, after providing this overview of aggregate-level changes in non-numeric response, we used a combination of modelling strategies to examine the most salient predictors of non-numeric IFS response among individuals. We first estimated separate logistic regression models predicting non-numeric IFS for each of the 91 surveys included in our analytic sample. These models included all individual-level variables described earlier. We then estimated multilevel logistic regression models predicting non-numeric IFS for the full sample and the sexually active subsample (to examine the contraceptive use measure). These models used a three-level modelling strategy that nests women within surveys, which are nested within countries. Logistic regressions with random coefficients for each survey and country were estimated using HLM 6. For further technical details about our multilevel models, see Appendix B.

These different modelling strategies offered distinct and complementary advantages. The survey-specific models allowed us to estimate individual-level effects within specific national contexts at particular points in time, and to assess variation in these associations across surveys. In contrast, the multilevel models allowed us to estimate the effects of the covariates across the entire sample. Additionally, in the multilevel modelling framework, we included the survey-level variables, which reflect differences in national context at the time when each survey was conducted. Finally, by comparing differences in the contextual-level terms in the multilevel models, we were able to assess which countries and years had unexpectedly high or low levels of non-numeric IFS response, net of the effects of individual-level covariates.

Results 1: descriptive overview of prevalence and trends in non-numeric IFS response

We begin by examining trends over time in non-numeric IFS for countries in our sample. Table 1 gives the weighted proportion of non-numeric IFS response for each of the 91 surveys included in our analysis, and indicates whether each country experiences a significant decline, significant increase, or no significant change between the first and last surveys (significance assessed using two-tailed *t*-tests). The proportion providing a non-numeric response to the IFS question declines significantly over time in the majority (70 per cent) of countries included in this analysis.

Burkina Faso experiences the most substantial decline in non-numeric response between the two surveys, with 21 per cent of women providing a non-numeric response in 1999 and 4 per cent doing so in 2010. Other countries that experience notable declines include Mozambique (from 17 per cent in 1997 to 2 per cent in 2003), Bangladesh (from 11 per cent in 1994 to less than 2 per cent in 2007), Niger (from 24 per cent in 1998 to 15 per cent in 2006), and Bolivia (from 9 per cent in 1994 to 2 per cent in 2008).

Figure 1 plots the proportion of women who provide a non-numeric IFS response in each survey and the average linear trend over time across each region. In all three regions, the trend lines plotted in Figure 1 show declining proportions of non-numeric IFS over time; this decline is steeper in Latin America than in Asia and sub-Saharan Africa. This difference in slope could be an artefact of the more uneven coverage of surveys across years for Latin America. Nonetheless, it is worth noting that Coale's (1973) and Van de Walle's (1992) postulates—that non-numeric IFS response should decline before the onset of a country's fertility transition—would predict a greater decline in non-numeric IFS over time for Africa, where more countries are at earlier stages of their fertility transitions, compared with Latin America and Asia, where most countries entered the fertility transition decades before the period of observation.

Results 2: non-numeric IFS response and aggregate-level fertility change

In this section, we explore further whether fertility transition theorists' predictions have been borne out by examining the association between changes in aggregate fertility and trends in non-numeric IFS response. We begin by doing so cross-sectionally; Figure 2 plots the proportion of women who provide a non-numeric response in the survey against the TFR for the corresponding year. This figure shows that as fertility rates decrease across surveys (going from left to right on the chart), the proportion of women who provide a non-numeric IFS response also decreases. These results offer preliminary support for interpreting non-numeric IFS response through the lens of the fertility transition theory. However, the observations are more spread out around the regression line at higher TFRs. This pattern suggests that there are likely to be additional factors influencing the relationship between total fertility and proportions of non-numeric IFS response.

While Figure 2 shows that in a given year, countries with higher TFRs also tend to report higher proportions of women providing a non-numeric response, it does not tell us about how these two phenomena are related within countries,

Table 1 Proportion of women providing a non-numeric response to the ideal family size question in each survey, indicators of net change in non-numeric ideal family size between first and last survey in each country, and year of onset of fertility transition, for 32 countries, 1993–2011

Country	1993–95	1996–98	1999–2001	2002–04	2005–07	2008–11	Net change	Onset of fertility transition
SUB-SAHARAN AFRICA								
Benin		0.056	0.109		0.076		+ ***	2004
Burkina Faso			0.210	0.050		0.035	– ***	Not yet
Cameroon		0.149		0.145		0.070	– ***	2010
Ivory Coast	0.024	0.014					–	1989
Ethiopia			0.180		0.103	0.106	– ***	2003
Ghana	0.073	0.072		0.020		0.016	– ***	1986
Guinea			0.042		0.105		+ ***	2007
Kenya	0.057			0.052		0.036	– *	1984
Madagascar		0.100		0.091		0.059	– ***	1980
Malawi			0.034	0.034		0.021	– ***	2001
Mali		0.107	0.246		0.172		+ ***	Not yet
Mozambique		0.168		0.017			– ***	1996
Namibia			0.041		0.010		– ***	1988
Niger		0.238			0.153		– ***	Not yet
Nigeria				0.108		0.135	+ **	Not yet
Rwanda					0.037	0.011	– ***	1990
Tanzania		0.078	0.028	0.018			– ***	1992
Uganda	0.068		0.053		0.036	0.026	– ***	2009
Zambia		0.052		0.061	0.064		+ *	1993
Zimbabwe	0.007				0.012	0.009	+	1984
ASIA								
Bangladesh	0.110	0.058	0.030		0.017		– ***	1983
Cambodia			0.071		0.034	0.017	– ***	1972
Indonesia		0.205		0.144			– ***	1975
Nepal	0.025		0.017		0.002	0.003	– ***	1987
Philippines	0.015	0.018		0.011		0.010	– ***	1969
Vietnam		0.004		0.003			–	1977
LATIN AMERICA								
Bolivia	0.085	0.033		0.020		0.016	– ***	1977
Dom. Republic		0.016	0.020	0.015	0.009		– ***	1967
Guatemala	0.136		0.181				+ ***	1986
Haiti	0.015		0.026		0.001		– ***	1972
Nicaragua		0.030	0.035				+	1975
Peru		0.042	0.017				– ***	1972

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
+ indicates countries that experienced a net increase over time.
– indicates countries that experienced a net decrease over time.
Notes: Estimates of proportion of respondents providing a non-numeric ideal family size have been weighted to adjust for regional variation in sampling within countries. *T*-statistics were used to measure net change, comparing the proportion providing a non-numeric response for the first survey and last survey included for each country. See the supplementary material for more information about the onset of fertility transition variable.
Source: As for Figure 1.

or whether national-level trends in non-numeric response correspond to different patterns of decline in the TFR. Figure 3 shows the association between non-numeric IFS response and the TFR across the window of observation for each country. All countries in our sample experience a decline in TFR between the first and last survey, so the lines move from left (higher fertility) to right (lower fertility) over time. To visualize the relationship between aggregate fertility rates and proportions of non-numeric IFS response more clearly, this figure is divided into three panels according to different TFR trajectories across the observation period. Figure 3(a) shows the 13 countries with consistently high TFRs throughout the observation period (starting with a TFR above 4.5 and experiencing a total decline in TFR of less than 0.7); many of these countries experience the most substantial declines

