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ABSTRACT

Since 1960 South Africa has seen a steep fall in fertility levels and currently the total fertility rate is the lowest on the African continent. Given the high prevailing levels of fertility in African countries, a better understanding of the factors behind the fertility transition can be valuable not only for South Africa, but also more widely for other African countries.

This paper uses the National Income Dynamics Study data to construct a retrospective panel to investigate reasons for the decline in fertility in South Africa since the 1960s. The analysis attributes a large share of the observed fertility decline across birth cohorts to improving education levels and the lower prevalence of marriage. However, a considerable segment of the transition is ascribed to the unobservables. This may include HIV/AIDS, the increased use of contraceptives and changes in intra-household relationships and the social role of women.

Keywords: South Africa, fertility, education, marriage, social norms
JEL codes: J13, J12

The fertility transition in South Africa: A retrospective panel data analysis

Laura Rossouw, Rulof Burger
and Ronelle Burger

1. Introduction

South Africa has witnessed a decline in fertility since the 1960s. According to the estimates of Moultrie and Timaeus (2002) total fertility rates[1] were around six children per female in the 1960s and by the 1990s it had dropped to between 3 and 4. While some authors contend that the drop in fertility has been remarkably sharp (Swartz, 2002: 539; Kaufman, 1997), this is not universally acknowledged and Caldwell and Caldwell (1993) argue that given South Africa's state of development and the resources invested in promoting family planning one may have expected a steeper decline.

What is however not disputed is that this is the furthest fall in fertility witnessed on the African continent (Moultrie and Timaeus, 2002). Given the concern regarding the relatively high fertility rates that prevail in African countries, understanding the factors behind the decline in South African fertility may be significant and valuable not only within the South African context, but also more widely.

In South Africa there has been very little research on fertility patterns and decisions up until the 1980s. This lack of research is attributed to inadequate and unreliable census coverage of the African population during the apartheid period, as well as political sensitivities surrounding demographical trends due to White fears of explosive Black population growth (Moultrie and Timæus, 2003: 265 – 266).

[1] The total fertility rate calculates fertility for an average individual under a hypothetical scenario, assuming current age-specific fertility rates and that the individual lives to the end of her child bearing years.

The National Income Dynamics Study (NIDS) data provide a rare opportunity to better understand the fertility patterns over this era. Not only does it provide a window unto fertility patterns, but the richness of the data also allows us to examine the factors that influenced the fertility decisions over this period. The data enable the construction of a panel to model fertility decisions over the past five decades using female respondents' detailed birth histories and a matching panel of variables based on a range of retrospective questions. In addition to the retrospective panel feature, the NIDS data set has a considerably larger set of variables than the Census and a larger sample than the Demographic and Health Surveys (DHS).

The paper starts with an overview of the fertility decline, documenting patterns and trends and outlining the main literature. This is followed by a description of the NIDS data and an assessment of the reliability of its retrospective fertility data. Section four shows the regression analysis for the panel of variables for various subsamples, using both a pooled OLS and a fixed effect approach. The paper then demonstrates how to identify the drivers of the fertility decline using a decomposition technique that is appropriate for our retrospective panel dataset.

2. Background

The decrease in fertility rates in South Africa is well documented (Caldwell & Caldwell, 1993; Moutrie & Timæus, 2003; Udjo, 1997; Chimere-Dan, 1997; Department of Health, 1998). South African fertility has shown a strong decline since the 1960s. White fertility was already at reasonably low levels in the 1960s and the decline in fertility was therefore largely lead by a decline in African and Coloured fertility.

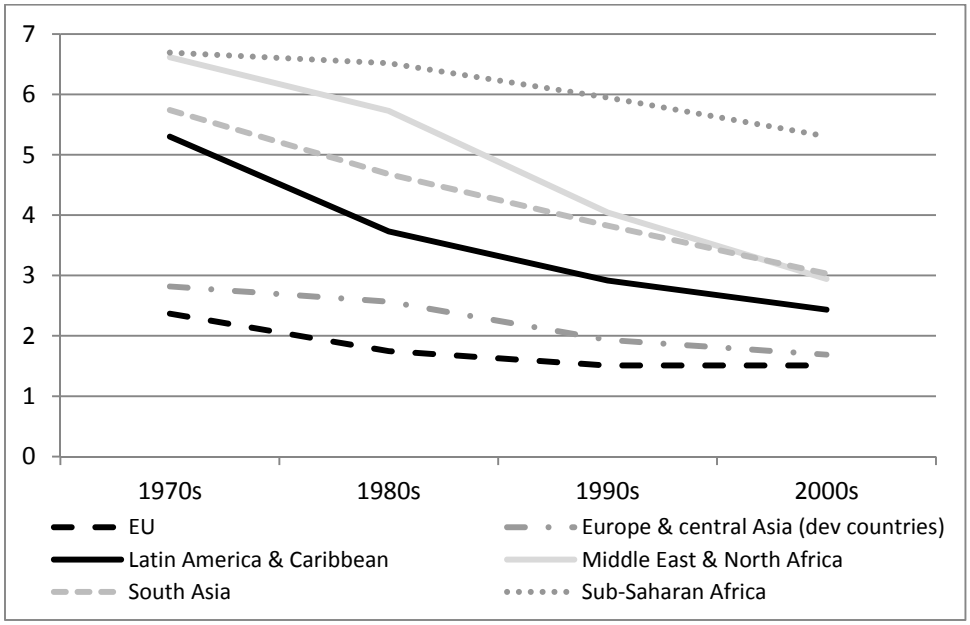
Moultrie and Timæus (2003) compare the 1998 DHS, 1996 and 1970 census data to estimate trends between 1948 and 1996. They find that fertility for the African population started to decline gradually from the 1960s onwards and then the decline accelerated in the 1980s. Where the total fertility rate for African women was around 7 children in the late 1950s, this had declined to 3.5 by 1996. Moultrie *et al.* (2008) argue that the fertility decline might have stalled since the 1990s.

Although apartheid was instrumental in sustaining such racial divisions, the stark racial differences in fertility patterns were evident prior to the introduction of the formal apartheid policy of separate development. In the 1940s, the total fertility rate for White South Africans

was 3.5 children per woman and the average total fertility rate for the other racial groups was 6.5 children per women (Chimere-Dan, 1993: 32).

Figure 1 shows the changes in the fertility rates for several world regions over the past four decades based on World Bank data. A comparison of Figure 1 and the racial fertility patterns in Figure 5 (in section 3) reveals that South Africa's fertility decline followed a similar path to that of South Asia, the Middle East and North Africa and was dissimilar to the trend observed in the Sub-Saharan African region where fertility rates have remained comparatively high. The fertility trend for South African Whites appears similar to patterns in central Asia and less developed areas in Europe. Fertility for the Coloured population lies below that for the African population and above fertility levels for the White population. Figure 1 shows that fertility patterns for the Coloured population may be most similar to the trend in Latin America and the Caribbean.

Figure 1: Comparison of total live births, by decade and country



Source: World Bank (2012)

The strong decline in fertility over this period has been attributed to a long list of phenomena. Moultrie and Timæus (2003: 280) emphasise that there is no single reason for the decline in South African fertility, but rather that there has been a range of contributing factors. Such factors include population policies (Caldwell & Caldwell, 1993; Kaufman, 1997; Moultrie and Timæus, 2003; Swartz, 2002; Chimere-Dan, 1993; Cooper *et al.*, 2004); changing social norms and institutions (Swartz, 2002; Kaufman, 1997; Moultrie and Timæus, 2001);

improved income levels (Ben-Porath, 1974); higher educational attainment (Department of Health, 1998); lower child mortality (Birdsall, 1988); and possibly also HIV/AIDS (Moultrie & Timæus, 2003; Garenne *et al.*, 2007). These factors will each be discussed in turn below.

2.1 Population policies

The population policies launched by the government aimed to promote family planning via a combination of supply measures (making contraception more widely available, providing information on family planning) and demand measures (advancing education, primary health care and the economic participation of women) (Caldwell & Caldwell, 1993; Swartz, 2002: 54; Chimere-Dan, 1993: 34). The impact of the population policies may have been enhanced by rapid urbanization that brought individuals born and raised in rural areas in contact with city dwellers who generally had more exposure to and awareness of contraceptive methods. (Moultrie & Timæus, 2001: 210; Moultrie & Timæus, 2003: 280).[2]

Over this period there was a significant shift in the motivation and aims behind these policies. Policies such as the 1974 state-funded National Family Planning Programme were motivated by apartheid era ideologies and intended to curb African population growth rates (Kaufman, 1997: 24-25). Since 1994 the focus has been increasingly on improving the health and status of South African women. The Choice on Termination of Pregnancy Act was introduced in 1996 and this policy made it easier for women to have safe and legal abortions. The effect was an increase in the rate of legal abortions and a decrease in maternal deaths during birth. In 1998 a new population policy was launched and it was completely detached from population growth and focussed on improving the status of women and changing male perspectives on contraception (Cooper *et al.*, 2004).

Due to the high cost of these population programmes, there is considerable debate on their effectiveness. Surveys show that contraception knowledge and usage is much higher in South Africa than in other African countries. According to the Demographic and Health Survey of 1998 all South African female respondents were aware of at least one way to prevent pregnancy, while three-quarters of women reported that they had used contraceptive methods (Department of Health, 1998: 18-20). This is considerably higher than rates for the rest of Sub-Saharan Africa: similar surveys show that 66 percent of women in Cameroon, 49 percent of women in Sudan and 40 percent of women in Senegal had never heard of any method of

[2] From 1987 to 1989, 56 percent and 74 percent of women in Johannesburg and Cape Town respectively used contraception methods, while only 43 percent of rural inhabitants practised a form of contraception (Caldwell & Caldwell, 1993: 247). These differentials form part of a well-established relationship: Moultrie and Timæus (2001: 210) show that African fertility is 15% lower in urban areas than in rural areas.

pregnancy postponement and in Sudan and Senegal the share of women who made use of contraceptive women was below 6 percent (Bongaarts *et al.*, 1983: 526).

It is difficult to ascertain to what extent high levels of contraceptive use can be attributed to the population programmes because there were also large shifts in the demand for contraception over this period that were unrelated to these programmes. The population programmes provided women with access to family planning services and contraception, but changing social norms around female fertility ensured that there was a strong demand for such services.

2.2 Social norms and institutions

Fertility decisions are influenced by reigning social norms and institutions. The pioneer of the demographic transition theory, Frank Notestein, emphasised that high fertility rates are associated with collective norms that favour the notion of the extended family over that of the individual and traditional institutions and structures that create few prospects for women outside of the orthodox roles of wife and mother (Notestein, 1953).

In South Africa social norms responded to the restrictive apartheid era migrant labour system that regulated the flows of African workers.[3] Under this system African men often had to leave their wives and children behind in rural homelands areas to seek work in the cities. The long absences of the men created considerable financial and social uncertainty and placed much strain on these households. Women responded by attempting to gain more control over their own lives and many eventually started to function as the heads of their households (Swartz, 2002). They responded to the precarious situations that they faced by trying to secure their own income flows, delaying or avoiding marriage (Kaufman, 1997: 22; Zwang & Garenne, 2008: 102) and limiting fertility (as predicted by Notestein's theory).[4]

The decrease in marriage rates – especially amongst African women – reinforced the fertility decline (Swartz, 2002; Kaufman, 1997). However, Chimere-Dan (1997) finds that lower marriage rates have had a weaker than expected impact on fertility due to the breakdown of

[3] Ten homelands were demarcated as areas where Africans would reside. Africans working in cities in the rest of South Africa were treated as guests and required permission to stay from the authorities. This permission to stay was captured in their passbook, which they had to always carry with them (Kaufman, 1997). Section 10 of the 1951 Native Laws Amendment Bill required that Africans could not stay in an urban area for longer than 72 hours unless they were born there or haves stayed there for at least 15 years or had worked for one employer continuously for ten years. Dependents of individuals satisfying these conditions were also allowed if they usually lived with the workers and had entered the area legitimately.

[4] There may also be an interaction between these two decisions. Palamuleni *et al.*(2007: 127) argue that women who are not married may find it easier to limit the number of children they want to have because there are fewer restrictions and expectations from family members and husbands regarding ideal family size.

the traditionally strong relationship between marriage and fertility – especially amongst younger women.[5]

This period saw more efforts from women to secure their own livelihood, but in turn, the market also responded with a gradual broadening of the space for female employment via the lifting of formal restrictions and the combating of prejudice and discrimination. Significantly, Burger and Von Fintel (2009)'s analysis of labour market trends show that there has been a gradual convergence in male and female participation rates as well as the likelihood of male and female employment over birth cohorts ranging from the 1930s to the 1990s.