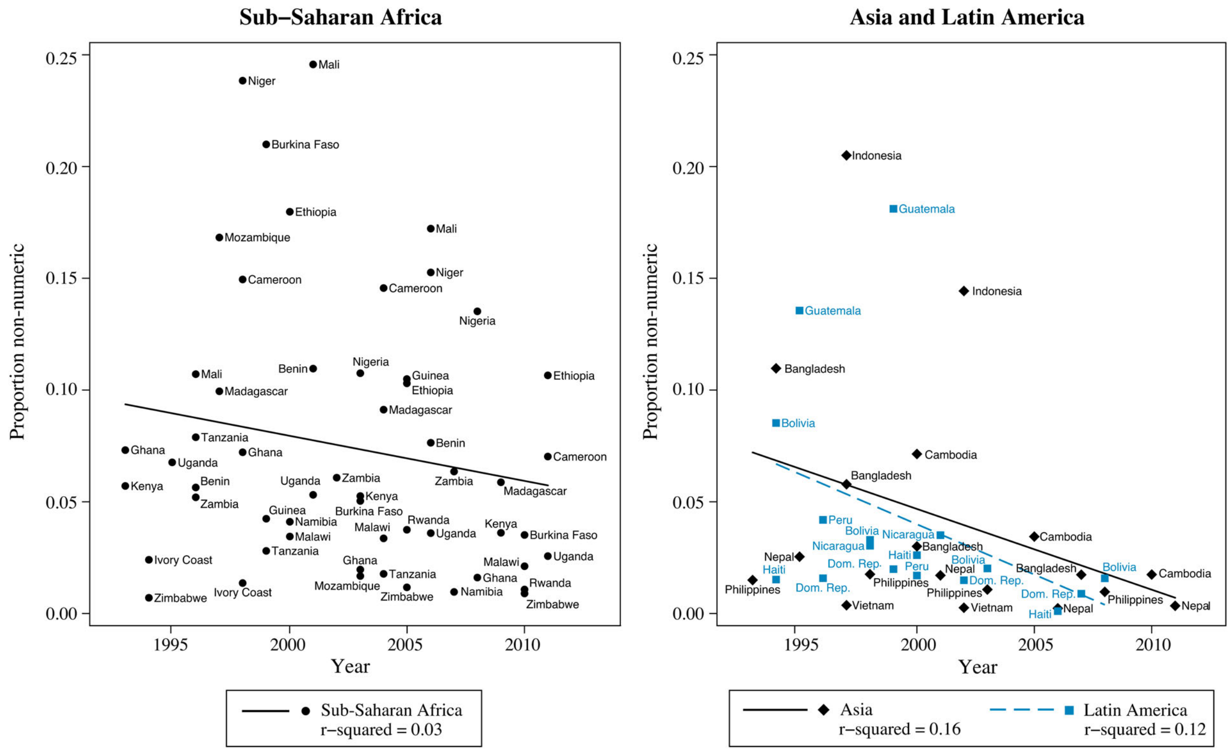

Figure 1 Scatterplot showing the proportion of women providing a non-numeric response to the ideal family size question against year of survey, for 91 surveys in 32 countries, by world region, 1993–2011

Notes: Each dot represents one of the 91 DHS surveys included in our sample. Proportions are weighted to adjust for regional variation in sampling within countries. Surveys conducted in sub-Saharan Africa appear in the left-hand panel, and surveys conducted in Asia (diamonds) and Latin America (squares) appear in the right-hand panel. Linear regression lines were calculated separately for each world region.

Source: DHS implementing partners and ICF International. Demographic and Health Surveys 1993–2011.

in non-numeric IFS response. Figure 3(b) shows the ten countries that start off with high TFRs (above 4.5) and experience substantial declines in TFR (at least 0.7); these countries tend to start off with lower levels of non-numeric response (with the exceptions of Ethiopia and Cameroon) and to experience a smaller net change in non-numeric response. Finally, Figure 3(c) shows the nine countries that enter the observation period with relatively low TFRs (below 4.5), and reveals that countries that begin the observation period with lower total fertility tend to report lower levels of non-numeric response, with the obvious exception of Indonesia.

Having examined how the TFR and aggregate levels of non-numeric IFS are related *during the period of observation* for each country, we next explore the extent to which non-numeric IFS response may reflect the types of *longer-term fertility trend* that are the focus of fertility transition theory. While Figure 3 plots the association between non-numeric IFS and contemporaneous estimates of TFR for each survey, Figure 4 displays the association between non-numeric IFS and year of survey, differentiated according to the period in which each country enters the fertility transition—a demographic milestone that occurs before the observation window for most countries in our sample (see Table 1 for the year of onset for each country and the supplementary material for more information about how the timing of onset was determined).

There are four possible ways that trends in non-numeric IFS during the period of observation might be related to the timing of the onset of the fertility transition. If a shift in non-numeric IFS were an *antecedent* to fertility change, something that takes place well before any changes in actual childbearing behaviour, one would expect to see a more marked decline in the level of non-numeric IFS in countries that have not yet entered the fertility transition. If, as suggested by Van de Walle (1992) and Coale (1973), a shift from non-numeric to numeric IFS were a *precondition* for the fertility transition, one would expect countries that entered the fertility transition either shortly before or during the period of observation to exhibit steeper declines in non-numeric IFS. If

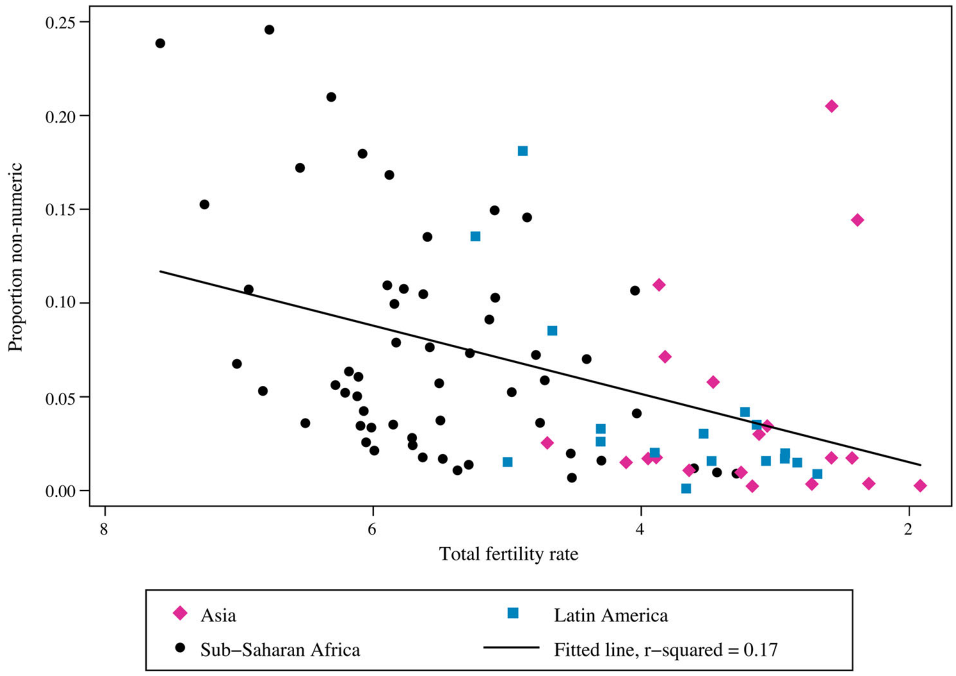

Figure 2 Scatterplot showing the proportion of women providing a non-numeric response to the ideal family size question against total fertility in year of survey, for 91 surveys in 32 countries, by world region, 1993–2011
Notes: The two outlying points in the upper right corner are from Indonesia, which reports unusually high levels of non-numeric response considering its fertility profile (see also Figure 3(c)). Total fertility declined throughout the period of observation for all countries in our sample, so the trends can be read from left (higher TFR) to right (lower TFR) over time.
Source: As for Figure 1.

declines in non-numeric IFS were a *consequence* of the onset of a country's fertility transition—that is, if numeric IFS responses were more closely connected to other indicators of development that occur at later stages in a country's fertility transition, such as universal primary education—then one would expect countries that began their fertility transition well before the window of observation to exhibit more marked patterns of decline in non-numeric IFS. Finally, if levels of non-numeric IFS were completely *unrelated* to how women conceptualize fertility, but were triggered by other factors such as experiences during the survey interview (Olaleye 1993) or beliefs about the risks related to verbalizing one's desires (Castle 2001), then one might not see any relationship between this measure and the timing of the fertility transition.

Figure 4 shows modest support for interpreting non-numeric responses through the lens of the demographic transition theory as a precondition or early indication of aggregate fertility decline (Coale 1973; Van de Walle 1992). The proportion of respondents who provide a non-numeric response is higher, on average, in Figures 4(c) and (d), which display respectively countries that entered the fertility transition most recently and those that have yet to enter the fertility transition, compared with Figures 4(a) and (b), which display countries that experienced the onset of the transition earlier. Further, the average slope of the lines is steepest (most negative) in Figure 4(c), which displays countries that entered the fertility transition during or less than five years before the observation window (the average slope in Figure 4(c) is –0.54 compared with an average of –0.21 for the other three charts). Lastly, for the five countries that have not yet entered the fertility transition at the time of their last survey (Figure 4(d)), we see no clear pattern in terms of trends in non-numeric response: three out of five of these countries actually experience a net *increase* in levels of non-numeric fertility response over time. Together, these results support Van de Walle's (1992) postulate that declining non-numeric IFS will occur around the time of onset of a country's fertility transition.

When examined according to aggregate-level trends as well as national-level trajectories, our results broadly support the idea that as countries' fertility rates decline, women are more likely to assign numeric values to their fertility preferences.

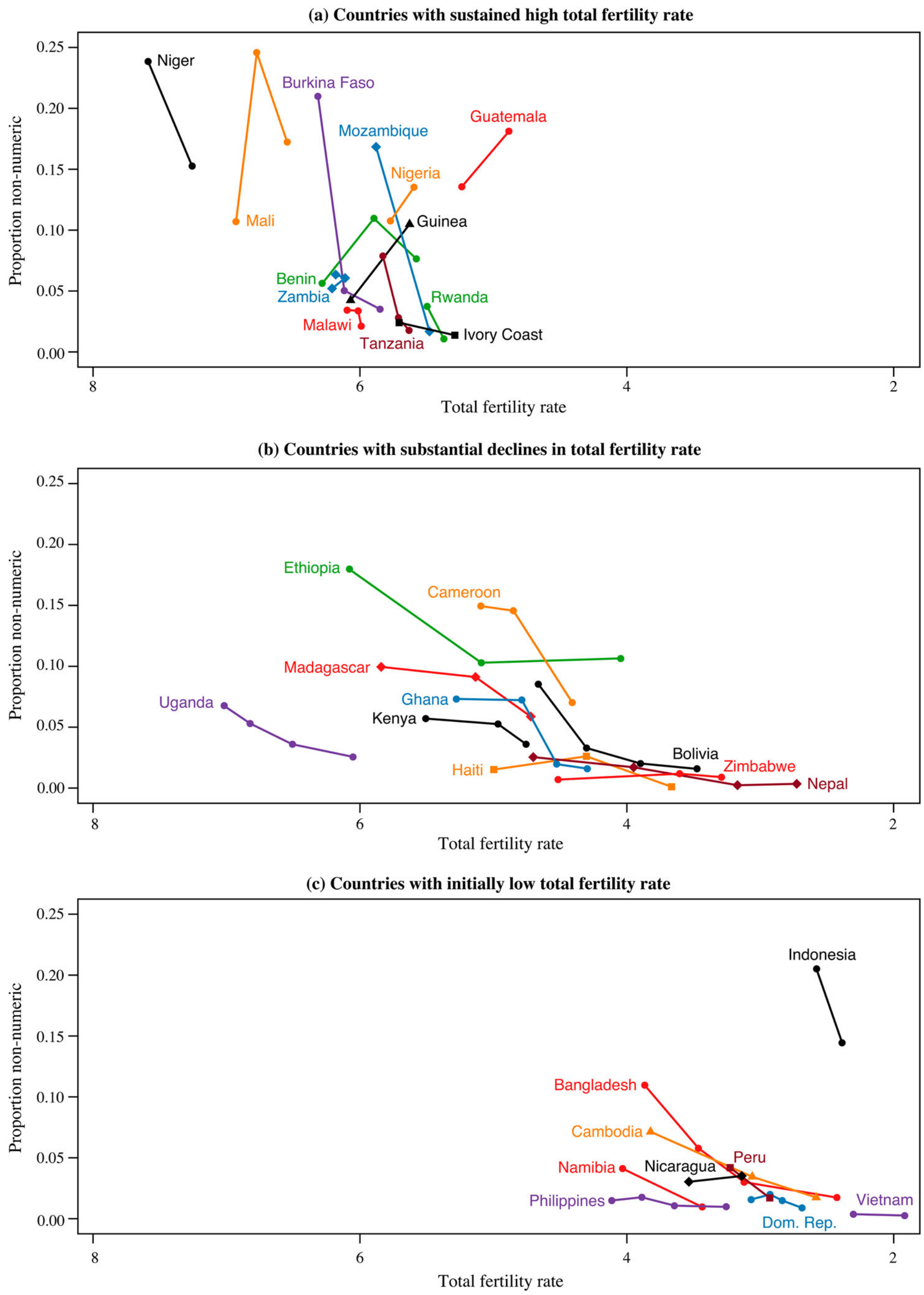

Figure 3 Connected lines showing the proportion of women providing a non-numeric response to the ideal family size question against total fertility for 32 countries, differentiated according to trends in total fertility during the window of observation (1993–2011)
Note: Total fertility declined throughout the period of observation for all countries in our sample, so all lines can be read from left (higher TFR) to right (lower TFR) over time.
Source: As for Figure 1.

However, the heterogeneity in the magnitude of these associations indicates that total fertility is likely not the only factor associated with the decline in non-numeric IFS response, and suggests that researchers should use caution when interpreting non-numeric response through the lens of fertility transition theory.

Results 3: identifying predictors of individual-level non-numeric IFS response

Survey-specific models

Next, we examine which characteristics are associated with variation in non-numeric response at the

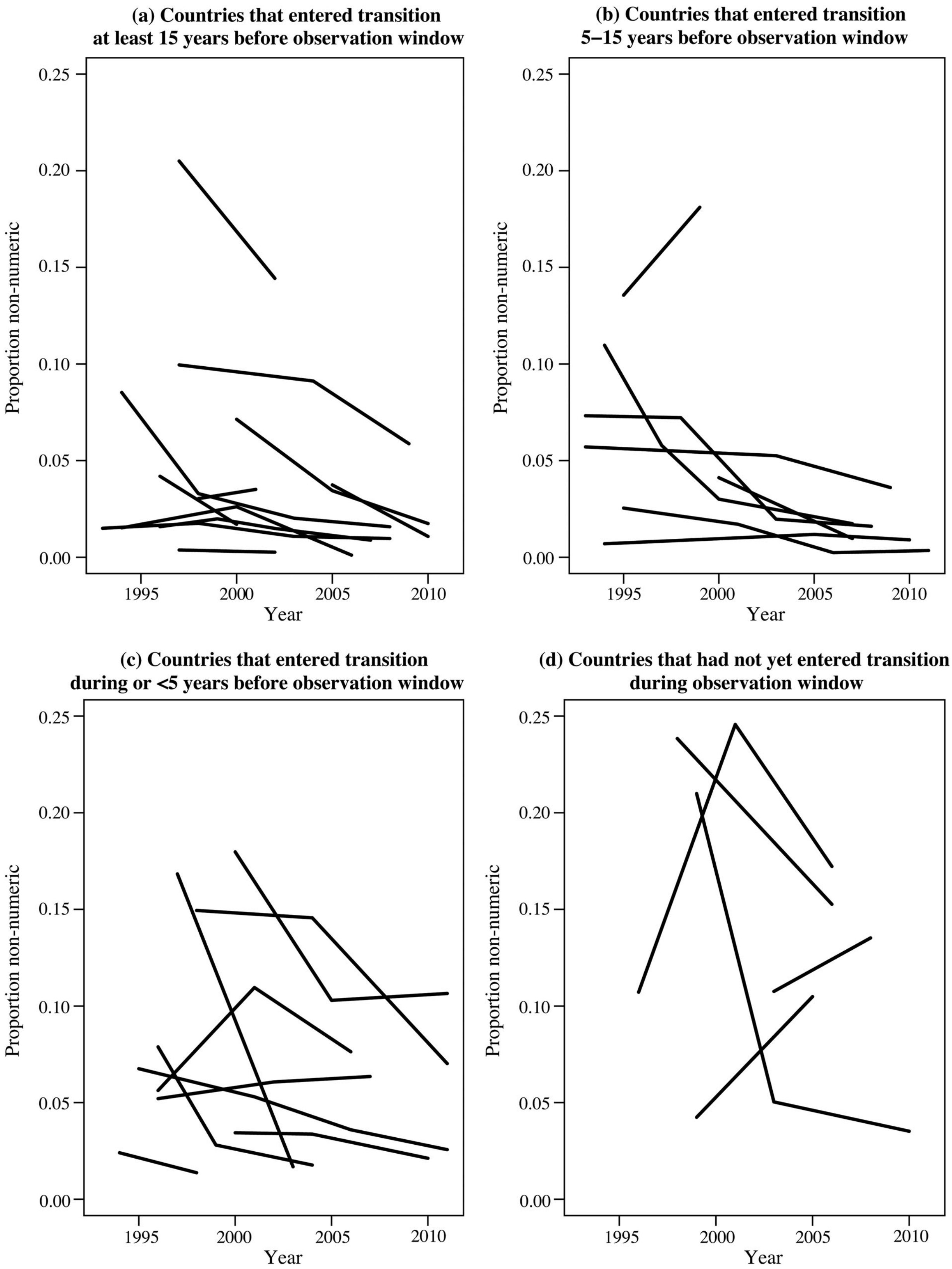

Figure 4 Percentage of women providing a non-numeric response to the ideal family size question against year of survey (1993–2011), for 32 countries, differentiated according to the onset of the country's fertility transition
Notes: Onset of the fertility transition is defined as the year in which a country experienced a net decline in TFR of more than 10 per cent compared with its 1960 value. Information about TFRs is sourced from the World Indicators Database. For each country's year of onset of the fertility transition, see Table 1. Average slopes of lines: −0.23 for Panel (a), −0.10 for Panel (b), −0.54 for Panel (c), and −0.05 for Panel (d).
Source: As for Figure 1.

individual level. To do this we estimated a separate logistic regression model for each of the 91 surveys, with all individual-level independent variables listed earlier included in each model. This method allowed us to examine whether associations between these measures and non-numeric IFS varied considerably across the different contexts and time periods in our data. For the variables that are related to the three theoretical perspectives described earlier, Table 2 summarizes the results of these models in terms of both the average magnitude of the associations (upper half of the table) and the proportion of surveys in which each measure was significant (lower half of table). These summaries are provided for the sample as a whole, as well as for each region and time period.