Household relationships have also been affected by shifts in intergenerational household dynamics. Caldwell (1976) contends that because wealth tends to flow upward, from younger to older generations, in developing countries, it is a natural response for households to have more children to increase this flow of income. In such an environment children function as a type of old-age pension. This theory is relevant for South Africa because the escalation of pension payments to African senior citizens over this period is likely to have muted intergenerational reliance within this group and this would have reduced the influence of concerns about security in old-age on fertility decisions.

2.3 Wage and income

Fluctuations in wage and income levels may also influence fertility decisions. The literature identifies two opposing forces relating to the influence of income on fertility rates. Households want to purchase goods and services for consumption, but need to trade this off against their desire to have and raise children. At higher income levels households could care for more children without having to sacrifice consumption. However, the same change may also discourage fertility because rising wages increase the opportunity cost of raising children. The first influence is described as an income effect and the latter as a substitution effect. Ex ante, it is not clear which of these two influences would dominate (Ben-Porath, 1974: 189).

Such thinking is also exemplified in Becker's New Home Economics theory that models the household fertility decision as a trade-off between whether scarce time is spent having and raising children or rather on other desirable activities (Turchi, 1975: 108- 109; Becker & Tomes, 1976: 144-145). This trade-off is subject to a budget constraint, which is determined by the rate at which the household members' time can be transformed into consumer goods

[5] Nzimande (2007) argues that higher pre-marital fertility may be partly due to the postponement of marriage and shows that pre-marital fertility is more prevalent in co-habiting unions.

and services through the wage rate (Turchi, 1975: 108). Hence, Becker *et al.* (1960: 211) argue that a long-run increase in income will lead to an increase in the demand for children.

2.4 Education

Education is regarded as an important determinant of fertility decisions (Birdsall, 1988: 514; Ben-Porath, 1974: 190-191). The influence of education on fertility is evident in South African data: the fertility rate for women with no education is 4.5, while it is below replacement level (1.9) for women who have tertiary education (South African Department of Health, 1998).

Higher levels of education decrease desired fertility and close the gap between desired and unwanted fertility. Education affects these outcomes via various channels. More educated mothers generally have higher earning potential and therefore the opportunity cost of child-rearing is higher when measured in terms of foregone salaries and wages. Higher education levels may also increase a woman's awareness and knowledge of family planning and contraception.

2.5 Desired family size and gender preferences

Family size and gender preferences are crucial for decisions about fertility. Many authors have examined the interaction between child mortality and the desired family size. The literature suggests that a household can anticipate or react to the risk of a child dying in at least two ways: by replacement behaviour or by hoarding behaviour. Replacement behaviour is backward-looking: when a child is lost, he or she is replaced by having another child. Hoarding behaviour happens when ex ante there is compensation for the potential loss of a child by having more children (Birdsall, 1988: 519).[6] Hoarding behaviour is usually prominent in a country when the child mortality rate is high, and the over-compensation for the possibility of child loss naturally leads to higher fertility.

Gender preferences may also play an important role in decisions about having more children. According to Hartmann (2010:6) strong gender preferences are likely to boost fertility because childbearing will continue until the ideal number of boys or girls have been born. Research has shown that there is a strong preference for boys in some regions (Bhat & Zavier, 2003: 637; Clark, 2000; Campbell & Campbell, 1997; Das, 1987). This gender bias is often

[6] The theory for hoarding effects is that the higher the probability that a child might not survive, the more children a family will have in order to compensate for possible future loss (Hossain *et al.*, 2007: 772).

attributed to the higher income-earning capability of the males in certain societies, and therefore their ability to provide better old-age support to parents.

2.6 HIV/AIDS

In the South African context, HIV/AIDS is also seen as a potential contributor to fertility decisions, although the available data make it very difficult to estimate the impact. Most authors argue that HIV/AIDS has assisted in the fertility decline (Moultrie & Timæus, 2003: 281; Garenne *et al.*, 2007), but there are also some who think that it may have boosted fertility (Kalemli-Ozcan, 2006).

Women who know that they are HIV positive might be more reluctant to have children (Moultrie & Timæus, 2003: 281) due to the associated risks. However, Zaba and Gregson (1998) find little evidence of behavioural changes and conclude that HIV/AIDS may rather work via the symptoms and medical outcomes associated with the disease. These include a decrease in Spermatozoa in men who have progressed to AIDS; an increased risk of foetal loss amongst HIV-positive women; an increased vulnerability to other sexually transmitted infections which reduce the chance of conception; and an increase in mortality amongst women in their child-bearing years (Garenne *et al.*, 2007).

Kalemli-Ozcan (2006) expects HIV/AIDS to increase fertility because women may react to increasing mortality by having more children. However, it is important to note that this theory is based on cross-country data from the entire continent and not necessarily applicable to the South African context specifically.

3. Data

The empirical analysis in this paper uses the National Income Dynamic Study (NIDS) data collected by the South African Labour and Development Research Unit (SALDRU) during 2008. Although the survey is a cross-section, respondents were asked questions regarding fertility, migration and marital status retrospectively. This information can be used to construct an unbalanced panel data set.

Of course, retrospective panels can suffer from recall bias, particularly for events that occurred infrequently or long ago, or that were not particularly noteworthy (Baddeley, 1979: 25). However, one would expect this to be less of an issue for something memorable such as child births and mortalities. Furthermore, Blacker and Brass (1979: 49-50) attribute a large

part of measurement error in retrospective fertility data to shortcomings in survey structure. When a multi-pronged question approach is used (as was the case for NIDS) the margin of error for retrospective fertility outcomes is found to be much lower than in cases where a single survey question is used. However, measurement error is still likely to be more of a problem than in regular panel data.

In the NIDS data all females are asked to report the number of live births, as well as the date of birth and – where applicable – the date of death. However, for 1,221 out of the total 19,683 recorded births, respondents failed to report the birth year[7]. This allows us to explore the nature and extent of measurement error in our data. Table 1 below presents the coefficient estimates obtained from regressing the share of a woman's births that was undated on different demographic characteristics.