Knowledge of and experience with using contraception are the most consistently significant predictors of non-numeric family size out of the variables of interest. Women who report knowledge of modern contraception are less likely to provide non-numeric IFS responses in 80 per cent of the surveys, although the small proportion of women who report that they do *not* know a modern method of contraception in some surveys (notably Bangladesh, the Dominican Republic, and Nepal; see the supplementary material for more information) should be kept in mind when interpreting results for this variable in the country-specific models. Among the subsample of sexually active women, those who report having ever used contraception are significantly less likely to provide a non-numeric response to this question in 87 per cent of the survey-specific models.

When we examine the measures representing exposure to formal education, women who have attended primary school are significantly less likely to report non-numeric IFS in 39 per cent of the survey-specific models, and having completed primary school is significant in the expected direction in 57 per cent of the survey-specific models (reference category: no schooling). Of our three theoretical perspectives, mortality-related uncertainty is the least consistently supported in these models: women who have experienced a child's death are significantly more likely to offer a non-numeric response in only 33 per cent of the survey-specific models.

The magnitude of the associations was assessed using the discrete changes in predicted probability for these five dichotomous variables. Unlike coefficients or odds ratios, discrete changes in predicted probabilities have the advantage that they can be averaged across multiple logistic regressions and still be substantively meaningful (Long and Freese 2006; Mood 2010). The measures presented in the lower panel of Table 2 represent the average change in predicted probability associated with moving from the reference category to the value described in each row of the table (e.g., from no schooling to incomplete primary school). This measure shows that the change in predicted probability of providing a non-numeric response is largest in absolute magnitude for the variable representing having completed primary school: relative to having no schooling, women who completed primary school are about 4 per cent less likely to offer non-numeric responses, on average. The smallest changes in predicted probability of offering a non-numeric IFS response correspond to having experienced a child death (associated with a 0.6 per cent increase in the likelihood of offering a non-numeric response) and having completed some primary schooling (associated with a 0.5 per cent decrease in the likelihood of offering a non-numeric response).

Moving to regional and temporal comparisons, we find substantial variation across world regions for some variables, but no significant variation over time (significant differences were identified using one-way ANOVA tests). The educational attainment variables are both more likely to be significant (top panel) and produce larger differences in predicted probability (bottom panel) in Africa relative to Asia, with Latin America in between the two. Knowledge of modern contraception predicts larger changes in non-numeric IFS response in Asia and Latin America relative to Africa. Experiencing a child death is associated with larger changes in predicted probability of non-numeric fertility in Asia, compared with the other two regions.

Multilevel models

To assess these associations across our entire sample of women while accounting for the non-independence of observations and to examine whether differences in national context influence women's likelihood of thinking numerically about their fertility, we estimated a pair of three-level logistic regression models, with women nested within surveys and surveys within countries. Table 3 presents the results for all women (Model 1) and the sexually active subsample (Model 2). For the individual-level variables corresponding to the three theoretical perspectives we focus on, the results from these models largely confirm the findings from the survey-specific models. Consistent with our findings in Table 2, at the individual level we find the

Table 2 Summary of results from logistic regression models, estimated separately for each of 91 surveys, predicting the proportion of women providing a non-numeric response to the ideal family size question

		Regional comparison				Temporal comparison			
	All surveys	Africa	Asia	Latin America	One-way ANOVA	1993–98	1999–2004	2005–11	One-way ANOVA
	Proportion of surveys in which coefficient was significant								
Experienced child death	0.333	0.389	0.150	0.353	1.97	0.323	0.303	0.375	0.20
Incomplete primary (ref: no schooling)	0.385	0.475	0.150	0.353	3.51*	0.354	0.424	0.375	0.17
Completed primary (ref: no schooling)	0.573	0.694	0.250	0.529	6.80**	0.581	0.636	0.500	0.61
Knowledge of a modern method of contraception	0.802	0.814	0.697	0.882	1.02	0.806	0.848	0.750	0.49
Ever used any method of contraception[1]	0.871	0.895	0.897	0.833	0.57	0.893	0.833	0.888	0.28
	Mean discrete change in predicted probability								
Experienced child death	0.006	0.005	0.012	0.004	3.29*	0.005	0.007	0.007	0.20
Incomplete primary (ref: no schooling)	−0.005	−0.007	−0.001	−0.003	3.32*	−0.005	−0.006	−0.005	0.16
Completed primary (ref: no schooling)	−0.041	−0.051	−0.016	−0.026	5.41**	−0.047	−0.046	−0.032	1.02
Knowledge of a modern method of contraception	−0.032	−0.026	−0.044	−0.041	3.78*	−0.036	−0.031	−0.028	0.70
Ever used any method of contraception[1]	−0.019	−0.018	−0.027	−0.019	0.74	−0.022	−0.020	−0.016	0.56

[1]Because of the additional sample size reductions for ever use of contraception (excluding respondents who had never experienced sexual intercourse and surveys that did not provide information on use of contraception or previous sexual intercourse), a separate set of models was estimated for this variable, and all other results in the table exclude this measure. These models predicting ever use of contraception do not include knowledge of modern contraception, owing to issues of multicollinearity.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
Notes: Models were estimated separately for each of the 91 surveys in the analytic sample, and controlled for age, number of living children, whether the respondent was currently pregnant, Muslim religion, marital status, educational attainment, experience of child death, and knowledge of modern contraception. F-Statistics from one-way ANOVA tests are used to test for significant differences in means across regions and time period.
Source: As for Figure 1.

strongest support for the effect of knowledge and use of contraception (Models 1 and 2, respectively), and for the effect of formal education (especially completed primary). Experiencing a child's death, on the other hand, has a smaller association with non-numeric IFS response, though this association is still highly significant (given the large sample size, the majority of individual-level variables are expected to be statistically significant in the pooled models).

Regarding the contextual-level variables, the results from both models in Table 3 show that even after accounting for all individual- and survey-level covariates, survey year remains a statistically significant ($p < 0.01$) and negative predictor of non-numeric IFS. This shows that even after accounting for all individual- and contextual-level variables, as well as random variation across surveys and countries, the decline in non-numeric IFS response during this period remains significant. For each additional year, women's odds of providing a non-numeric response decrease by 6 per cent among all women (Model 1) and 4.8 per cent among sexually active women (Model 2).

Model 1 in Table 3, which was estimated among the full sample of women, indicates that the relationship between a country's HIV prevalence and non-numeric IFS is also significant. However, the direction of this relationship runs contrary to previous literature on mortality-related uncertainty: women living in higher-prevalence countries are less likely to provide a non-numeric IFS response. We interpret this relationship as perhaps being an indicator of greater exposure to HIV prevention programming, much of which overlaps with family planning rhetoric. More broadly, higher national-level HIV prevalence might suggest a context in which sexual intercourse is more frequently discussed as something requiring caution and planning (Cleland and

Table 3 Odds ratios from three-level logistic regression models predicting the proportion of women providing a non-numeric response to the ideal family size question

	Model 1 (full sample)	Discrete change in predicted probability[1]	Model 2 (sexually active subsample)	Discrete change in predicted probability[1]
Intercept	0.052***		0.042	
	(0.204)		(0.145)	
Level-1 variables				
Knowledge of a modern method of contraception	0.554***	−0.022	–	–
	(0.012)		–	
Ever used any method of contraception	–	–	0.587***	−0.037
	–		(0.012)	
Education level (ref. = no schooling)				
Incomplete primary	0.779***	−0.007	0.794***	−0.015
	(0.012)		(0.013)	
Completed primary	0.447***	−0.023	0.482***	−0.047
	(0.015)		(0.016)	
Experienced child death	1.228***	0.006	1.209***	0.013
	(0.010)		(0.010)	
Age	1.013***	0.005	1.017***	0.017
	(0.001)		(0.001)	
Currently pregnant	1.088***	0.003	1.095***	0.006
	(0.015)		(0.015)	
Number of living children	1.069***	0.002	1.080***	0.004
	(0.002)		(0.002)	
Muslim	1.367***	0.010	1.297***	0.018
	(0.014)		(0.016)	
Married/in union	0.744***	−0.009	0.984	−0.001
	(0.011)		(0.013)	
Socio-economic status (ref. = middle quintile)				
Lowest quintile	1.116***	0.003	1.106***	0.007
	(0.013)		(0.014)	
Second quintile	1.016	0.000	1.017	0.001
	(0.014)		(0.015)	
Fourth quintile	0.968*	−0.001	0.976	−0.002
	(0.015)		(0.016)	
Highest quintile	0.959*	−0.001	0.980	−0.001
	(0.017)		(0.018)	
Urban residence	0.873***	−0.004	0.919***	−0.006
	(0.013)		(0.013)	
Level-2 variables				
Year	0.940**	−0.004	0.952**	−0.010
	(0.016)		(0.016)	
Percentage of population living in an urban area	1.012	0.011	1.016	0.036
	(0.014)		(0.015)	
GDP per head (in 100 USD)	0.976	−0.007	0.975	−0.011
	(0.020)		(0.021)	
Total fertility	1.021	0.001	0.993	−0.001
	(0.191)		(0.200)	
Percentage of women ever attended school	1.660	0.005	2.112	0.021
	(0.970)		(0.953)	
<5 child mortality rate	1.000	0.000	1.001	0.002
	(0.005)		(0.005)	
Adult HIV prevalence	0.921*	−0.007	0.938^{+}	−0.014
	(0.036)		(0.038)	

(*Continued*)

Table 3 Continued.

	Model 1 (full sample)	Discrete change in predicted probability[1]	Model 2 (sexually active subsample)	Discrete change in predicted probability[1]
Variance components				
Level-2 variance	0.210***		0.225***	
Level-3 variance	0.546***		0.508***	

[1]Discrete change in predicted probability assumes other variables are held at their mean level. For continuous variables, the change indicates the difference between the mean and one standard deviation above the mean.
$^{+}p < 0.10$; $*p < 0.05$; $**p < 0.01$; $***p < 0.001$.
Notes: Standard errors in parentheses. All models also control for the language of the interview. Model 1: N1 = 1,045,897 women; N2 = 91 surveys; N3 = 32 countries. Model 2: N1 = 810,781 women; N2 = 84 surveys; N3 = 30 countries (sexually active subsample).
Source: As for Figure 1.

Watkins 2006; Robinson 2011). The significance of this association diminishes among the sample that is limited to sexually active women (Model 2), but this is likely a result of the smaller number of surveys in this sample (see the supplementary material for further details). We find no evidence to indicate that any of the other survey-level variables are significantly associated with non-numeric IFS. These null findings for contextual-level variables, however, should be interpreted with caution, as significant effects are difficult to detect due to the small sample size at the survey level ($N = 91$ in Model 1, $N = 84$ in Model 2).

Figure 5 shows variation in magnitude of the country- and survey-level coefficients in the full-sample multilevel model (Model 1 in Table 3), holding individual-level variables constant. This approach identifies countries and surveys that are outliers in terms of the prevalence of non-numeric IFS, given their values for the individual-level variables. To examine *country-level* effects, we present posterior mean estimates for the country-level random intercepts. These values provide a measure of the total amount of variation between countries that is not explained by individual- or survey-level covariates. For example, a positive value for this measure indicates that individuals within a country have higher levels of non-numeric response than would be expected, given their observed values for individual- and survey-level covariates. In Figure 5, these country-level values are represented with a dot for each country. Values that are significantly different from zero at a 95 per cent level of confidence are displayed with filled circles, while values that are not statistically significant are displayed with open circles. The figure shows that 11 out of 32 countries have country-level estimates that are significantly different from what would be predicted given the individual- and survey-level variables included in the model, suggesting that the random coefficients at the country level are capturing substantial variation in non-numeric IFS between countries.

To assess variation at the *survey level*, we present the model estimates of the total group-level effects for each survey, often referred to as the posterior intercepts (Snijders and Bosker 1999, p. 60). These provide an estimate of the total main effect of country i and survey j, controlling for individual-level variables, while including the observed values of all group-level variables and random effects. When compared with the country-level random intercepts, these values show the *additional* variation captured through survey-level variables and random coefficients. Surveys with positive posterior intercepts have a higher level of non-numeric IFS than would be expected based on their individual-level variables, while surveys with negative values for this measure have lower than expected levels of non-numeric IFS response than would be expected given their individual-level variables. In Figure 5, these values are represented with labels identifying the year that each survey was administered, with significant values printed in bold italic. Of the 91 surveys, 18 have posterior intercepts that are significantly different from zero.

Taking the country-level and survey-level estimates together, these results show that Indonesia, Guatemala, and Cameroon report higher levels of non-numeric fertility than expected given their individual-level variables, though when the survey-level estimates for Guatemala 1995 and Cameroon 2011 are taken into consideration, this difference is no longer significant. The differences between country- and survey-level estimates result from changes over time in non-numeric IFS. In Guatemala, non-numeric IFS increases over time, thus once the negative coefficient for time of survey is accounted for, the value for 1999 reveals itself to be an outlier. In Cameroon, non-numeric IFS is twice as high in the two earlier surveys than in the 2011 survey; thus, the contextual-level effect is not significant for the

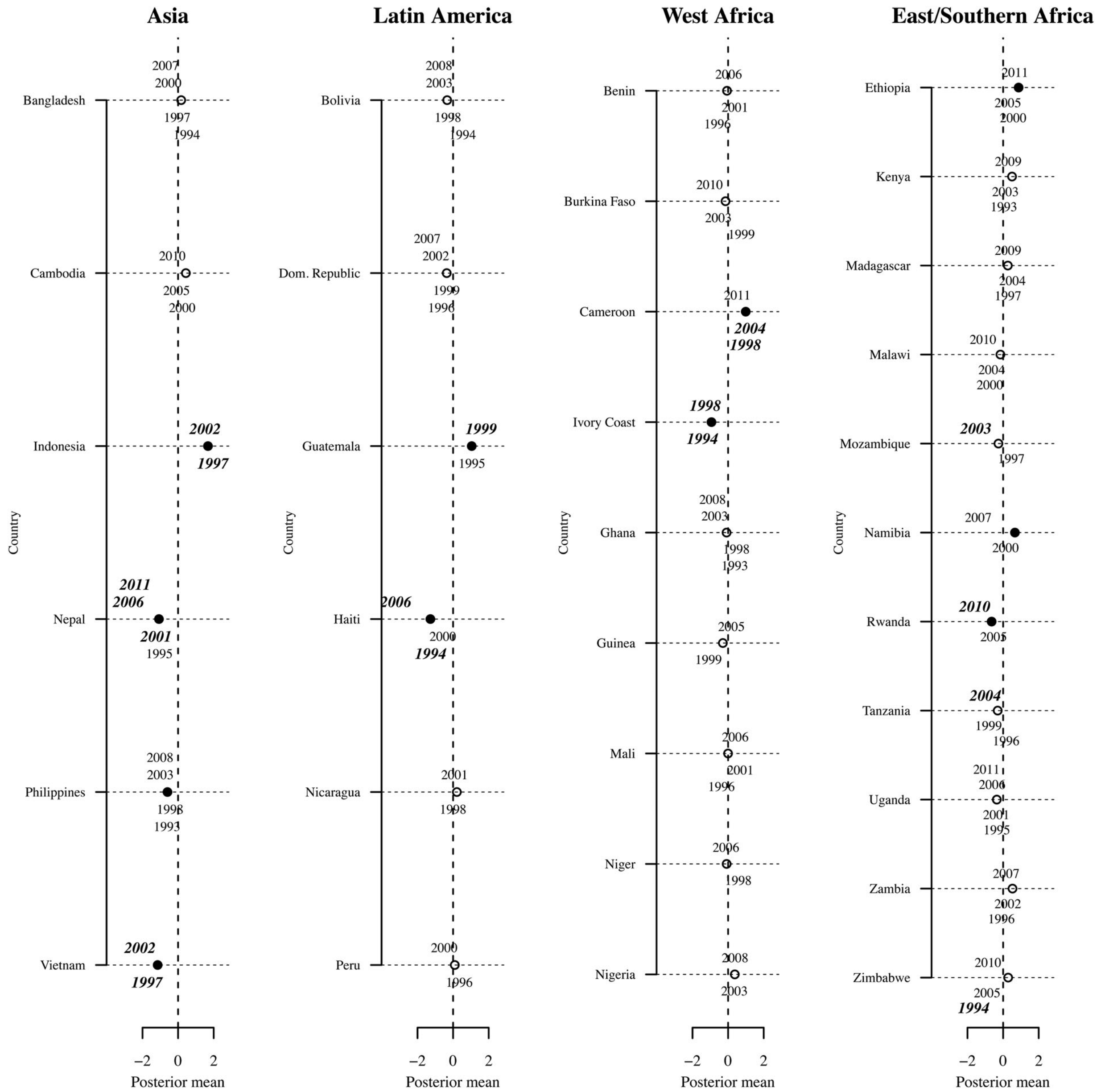

Figure 5 Country-level effects and total contextual effects (combining country and survey levels) from a multi-level logistic regression model predicting non-numeric response to the ideal family size question, for 91 surveys in 32 countries (1993–2011)

Notes: The dots represent the country-level effects, estimated using posterior means of the random intercepts for each country. Positive values (e.g., Indonesia, Cameroon) indicate that a country reports higher levels of non-numeric IFS than would be predicted given observed values for all individual- and survey-level variables. Negative values (e.g., Vietnam, Haiti) indicate that a country reports lower levels of non-numeric IFS than would have been predicted given observed values for all individual- and survey-level variables. Values that are significantly different from zero at a 95 per cent level of confidence are displayed with filled circles (e.g., Ethiopia), while values that are not statistically significant are displayed with open circles (e.g., Kenya). The printed years represent the combined country- and survey-level effects, that is, the posterior intercepts for levels 2 and 3. They represent the total group-level variation included in the model. When compared with country-level effects, these values show the additional variation captured at the survey level. The labels are centred around the data points, so the precise estimate is between the second and third digits of each year. Values that are significantly different from zero at a 95 per cent level of confidence are printed in bold italic.