Table 1: OLS regression for unreported birth years as share of total live births

Birth year	-0.003*** *(0.0003)*
Live births	0.016*** *(0.0022)*
African	0.031*** *(0.0111)*
Coloured	0.039*** *(0.0127)*
Indian	0.014*** *(0.0141)*
Education	-0.009*** *(0.0003)*
Constant	0.266*** *(0.0240)*
R squared	0.2186
Observations	7126

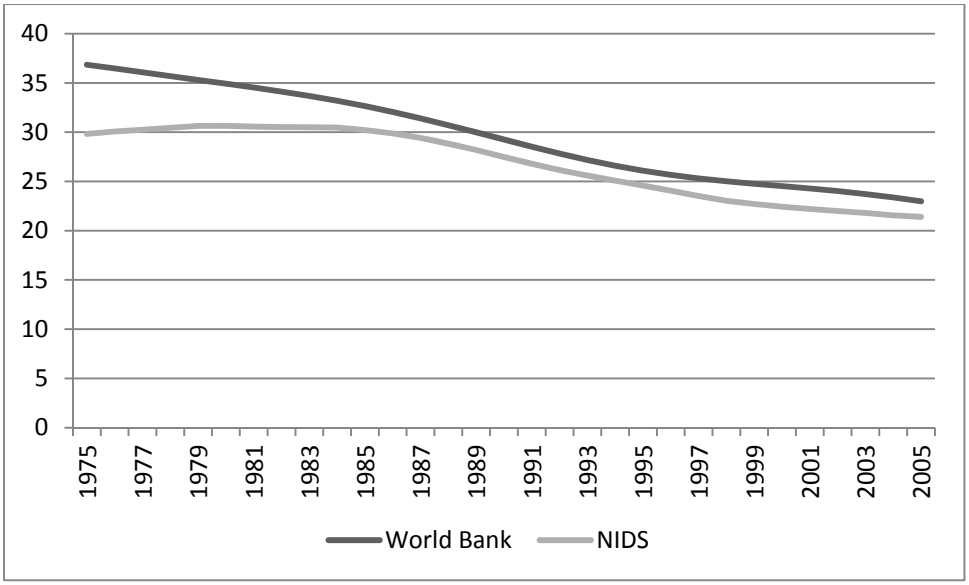
The results demonstrate that birth years are more likely to be missing the older the woman is at the time the survey is taken, the more children she gave birth to, the lower her level of schooling and if she was African or Coloured rather than Indian or White (Whites are the reference group in this regression). This failure to accurately recall the date of births means that fertility will be underestimated in our dataset. The fact that this is more of a problem for women born longer ago means that the magnitude of the under-estimation will be smaller for more recent years and increase as we move further into the past. One way of addressing the

[7] In our retrospective panel data set these births are set to missing. Women who fail to report the birth year of at least one of her children are excluded from the NIDS sample when estimating fertility rates in the remainder of the article.

issue is to omit all women who could not report birth years for all of their children. However, the fact that these women are disproportionately drawn from those with a large number of children means that this is unlikely to completely remove the downward bias.

In order to investigate the magnitude of this bias, we compare our crude birth rate[8] with the estimates of the crude birth rate from the World Bank (2012). Figure 2 reveals that the NIDS data produce a crude birth rate that is very similar to the World Bank estimates for the 1985 to 2005 period, but that the degree of underestimation increases for data further into the past. The patterns in the gaps between the World Bank and the NIDS fertility estimates are consistent with our expectations, and means that the data are likely to understate the magnitude of the fertility decline that occurred prior to 1985.

Figure 2: Comparison of crude births (1975-2005): World Bank and NIDS data estimates

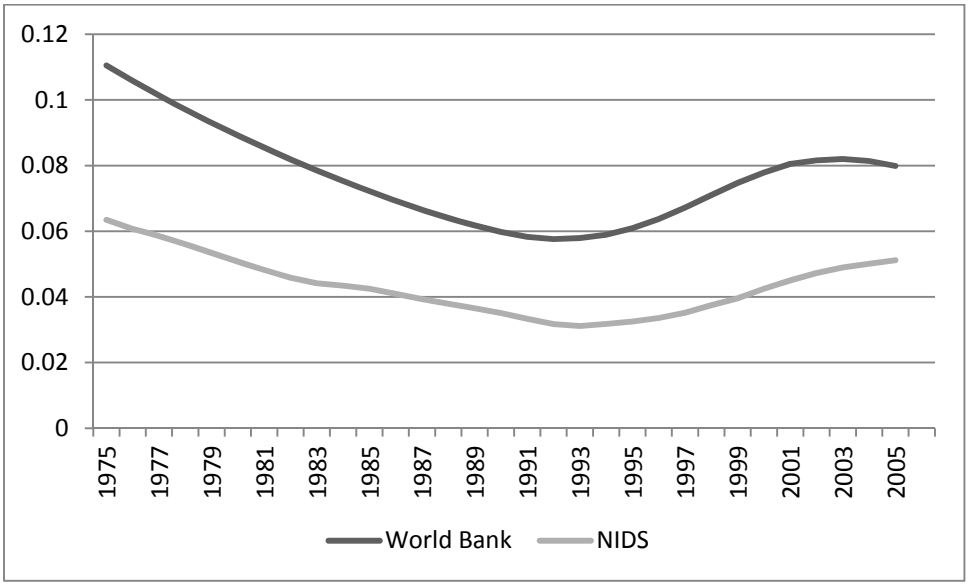


Source: World Bank (2012); NIDS, own calculations

Figure 3 compares the child mortality rate[9] estimates produced by the NIDS data to that reported by the World Bank (2012). The estimates are broadly similar: both sets of estimates show a U-shaped mortality curve with a turning point in the early 1990s. However, the NIDS data underrepresent child mortality. Again we find that the discrepancy is an increasing function of the recall period.

[8] The crude birth rate is defined as the births per 1, 000 people per year.
[9] The child mortality rate is the probability that a child born in a specific year or period will die before reaching the age of five (based on the prevailing age-specific mortality rates).