Source: As for Figure 1.

later survey. On the other hand, Vietnam, Ivory Coast, and Nepal report lower levels of non-numeric fertility in all surveys than predicted given their values for the individual-level variables, though the total contextual effect for Nepal 1995 is not significantly different from zero. In Nepal, this difference is again likely because the proportion of non-numeric IFS changes substantially between surveys: the proportion offering non-numeric IFS responses declines substantially from 2.5 per cent in 1995 to only 1.7 per cent in 2001, and then declines further to less than 0.5 per cent in 2006 and 2011. Ethiopia and Namibia report country-level effects that are significantly higher than would be expected, but once the survey-level variables are taken into consideration, the group-level effects are no longer significant for any surveys. These results are driven by the survey-level variables in each country—the low percentage of women that have ever been to school and low GDP per head in Ethiopia, and the high HIV prevalence and low percentage urban in Namibia—which move the total group-level estimates closer to what the model would predict. Finally, Figure 5 also highlights cases in which one survey within a country is a significant outlier; for example, Zimbabwe 1994, which reports unexpectedly low levels of non-numeric IFS.

Discussion and conclusions

This paper focuses on a topic that demographers have long theorized—women offering words instead of numbers when asked about their IFS. The proportion of women offering a non-numeric response to the IFS question declined significantly in the majority of the 32 countries in our sample over the past two decades, and this decrease over time remained significant in all of our multilevel models. This suggests that 'numeracy about children', as Van de Walle (1992, p. 490) termed this concept 25 years ago, has indeed increased across the developing world since then.

Our results also provide evidence for fertility theorists' postulate that changes in the prevalence of non-numeric IFS response are associated with changes in fertility behaviour. National-level comparisons between levels of non-numeric response and TFRs offer support for the common assumption that such responses are indicative of high fertility, pre-transition contexts. When we look cross-sectionally across surveys, we find that surveys conducted in countries with higher total fertility also tend to report more women offering non-numeric IFS responses. When we look within countries over time, changes in these two phenomena are correlated for the majority of our sample; as fertility rates decline, so do levels of non-numeric IFS. We also find that countries that entered the fertility transition shortly before or during the observation window experience the steepest declines in non-numeric IFS. Conversely, countries that have not yet entered the transition show no consistent pattern of decline in non-numeric IFS. These results together provide empirical support for Van de Walle's (1992) hypothesis that the steepest declines in non-numeric IFS will occur around the time of onset of a country's fertility transition.

Results from our multivariate analysis suggest that at an individual level, non-numeric IFS is tied less to mortality-related uncertainty and more to knowledge (both general and fertility-specific). Women who report knowledge of or experience of using contraception are substantially less likely to provide non-numeric IFS responses. Exposure to formal education also decreases the odds of women providing a non-numeric IFS response, consistent with previous small-scale studies (Riley et al. 1993; Hayford and Agadjanian 2011). Our findings also corroborate findings from Nepal and Mozambique, that experiencing a child death is positively associated with non-numeric IFS (Sandberg 2005; Hayford and Agadjanian 2011). On the other hand, our results deviate from previous studies concerning the contextual effect of HIV prevalence: our results indicate that as HIV prevalence increases, women are *less* likely to provide a non-numeric response, suggesting that this measure may capture other factors such as family planning and safe-sex discourses.

Our study provides new insights into how non-numeric IFS relates to broader patterns of fertility and social change across the developing world. Yet we acknowledge three key limitations. First, the countries in our analysis contributed different numbers of surveys from varying time points. We structured our analysis to accommodate this heterogeneity, both in our descriptive analyses and the multivariate models. Nonetheless, this heterogeneity limits the conclusions we can draw from our data. Relatedly, because only six countries in each of Latin America and Asia fitted our sampling criteria, we were unable to examine regional trends in our multilevel analysis. And because our data spanned only 19 years, we were unable to disentangle period-specific effects from processes that might occur during other episodes of widespread fertility decline.

Second, like all survey researchers, we can only analyse questions as they were asked. The quasi-counterfactual nature of the IFS question has been criticized by scholars who worry that family size preferences are subject to poor reliability and construct validity (Bankole and Westoff 1998). The concept of IFS may also fail to capture the complex nature of family planning by relying too heavily on rational choice models of fertility (Cleland 1973; Johnson-Hanks 2007). Although we controlled for language, any cultural and ideational differences within our sample may influence how this question is interpreted. Additionally, we have no information about the extent to which women's IFS responses are driven by extra-individual factors, such as influence from husbands or extended families (Isiugo-Abanihe 1994; Dodoo 1998).

Third, our contextual variables were measured at the country level. This aggregation likely does not accurately capture the contexts of many women in our sample, which are much more heterogeneous and localized. While defining contexts using smaller geographical areas would have been preferable, certain measures—such as HIV prevalence and GDP per head—are unavailable for sub-country units.

Our results point to additional lines of enquiry that extend beyond the scope of our study, which we hope will inspire future research. While ancillary analyses explored differences across types of non-numeric IFS response using the surveys that include multiple non-numeric categories (see the supplementary material), we did not fully investigate these nuances. Yet non-numeric responses could indicate various perspectives, only some of which align with fertility transition theory. One woman might provide a non-numeric response because she is in school and does not yet know what her career might look like, another might not provide a number because she believes that family size is determined by God, while another might want as many children as possible. Qualitative data that enable researchers to investigate the answers people give, rather than simply whether they are words or numbers, would further enhance our understanding of how non-numeric fertility preferences are socially patterned. Additionally, many of the individual- and survey-level factors explored here are interrelated, such as women's knowledge of family planning and educational attainment; these interdependencies should be further examined in future research on this topic.

Despite these limitations, by extending our knowledge of non-numeric fertility preferences across space and time, the research presented here shows what such responses reveal about aggregate-level fertility trends and individual-level perspectives. In the aggregate, non-numeric IFS declines most substantially in the early stages of countries' fertility transitions. Among individuals, women's propensity to provide a non-numeric IFS response is influenced by a host of factors, most notably knowledge of modern contraception and exposure to formal education. Like demographers before us have presupposed, understanding the dynamic nature of declining non-numeric IFS illuminates the subjective underpinnings of demographic data.

Notes

1 Margaret Frye is at the Department of Sociology, Princeton University, Princeton, NJ 08544, USA. E-mail: mfrye@princeton.edu. Lauren Bachan is at Pennsylvania State University.

2 Previous versions of this paper were presented at the 2013 meeting of the Population Association of America (New Orleans, LA, USA) and the 2013 meeting of the International Union for the Scientific Study of Population (Busan, South Korea).

3 This research was supported by funding from the Canadian Institute for Advanced Research (CIFAR) and the Eunice Kennedy Shriver National Institute of Child Health and Human Development (Population Research Infrastructure Grant R24-HD041025 and Interdisciplinary Training Grants T32 HD007514 and T32 HD00727527). The authors would also like to thank German Rodriguez, Brandon Stewart, John Casterline, Sarah Hayford, Alexandra Killewald, and Emily Smith-Greenaway for their helpful comments on initial versions of this paper.

References

Bachrach, C. A. 2014. Culture and demography: From reluctant bedfellows to committed partners, *Demography* 51(1): 3–25.

Bankole, A. and C. Westoff. 1998. The consistency and validity of reproductive attitudes: Evidence from Morocco, *Journal of Biosocial Science* 30(4): 439–455.

Basu, A. M. 2002. Why does education lead to lower fertility? A critical review of some of the possibilities, *World Development* 30(10): 1779–1790.

Becker, G. and H. Lewis. 1973. On the interaction between the quantity and quality of children, *Journal of Political Economy* 81: S279–S288.

Becker, G. 1991. The demand for children, in *A Treatise on the Family.* Chicago: Chicago University Press, pp. 135–154.

Bongaarts, J. and S. C. Watkins. 1996. Social interactions and contemporary fertility transitions, *Population and Development Review* 22(4): 639–682.

Bongaarts, J. 2003. Completing the fertility transition in the developing world: The role of educational differences and fertility preferences, *Population Studies* 57(3): 321–335.

Bongaarts, J. and J. Casterline. 2013. Fertility transition: Is sub-Saharan Africa different?, *Population and Development Review* 38(s1): 153–168.

Caldwell, J. C. 1976. Toward a restatement of demographic transition theory, *Population and Development Review* 2 (3/4): 321–366.

Caldwell, J. C., P. Reddy, and P. Caldwell. 1985. Educational transition in rural South India, *Population and Development Review* 11: 29–51.

Caldwell, J. C. and P. Caldwell. 1987. The cultural context of high fertility in sub-Saharan Africa, *Population and Development Review* 13(3): 409–437.

Castle, S. 2001. "The tongue is venomous": Perception, verbalisation and manipulation of mortality and fertility regimes in rural Mali, *Social Science & Medicine* 52 (12): 1827–1841.

Cleland, J. 1973. A Critique of KAP studies and some suggestions for their improvement, *Studies in Family Planning* 4(2): 42–47.

Cleland, J. and C. Wilson. 1987. Demand theories of the fertility transition: An iconoclastic view, *Population Studies* 41(1): 5–30.

Cleland, J. 2001a. The effects of improved survival on fertility: A reassessment, *Population and Development Review* 27: 60–92.

Cleland, J. 2001b. Potatoes and pills: An overview of innovation-diffusion contributions to explanations of fertility decline, in *Diffusion Processes and Fertility Transition: Selected Perspectives*. Washington, DC: National Academy Press, pp. 39–65.

Cleland, J. 2002. Education and future fertility trends, with special reference to midtransitional countries, *Population Bulletin of the United Nations* (48/49):183–194.

Cleland, J. and S. C. Watkins. 2006. The key lesson of family planning programmes for HIV/AIDS control, *AIDS* 20 (1): 1–3.

Coale, Ansley J. 1973. The demographic transition reconsidered, in *International Population Conference*, Vol. 1. Liege: International Union for the Scientific Study of Population, pp. 53–72.

Debpuur, C., J. F. Phillips, E. F. Jackson, A. Nazzar, P. Ngom, and F. N. Binka. 2002. The impact of the Navrongo project on contraceptive knowledge and use, reproductive preferences, and fertility, *Studies in Family Planning* 33(2): 141–164.

Diamond, I., M. Newby, and S. Varle. 1999. Female education and fertility: Examining the links, in C. Bledsoe, J. Casterline, J. Johnson-Kuhn, and J. Haaga (eds.), *Critical Perspectives on Schooling and Fertility in the Developing World*. Washington, DC: National Academies Press, pp. 23–48.

Dodoo, F. 1998. Men matter: Additive and interactive gendered preferences and reproductive behavior in Kenya, *Demography* 35(2): 229–242.

Doepke, M. 2005. Child mortality and fertility decline: Does the Barro-Becker model fit the facts? *Journal of Population Economics* 18(2): 337–366.

Duncan, C., K. Jones, and G. Moon. 1996. Health-related behaviour in context: A multilevel modelling approach, *Social Science & Medicine* 42(6): 817–830.

Dyson, T. and M. Murphy. 1985. The onset of fertility transition, *Population and Development Review* 11(3): 399–440.

Easterlin, R. A. and E. N. Crimmins. 1985. *The Fertility Revolution: A Supply-Demand Analysis*. Chicago: University of Chicago Press.

Freedman, R. 1997. Do family planning programs affect fertility preferences? A literature review, *Studies in Family Planning* 28(1): 1–13.

Hammel, E. A. 1990. A theory of culture for demography, *Population and Development Review* 16(3): 455–485.

Hayford, S. R. and V. Agadjanian. 2011. Uncertain future, non-numeric preferences, andthe fertility transition: A case studyof rural Mozambique, *African Population Studies* 25(2): 419–439.

Hayford, S. R., V. Agadjanian, and L. Luz. 2012. Now or never: Perceived HIV status and fertility intentions in rural Mozambique, *Studies in Family Planning* 43(3): 191–199.

Henry, L. 1961. Some data on natural fertility, *Biodemography and Social Biology* 8(2): 81–91.

ICF International. 2012. *Survey Organization Manual for Demographic and Health Surveys* (Tech. Rep.). Calverton, MD: MEASURE DHS.

Isiugo-Abanihe, U. C. 1994. Reproductive motivation and family-size preferences among Nigerian men, *Studies in Family Planning* 25(3): 149–161.

Jensen, E. 1985. Desired fertility, the "up to god" response, and sample selection bias, *Demography* 22 (3): 445–454.

Johnson-Hanks, J. 2004. Uncertainty and the second space: Modern birth timing and the dilemma of education, *European Journal of Population* 20(4): 351–373.

Johnson-Hanks, J. 2005. When the future decides uncertainty and intentional action in contemporary Cameroon, *Current Anthropology* 46(3): 363–385.

Johnson-Hanks, J. 2006. *Uncertain Honor: Modern Motherhood in an African Crisis*. Chicago: University of Chicago Press.

Johnson-Hanks, J. 2007. Natural intentions: Fertility decline in the African demographic and health surveys, *American Journal of Sociology* 112(4): 1008–1043.

Kirk, D. 1996. Demographic transition theory, *Population Studies* 50(3): 361–387.

Knodel, J. 1977. Family limitation and the fertility transition: Evidence from the age patterns of fertility in Europe and Asia, *Population Studies* 31(2): 219–249.

Knodel, J. 1979. From natural fertility to family limitation: The onset of fertility transition in a sample of German villages, *Demography* 16(4): 493–521.

Lee, R. 2003. The demographic transition: Three centuries of fundamental change, *Journal of Economic Perspectives* 17(4): 167–190.

LeGrand, T., T. Koppenhaver, N. Mondain, and S. Randall. 2003. Reassessing the insurance effect: A qualitative analysis of fertility behavior in Senegal and Zimbabwe, *Population and Development Review* 29 (3): 375–403.

Levine, R. A., E. Dexter, P. Velasco, S. Levine, A. R. Joshi, K. W. Stuebing, and F. M. Tapia Uribe. 1994. Maternal literacy and health care in three countries: A preliminary report, *Health Transition Review* 4(2): 186–191.

Long, J. S. and J. Freese. 2006. *Regression Models for Categorical Dependent Variables Using Stata*. College Station, TX: Stata Press.

Mahmood, N. and K. Ringheim. 1997. Knowledge, approval and communication about family planning as correlates of desired fertility among spouses in Pakistan, *International Family Planning Perspectives* 23: 122–145.

Martin, T. C. 1995. Women's education and fertility: Results from 26 demographic and health surveys, *Studies in Family Planning* 26(4): 187–202.

Mason, K. O. 1992. Culture and the fertility transition: Thoughts on theories of fertility decline, *Genus* 48(3): 1–14.

McCarthy, J. and G. A. Oni. 1987. Desired family size and its determinants among urban Nigerian women: A two-stage analysis, *Demography* 24(2): 279–290.

Montgomery, M. R. and J. B. Casterline. 1993. The diffusion of fertility control in Taiwan: Evidence from pooled cross-section time-series models, *Population Studies* 47(3): 457–479.

Mood, C. 2010. Logistic regression: Why we cannot do what we think we can do, and what we can do about it, *European Sociological Review* 26(1): 67–82.

Morgan, S. P. 1982. Parity-specific fertility intentions and uncertainty: The United States, 1970 to 1976, *Demography* 19(3): 315–334.

Olaleye, D. 1993. *Ideal Family Size: A Comparative Study of Numerical and Non-numerical Fertility Desires of Women in Two sub-Saharan African Countries (No. 7)*. Calverton, MD: Macro International.

Raudenbush, S. W. 2004. *HLM 6: Hierarchical Linear and Nonlinear Modelling*. Lincolnwood, IL: Scientific Software International.

Riley, A. P., A. I. Hermalin, and L. Rosero-Bixby. 1993. A new look at the determinants of nonnumeric response to desired family size: The case of Costa Rica, *Demography* 30(2): 159–174.

Robinson, R. S. 2011. From population to HIV: The organizational and structural determinants of HIV outcomes in sub-Saharan Africa, *Journal of the International AIDS Society* 14(Suppl 2): S6.

Rosero-Bixby, L. and J. B. Casterline. 1993. Modelling diffusion effects in fertility transition, *Population Studies* 47(1): 147–167.

Ruiter, S. and N. D. de Graaf. 2006. National context, religiosity, and volunteering: Results from 53 countries, *American Sociological Review* 71(2): 191–210.