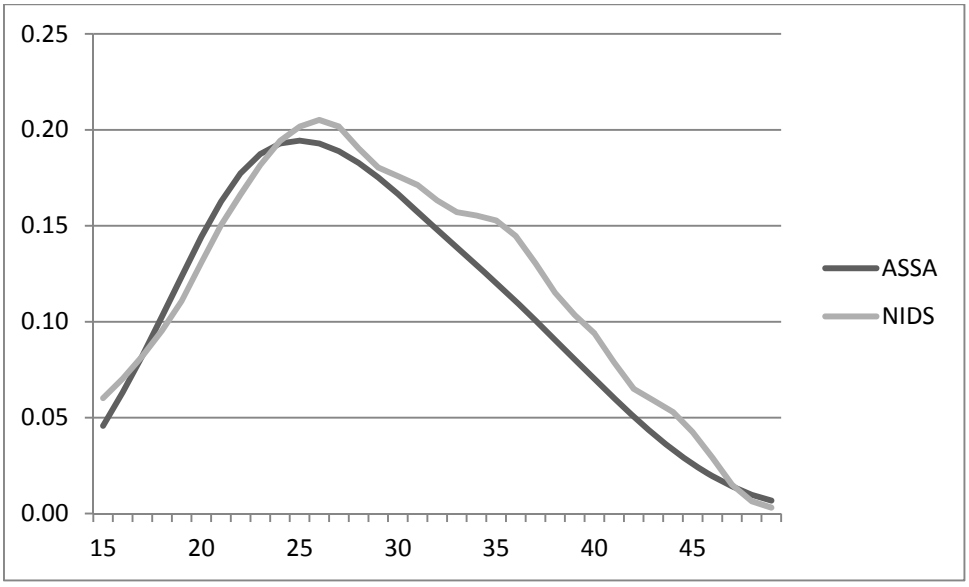
Figure 3: Comparison of child mortality rate (1975-2005): World Bank and NIDS data estimates



Source: World Bank (2012); NIDS, own calculations

Finally, Figure 4 compares the estimated probability of women of different ages giving birth in 1990 from the NIDS data (plotted using a kernel-weighted local polynomial smoother) and the Actuarial Society South Africa (ASSA) 2008 lite model (ASSA 2008). The NIDS data produce slightly higher estimates for women aged 25 to 45, but are generally very similar to the ASSA estimates.

Figure 4: Comparison of birth probabilities (1990), by age: ASSA and NIDS data estimates



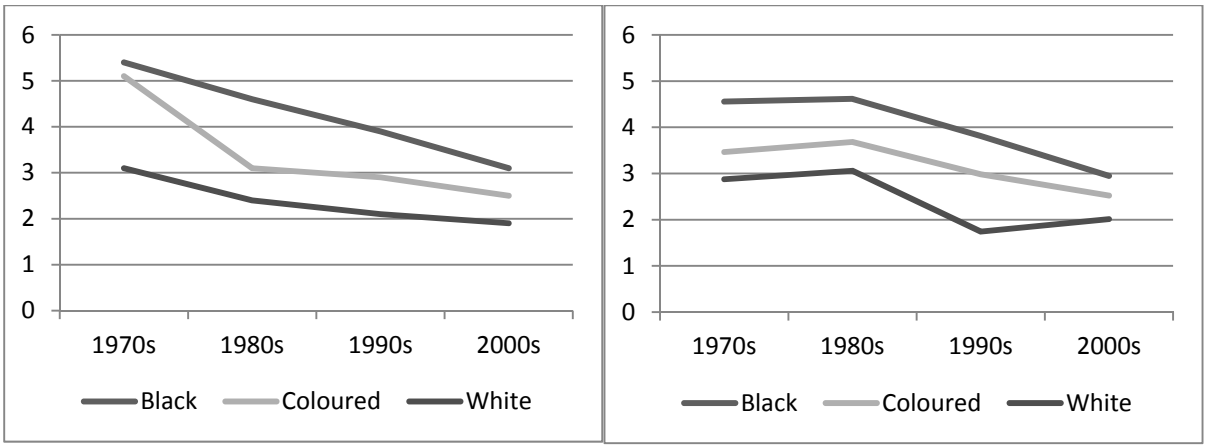
Source: Actuarial Society South Africa; NIDS, own calculations

The analysis shows that the NIDS data are in line with many of the South African fertility and mortality trends documented in other data sources. It also demonstrates that the reliability of this retrospective panel decreases as the recall period lengthens and we find that the recall of events occurring before 1975 may be problematic. For this reason our empirical analysis will focus on the fertility outcomes of women born after 1955 and before 1990: those who were in their highest birth probability years between 1975 and 2008. For similar reasons Moultrie and Dorrington (2009) decided to exclude women older than 49 at the time of the survey from their sample. Moultrie and Dorrington (2009) assessed the reliability of NIDS fertility data by comparing patterns in NIDS with that of the Community Survey 2007.

Examining the similarity of fertility patterns for each race estimated by NIDS and larger sample data provide an important further check on the reliability of the NIDS fertility questions. Figure 5 (a) and (b) below depict the estimation of the fertility decline according to race by Swartz and from the NIDS data respectively. Both graphs show stark racial differentials in the fertility patterns, but it is also clear that there are more kinks and jumps in the NIDS data. Moultrie and Dorrington (2009) perform a similar check using NIDS data and the Community Survey of 2007 and they conclude that the Indian, White and Coloured patterns are not well matched, but the African samples do align well. This provides further motivation for concentrating our analysis on the African population.

Figure 5: Comparison of total live births, by decade and race: Schwartz (2009) and NIDS data estimates

a) Schwartz (2002) b) NIDS



Source: Swartz (2002); NIDS, own calculation

4. Empirical analysis

4.1 Constructing a model of fertility decisions

Suppose fertility y_{it} for individual i in period $t$can be expressed as

$$y_{it} = \theta(a_{it}) + \boldsymbol{x}_{it}\boldsymbol{\beta} + \eta_i + u_{it} \quad [1]$$

where $\theta(.)$ represents the potentially non-linear effects of age, a_{it}, $\boldsymbol{x}_{it}$ is a vector that contains other observable determinants of fertility, and η_i and u_{it} represent unobservable fertility determinants that are time-invariant and time-varying respectively. In this case the individual level fixed effect, η_i, may capture a wide range of influences that fluctuate mainly across individuals or generations rather than over time for a specific individual, such as the effect of prevailing social norms and institutions, preferences for children, and attitude towards contraceptive use. In as far as these factors are shared across cohorts equation [1] can be rewritten as

$$y_{it} = \delta(c_i) + \theta(a_{it}) + \boldsymbol{x}_{it}\boldsymbol{\beta} + e_{it} \quad [2]$$

where $\delta(c) = E(\eta_i|c_i = c) =$ and $e_{it} = u_{it} + \eta_i - \delta(c_i)$. In this case $\delta(c)$ captures the effect of generation-specific unobservable fertility determinants for all individuals born in birth year c. Estimates of the $\delta(.)$ and $\theta(.)$ functions, as well as the $\boldsymbol{\beta}$-coefficients can be obtained using ordinary least squares (OLS) under the assumption that $E(e_{it}|\boldsymbol{x}_{it}, a_{it}, c_i) = 0$. With the panel component of the data it is also possible to relax this assumption somewhat, and to estimate the parameters from model [1] with a fixed-effects (FE) regression under the assumption that $E(u_{it}|\boldsymbol{x}_{it}, a_{it}) = 0$. In the regressions below, the age and birth year functions are both approximated using splines with 5-year gaps between the knots.