Sandberg, J. 2005. The influence of network mortality experience on nonnumeric response concerning expected family size: Evidence from a Nepalese mountain village, *Demography* 42(4): 737–756.

Snijders, T. and R. Bosker. 1999. *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modelling*. London: Sage Publishing.

Thornton, A. 2001. The developmental paradigm, reading history sideways, and family change, *Demography* 38 (4): 449–465.

Thornton, A. 2013. *Reading History Sideways: The Fallacy and Enduring Impact of the Developmental Paradigm on Family Life*. Chicago: University of Chicago Press.

Trinitapoli, J. and S. Yeatman. 2011. Uncertainty and fertility in a generalized AIDS epidemic, *American Sociological Review* 76(6): 935–954.

United Nations Population Division 2013. *World Population Prospects: The 2012 Revision*. Working Paper No. ESA/P/WP.228. New York: United Nations.

Van de Walle, E. 1992. Fertility transition, conscious choice, and numeracy, *Demography* 29(4): 487–502.

Watkins, S. C. 2000. Local and foreign models of reproduction in Nyanza Province, Kenya, *Population and Development Review* 26(4): 725–759.

Westoff, C. F. 1990. Reproductive intentions and fertility rates, *International Family Planning Perspectives* 16(3): 84–89.

World Bank. 2014, March. *World Development Indicators.*

Yeatman, S. 2009a. HIV infection and fertility preferences in rural Malawi, *Studies in Family Planning* 40(4): 261–276.

Yeatman, S. 2009b. The impact of HIV status and perceived status on fertility desires in rural Malawi, *AIDS and Behavior* 13(S1), 12–19.

Yeatman, S., C. Sennott, and S. Culpepper. 2013. Young women's dynamic family size preferences in the context of transitioning fertility, *Demography* 50(5), 1715–1737.

Appendix A. Overview of analytic samples and descriptive statistics for the variables included in the analysis

Table A1 List of countries included in the analytic sample, and for each country: year in which each survey was conducted, number of years between first and last survey, and total number of women

Country	First survey	Second survey	Third survey	Fourth survey	Years spanned	Analytic *N*
Sub-Saharan Africa						
Benin	1996	2001	2006		10	28,830
Burkina Faso	1999	2003	2010		11	35,804
Cameroon	1998	2004	2011		13	31,236
Ivory Coast	1994	1998			4	11,137
Ethiopia	2000	2005	2011		11	45,113
Ghana	1993	1998	2003	2008	15	19,989
Guinea	1999	2005			6	14,642
Kenya	1993	2003	2009		16	24,059
Madagascar	1997	2004	2009		12	32,298
Malawi	2000	2004	2010		10	47,800
Mali	1996	2001	2006		10	36,967
Mozambique	1997	2003			6	21,093
Namibia	2000	2007			7	16,260
Niger	1998	2006			8	16,726
Nigeria	2003	2008			5	40,652
Rwanda	2005	2010			5	24,900
Tanzania	1996	1999	2004		8	22,430
Uganda	1995	2001	2006	2011	16	30,802
Zambia	1996	2002	2007		11	22,582
Zimbabwe	1994	2005	2010		16	24,110
Asia						
Bangladesh	1994[1]	1997[1]	2000[1]	2007[1]	13	40,249
Cambodia	2000	2005	2010[2]		10	50,772
Indonesia	1997	2002			8	58,092
Nepal	1995	2001	2006	2011	16	40,592
Philippines	1993	1998	2003	2008	15	55,958
Vietnam	1997[1]	2002[1]			5	11,326
Latin America						
Bolivia	1994	1998	2003	2008	14	54,160
Dom. Republic	1996	1999	2002	2007	11	59,560
Guatemala	1995	1999			4	18,360
Haiti	1994	2000	2006		12	26,217
Nicaragua	1998	2001			3	26,542
Peru	1996	2000			4	56,640

[1]Excluded from models including ever use of contraception owing to missing measure of previous sexual intercourse.
[2]Excluded from models including ever use of contraception owing to missing measure of ever use of contraception.

Surveys excluded from study

We excluded all Phase I and Phase II surveys due to a change in probing protocol after respondents provide a non-numeric answer to the IFS question (see the supplementary material for more information). The following surveys were excluded because of missing values on variables included in our models: Bangladesh 2004 (missing education measures), Rwanda 2000, Tanzania 2010, and all Senegal surveys (missing religious affiliation), Bangladesh 2011 (missing information on contraceptive knowledge), Chad 2004, Indonesia 2007, and Mozambique 2011 (no information on language). Additionally, we excluded Haiti 2012 because it was administered shortly after the country's earthquake.

Table A2 Descriptive statistics for all variables used in the analysis for first and last survey in each country

	First survey		Last survey		
	Mean/ percentage	Standard deviation	Mean/ percentage	Standard deviation	*T*-statistic
Non-numeric response to ideal family size (%)	11.0	0.3	6.8	0.3	29.6***
Control variables					
Age	29.9	9.4	30.4	9.5	−10.6***
Number of living children	2.5	2.2	2.4	2.1	14.8***
Currently pregnant (%)	8.2	0.3	7.2	0.3	8.7***
Muslim (%)	44.2	0.5	43.2	0.5	5.4***
Married/in union (%)	77.6	0.4	74.4	0.4	18.0***
Urban residence (%)	28.8	0.5	35.3	0.5	−30.8***
Individual-level independent variables					
Experienced child death (%)	26.1	0.4	20.2	0.4	33.5***
Educational level					
No schooling (%)	31.5	0.5	23.1	0.4	42.7***
Incomplete primary (%)	21.6	0.4	20.5	0.4	5.9***
Completed primary (%)	46.8	0.5	56.4	0.5	−41.4***
Knowledge of a modern method of contraception (%)	90.1	0.3	94.0	0.2	−34.5***
Country-level independent variables					
<5 child mortality rate	126.0	53.6	91.8	48.1	2.7**
Percentage of women ever attended school	64.2	0.3	71.7	0.2	−1.2
Total fertility	5.1	1.3	4.4	1.4	2.0*
Adult HIV prevalence	4.4	5.7	3.7	4.6	0.5
GDP per head (in 100 USD)	601.8	598.8	990.5	978.6	−1.9*
Percentage of population living in an urban area	32.2	0.2	36.7	0.2	−1.13

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Notes: Estimates in this table have been weighted to adjust for regional variation in sampling within countries (individual-level variables only) and for differences in population size across countries (all variables). Population estimates for adults aged 15–45 were obtained from the United Nations Population Division (2013). For binary variables, the percentage of women who report the characteristic of interest is provided. Each *T*-statistic compares average values for the first survey and last survey.

Appendix B. Multilevel equations

All multilevel models were estimated using three-level logistic regression models, with random intercepts for surveys (level 2) and countries (level 3). The three-level modelling strategy nested women within surveys, which were nested within countries. This strategy is uniquely suited for repeated cross-sectional data with different periods of observation for each country and has been used and advocated by a number of scholars (Duncan et al. 1996; Ruiter and de Graaf 2006). To adjust for the fact that countries in our sample contributed different numbers of surveys at various time intervals, previous versions of our models estimated year as a random slope. However, results from likelihood ratio tests suggested that the random-coefficient approach was a better fit for our data.

For individuals i in survey j and country k, the *level-1 equation* is:

$$\ln\left[\frac{p_{ijk}}{1-p_{ijk}}\right] = \alpha_{0jk} + \sum_{n=1}^{N} \beta_n x_{ijk} + e_{ijk}$$

where p_{ijk} is the probability of responding non-numerically; α_{0jk} is an intercept for survey j in country k; β_n are a series of level-1 coefficients for the matrix (X) of individual-level variables; and e_{ijk} is the level-1 error component.

The *level-2 equation* defines the level-1 intercept α_{0jk} as an outcome variable:

$$\alpha_{0jk} = \theta_{00k} + \sum_{m=1}^{M} \beta_m z_{0jk} + \gamma_{0jk}$$

where θ_{00k} is an intercept for country k; β_m are a series of level-2 coefficients for the matrix (Z) of survey-level variables; and γ_{0jk} is a random component that allows the intercept to vary for each survey.

The *level-3 equation* defines the level-2 intercept θ_{00k} as an outcome variable:

$$\theta_{00k} = \delta_{000} + \mu_{00k}$$

where δ_{000} is a non-varying intercept; and μ_{00k} is a random component that allows the intercept to vary for each country k.

All variables were mean-centred for the multilevel models. Models were estimated with the HLM 6 software package, using the PQL parameter estimation strategy (Raudenbush 2004). We also estimated the models using the alternative estimator available in HLM 6 for non-linear models, Laplace 6, which produced nearly identical results.