We construct a panel of variables with measures of education, income, relationship status, geography, race and child mortality at various points at time using the NIDS retrospective questions.

Retrospective estimates of the years of schooling achieved by a specific point in time can be derived from questions asked to respondents about the highest level of schooling achieved, their first and last years in school and how many times they repeated which grades. In our regression analysis below, we allow for a non-linear schooling effect by using a spline allowing different slopes for primary, secondary and tertiary schooling.

We can construct retrospective estimates of relationship status over time using a combination of questions about current relationship status and how long the respondent has been in this relationship. These questions are used to construct dummy variables to indicate whether each woman was married, in a long-term relationship, widowed, divorced or never married at various points in time. We only have information about the timing of the current relationship status, so cannot know when, for example, currently divorced women were married. This information is inferred from the marriage patterns observed for other women, although this assumption means that this variable is measured with error.

Similarly, we generate a variable to track the movement of individuals across provinces over time using a question asking them in which province they resided at specific periods, which can then be used to create a province variable with time variation.

The NIDS data do not contain any retrospective information on employment, wages or income, so we use data from the South African Reserve Bank Quarterly Bulletins on real per capita GDP. Although this measure only varies over time, it should still be able to capture the effect that changes in average income levels have had on total fertility.

We construct a variable capturing the number of children that the women have had at a specific point in time based on the detailed retrospective birth records. To measure the impact of fertility as 'replacement' behaviour we also include an indicator of children that have died (again measured at different points in time).

We explore gender preferences by including dummy variables for whether a woman has only had boys or has only had girls. Again, this variable is created for the same individual at various time periods so that we can use it in our panel.

The dependent variable is the number of live births in a given year. Multiple births in one year are fairly rare – 345 out of a total of 19,335 births – so this is similar to a binary fertility variable.

4.2 Regression results

Table 2 reports the estimated coefficients for our fertility model: columns 1 to 4 estimate equation [2] for all South African women, African, Coloured and White[10] women respectively, using OLS, and column 5 estimates equation [1] for African women using the FE estimator. Starting with the fertility outcome for all races, we observe that the probability

[10] Given the small number of Indian women in the sample and the consequent measurement problems, the results from the fertility regression for this population group on its own are omitted.

of giving birth increases rapidly between the ages of 15 and 20, and then more slowly until peaking at 25, after which point fertility declines with older age. This is consistent with the age-profile estimated in Figure 5. The results in columns 2 to 4 show a similar age pattern for each of the races, although the fertility peak occurs at an earlier age for African women, and is quicker to decline for White women once they reach 30. The race coefficients in column 1 demonstrate that even after controlling for differences in other characteristics, African and Coloured women have higher fertility rates than White and (particularly) Indian women.

There is a negative and significant relationship between the income growth rate and fertility, which demonstrates that the fertility rate is countercyclical. The income effect is therefore shown to dominate the substitution effect for South African fertility. This effect is only significant for African women. Although the coefficient estimate on the log per capita income variable is positive, it is small and insignificant.

The education spline coefficients reveal that moving from no schooling to completed primary schooling increases the probability of giving birth, which is somewhat unexpected in light of our literature review in section 2. Although this effect is significant, it is relatively small compared to the much larger decrease in fertility associated with each additional year of secondary or – seemingly to a lesser extent – tertiary education. The race-specific regressions reveal the same schooling-fertility pattern for each of the population groups. We also observe that the slope coefficients for the total population are a little misleading. For African women the tertiary schooling effect is even stronger than the secondary schooling effect, but this slope estimate is heavily influenced by White women who are disproportionately represented amongst the tertiary educated and whose fertility decisions are less affected by schooling than for women of the other races.

The relationship status coefficients for the total population show that being married or in a long term relationship substantially increases the probability of having children relative to someone who has never been married, whereas this probability is only slightly higher for women who are divorced or widowed. However, this pattern varies between the population groups. White and Coloured women who are in long-term relationships are no more likely to have children than women who have never been married, whereas African women in long-term relationships have almost the same probability as married women. Widowed and divorced Africans have the same low fertility rates as the never-married, whereas this rate is significantly higher for Coloured widows and White divorcees.

Our estimates also support previous results by Palamuleni *et al.* (2007: 123) who found that fertility was the highest in Limpopo, Mpumalanga and KwaZulu Natal and the lowest in the Western Cape, Gauteng and the Free State. The population group regressions are broadly consistent with this provincial pattern with the exception of the Free State, which is a high fertility province for White and Coloured women, but a low fertility province for African women.

The number of existing children variable captures the impact of the number of previous children on a woman's future fertility outcomes. The relationship is shown to be negative and significant: the more children a woman has had, the fewer she is likely to have in the future.

The replacement effect coefficient estimate is positive and highly significant, which shows a strong inclination for women to react to death of a child by giving birth to more children. Both the previous children and child replacement effects are stronger for White than for African women, with the effect for Coloureds lying in the middle. This behaviour may provide tentative evidence of a stronger role of a desired or targeted family size amongst Whites.

Both gender bias variables are positive and significant for the population as a whole. Women are therefore more likely to have more children if they have not yet had both boys and girls. The sizes of these coefficients are very similar, which suggests a preference for having a gender mix but no bias in favour of children of either gender. This is surprising given the gender bias in favour of boys found in other countries, often attributed to the higher income-earning capacity of males in certain societies (Hartmann, 2010: 6). The results in columns 2 to 4 show that this pattern mainly applies to African women, whereas White women have no observable preference for mixed genders, and Coloured women have a significant male bias.

The birth year splines shows that even after controlling for other observable characteristics, there was still some combination of generation-specific unobservable factors that led to declining fertility for women born between 1965 and 1975; women who would have reached peak fertility between 1980 and 1990. Although only the 1965-1970 effect is statistically significant, the cumulative effect for the whole decade is equivalent to a decrease in 1.2 children born per year. The race-specific regressions reveal that this fertility decline was mainly driven by African women, whereas Coloured and White women show no significant birth year effects.

Table 2: Fertility probability regression results

VARIABLES	(1) All OLS	(2) African OLS	(3) Coloured OLS	(4) White OLS	(5) African FE
Age spline (15,20)	0.0303***	0.0313***	0.0287***	0.0190***	0.0451***
Age spline (20,25)	0.0009	-0.0000	0.0039	0.0075	0.0205***
Age spline (25,30)	-0.0074***	-0.0071***	-0.0100***	-0.0019	0.0104***
Age spline (30,35)	-0.0072***	-0.0068***	-0.0027	-0.0154**	0.0082***
Age spline (35,40)	-0.0106***	-0.0109***	-0.0103**	-0.0027	0.0005
Age spline (40,45)	-0.0077***	-0.0093***	-0.0046	-0.0001	-0.0046***
Age spline (45,50)	-0.0007	-0.0008	-0.0033	-0.0024	0.0030
Birth year spline (1956,1960)	-0.0009	-0.0021	0.0047	-0.0040	
Birth year spline (1960,1965)	0.0022	0.0024	-0.0017	0.0016	
Birth year spline (1965,1970)	-0.0044***	-0.0047***	0.0013	-0.0004	
Birth year spline (1970,1975)	-0.0025	-0.0026	-0.0015	-0.0023	
Birth year spline (1975,1980)	0.0002	0.0002	0.0024	-0.0028	
Birth year spline (1980,1985)	0.0006	0.0004	-0.0017	0.0057	
Birth year spline (1985,1989)	-0.0002	-0.0005	0.0050	-0.0033	
Coloured	-0.0194***				
Indian	-0.0489***				
White	-0.0365***				
Education spline: primary	0.0033***	0.0030***	0.0062*	0.0038	0.0072
Education spline: secondary	-0.0104***	-0.0099***	-0.0110***	-0.0068	-0.0148***
Education spline: tertiary	-0.0050**	-0.0121***	-0.0085	-0.0059	-0.0258***
Married	0.0735***	0.0708***	0.0710***	0.0928***	0.0935***
Long-term relationship	0.0545***	0.0579***	-0.0109	0.0114	0.0609***
Widowed	0.0173*	0.0119	0.0460*	0.0230	0.0196
Divorced	0.0172*	-0.0023	0.0152	0.0639**	-0.0260
Children	-0.0047**	-0.0028	-0.0108*	-0.0392***	-0.0925***
Replacement effect	0.0229***	0.0195***	0.0353***	0.0713***	0.0561***
Income growth rate	-0.1968***	-0.2114**	-0.2435	-0.5300	-0.2672***
Log of per capita income	0.0135	-0.0020	0.0735	0.0652	-0.1162***
Eastern Cape	0.0064	0.0054	0.0194	0.0333*	-0.0324
Northern Cape	0.0142*	0.0039	0.0248*	0.0245	0.0047
Free State	-0.0154**	-0.0197**	0.0157	0.0267	0.0266
Kwazulu-Natal	0.0235***	0.0212***	0.0029	0.0210	0.0770
North-west	0.0134*	0.0124*	-0.0246	0.0237	-0.0103
Gauteng	0.0055	0.0048	0.0180	0.0119	0.0459
Mpumalanga	0.0232***	0.0223***	0.0087	0.0200	0.0777
Limpopo	0.0218***	0.0198***	0.0493	0.0648**	0.1022**
Outside SA	0.0001	0.0036	0.0013	0.0000	0.0509
No boys	0.0207***	0.0225***	0.0237*	-0.0192	0.0744***
No girls	0.0224***	0.0215***	0.0122	-0.0086	0.0808***
Constant	-0.4843***	-0.3625*	-1.0937**	-0.3346	-0.3563**
Observations	95,294	73,858	15,890	6,463	73,858
R-squared	0.040	0.037	0.038	0.062	0.089
Number of pid					4,487

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

Since our interest is primarily in African women – the group whose fertility decline was most instrumental in driving the South African demographic transition –, we also estimate the model coefficients for African women with a FE regression. The schooling, marital status, GDP growth rate and gender bias variables are similar to their OLS values, although larger in magnitude in most cases. The replacement and previous children effects are also much larger, and are now closer to the estimated effects for White women. The province variables are generally larger in magnitude, but statistically insignificant. The log of average income is now estimated to have a large negative effect on fertility.

The most striking difference between the OLS and FE coefficients can be seen in the age effects, where the FE results now imply that African women only face a declining fertility rate after the age of 40. This seems highly unlikely, and may be partly driven by the higher fertility rate amongst the women from older generations who also reached older ages at the time of our dataset. For this reason, our preferred specification for the fertility outcomes of African women is the OLS regression results reported in column 2.

4.3 Explaining the South African fertility transition

The preceding section investigated the determinants of fertility, but we are specifically interested in explaining the fact that African women born more recently have a lower fertility rate than their older counterparts. Stated in terms of the fertility model in equation [2], we want to explain why $E(y_{it}|c_1) - E(y_{it}|c_2) > 0$, where c_1 is assumed to represent an older birth cohort than c_2. Women from younger generations may have fewer children because they possess observable characteristics $\boldsymbol{x}_{it}$ that are less conducive to fertility, or because the unobservable fertility determinants that apply to their generation, such as social norms or institutions, is consistent with lower birth rates. We can attempt to identify the importance of each of the fertility determinants by decomposing the change in the expected birth cohort fertility rate.

However, using conventional decomposition methods – such as the Oaxaca-Blinder approach (Blinder (1973) and Oaxaca (1973)) – is inappropriate since the different birth cohorts are observed at different ages. Specifically, women from older generations are also observed at older ages, whereas this is not the case for members of younger generations. Any life-cycle variation in the explanatory variables (such as the likelihood of being married increasing with

age) will therefore seem like a change in the expected values of these values for different birth cohorts: $E(\boldsymbol{x}_{it}|c_1) - E(\boldsymbol{x}_{it}|c_2)$,

For this reason, we also want to condition on age when we compare fertility rates. This allows us to decompose the conditional fertility decline more sensibly between two birth cohorts as

$$E(y_{it}|a_{it}, c_1) - E(y_{it}|a_{it}, c_2) = \delta(c_1) - \delta(c_2) + \{E(\boldsymbol{x}_{it}|a_{it}, c_1) - E(\boldsymbol{x}_{it}|a_{it}, c_2)\}\boldsymbol{\beta} \quad [3]$$

In order to apply this method, the population of African women is divided into five-year birth cohorts, and the average conditional fertility decline between two successive cohorts is decomposed. Conditional fertility rates and observable characteristics are estimated by regressing birth rates and the model regressors on an exhaustive set of age and birth cohort dummies, and taking the appropriate predicted values. The results from this decomposition are displayed in Figure 6 and Table 3. The decomposition reveals that the largest part of the fertility decline can be ascribed to increasing education, changing relationships, and unobservable factors.

Figure 6: Decomposition of the South African fertility decline, per birth decade

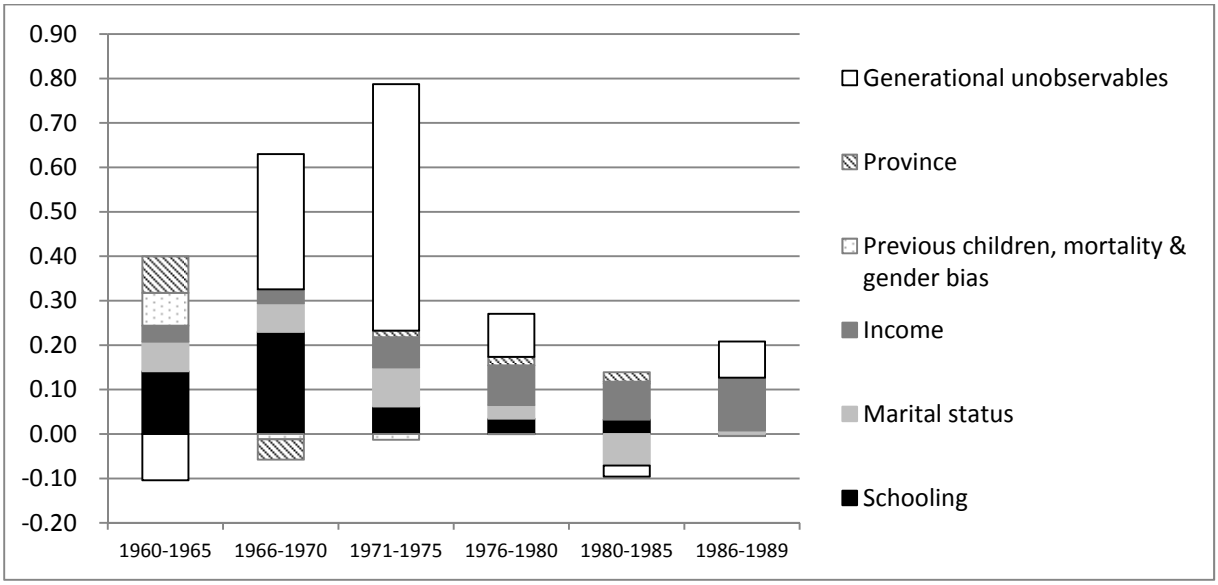


Table 3: Decomposition of the South African fertility decline, by birth cohort

Variables \ Birth cohort	1960-1965	1966-1970	1971-1975	1976-1980	1980-1985	1986-1989	TOTAL
Schooling	0.14	0.23	0.06	0.03	0.03	-0.00	0.50
Marital status	0.07	0.06	0.09	0.03	-0.07	0.01	0.19
Income	0.04	0.03	0.07	0.09	0.08	0.12	0.42
Previous children	-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.03
Mortality	0.07	-0.01	0.00	-0.01	0.00	-0.00	0.06
Province	0.08	-0.05	0.01	0.02	0.02	-0.00	0.09
Gender bias	0.01	-0.03	-0.05	-0.01	0.01	0.01	-0.07
Generational unobservables	-0.10	0.30	0.55	0.10	-0.02	0.08	0.91
TOTAL	0.30	0.54	0.73	0.25	0.05	0.21	2.07

African women born in the first half of the 1960s will expect to have 0.3 fewer children over their lives than women born five years earlier, and almost half of this decrease can be ascribed to their higher levels of schooling. In fact, the increase in education – secondary education in particular – was the biggest single contributor to the decrease in fertility for women born between 1955 and 1970. Although this effect continued to drive down fertility for those born after 1970, its importance waned over time.

Changes in relationship choices also contributed to the fertility decline. The effect of lower marriage rates on fertility grew stronger for successive birth cohorts until reaching a peak for those born in the first half of the 1970s, and starting to decline. Gender bias and the number of previous children both played a very minor role in the fertility decline, whereas migration patterns and improvements in child health contributed to the fertility decline experienced by women born in the first half of the 60s, but not after that. Increasing income levels did not play a major part in of the five-year comparisons, but had a minor effect across all the years. Changing social norms and other unobservable fertility determinants were initially unimportant, but caused a substantial fertility decline for those born in the second half of the 1960s and the first half of the 1970s, before also gradually decreasing in importance.

In total, African women born in the late 80s are expected to have at least two fewer children than those born in the late 50s. Better access to schooling, decreasing marriage rates and growing incomes can explain just more than half of this decrease. The remainder is mainly due to unobservable factors that are difficult to pin down, but this category of influences appears to have an amplified impact for women born between 1966 and 1975 and who were likely to make fertility decisions in the 1990s. Given the timing, candidate explanations include HIV/AIDS, increased contraceptive use, and changes in intra-household relationships and the social role of women.

5. Conclusion

This research examines fertility decisions by using the National Income Dynamics Study of 2008 (NIDS) to explore the factors contributing to the observed decline in fertility over the past five decades. As far as the authors know, no other research on South African fertility trends has been published using this data set.

The NIDS data provides a rare opportunity to better understand the fertility patterns in an era where there was very little publically available and transparent analysis of fertility trends due the political and ideological nature of population policies and the lack of reliable Census data on the African population. Through its retrospective questions, NIDS provides a window on this period that allows us to investigate the influence of various factors contributing to the fertility decline.

Using this data set, we were able to explain a large component of the fertility decline observed across birth cohorts. This analysis shows a prominent role for improving education levels and the lower prevalence of marriage in the fertility decline.

However, a large part of the puzzle remains unsolved. Unobservables also play a large role and this category may include many factors, such as HIV/AIDS, increased contraceptive use and changes in intra-household relationships and the social role of women. Some of these influences may also be difficult to disentangle, including the interaction between changes in intra-household dynamics and the availability of family planning services and contraceptives. Kaufman (1997:107) makes the point that “women took decisions to use family planning not solely because of educational materials or accessibility of clinics, but because circumstances in their lives compelled them to do so”…however “the services it provided undoubtedly facilitated declines in fertility and increased contraceptive use”.

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