Policy Brief

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The Consequences of Fertility for Child Health in Kenya: Endogeneity, Heterogeneity and the Control Function Approach.

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1. Introduction and Motivation

A number of millennium development goals (MDGs) focus on outcomes that can be enhanced by reproductive health services. In particular, child and maternal health issues comprise a significant focus of the MDGs. On the maternal side, the reproductive health indicators include maternal and perinatal health, measured by antenatal coverage, proportion of births attended by skilled health personnel and essential obstetric care. Inadequate availability of these services in Kenya is manifested by prevalence of low birth weight, high perinatal and post-natal mortality rates, and high maternal mortality ratios. Child mortality in Kenya has remained high over the last 2 decades and there has been little progress in mortality reductions between 1989 (59/1000) and 2003 (77/1000). The under five mortality rate was estimated at 113 per 1000 live births in 1989, fluctuating there between to reach an estimated 115 per 1000 live births in 2003. Infant mortality rose from 59 per 1000 live births in 1989 to 77 per 1000 live births in 2003. Maternal related reproductive health outcomes such as family planning and fertility have important consequences for child health and also for general household welfare. Contraceptive use increased from 26.9% in 1989 to 32.7% in 1998 and 39.0% in 2006. Total fertility rates however dropped from 6.7 in 1989 to 4.7 in 1998, but thereafter rose to 5.0 in 2006.

Public policy interventions for preventive and curative purposes, which promote the decline in maternal mortality ratios and fertility, are expected to improve the well being of children, families and society (Schultz 2008). The importance of fertility for child well-being is however underscored by the quantity-quality of children model. This model postulates that parents who have more children commit less of their time and resources to each of their children. Parents who are encouraged to have fewer children may therefore invest more in

the human capital per child, and therefore improve the health, education, and lifetime consumption opportunities of their children (Schultz, 2008).

This paper contributes to the debate on the link between women's reproductive health and child health outcomes. The study analyzes the impact of fertility on child mortality in Kenya taking into account endogeneity of fertility and heterogeneity, nonlinearities and complementarities arising from unobservable determinants of child health. Reduced form, instrumental variables and control function models are estimated using vectors of child, household and community characteristics as covariates. The study utilized the Demographic and Health Surveys (DHS) data for 2003. However, analysis of mortality requires the study of large populations or the cumulation of the mortality experience of smaller populations over long periods because death is a rare and noisy event (Mosley and Chen, 1984). For this reason, we use women's birth histories to create a long time series of data for cohorts of five year-old children born between 1988 and 2003. The rest of the paper is organized as follows: section 2 presents the methodology; section 3 presents a summary of the key findings; while section 4 presents the conclusions and policy implications.

2. Methodology

Conceptual issues

The relationship between fertility and child health is analyzed using the standard household choice framework (Schultz, 2008; Mwabu, 2009). Child mortality and fertility are interrelated and should therefore be analyzed as joint choices (Schultz, 2008; Schultz and Mwabu, 2003). Higher child mortality among the poor may increase their fertility through various mechanisms, such as replacement and insurance effects whereby in the presence of low child survival rates, parents may have more births than they otherwise might have had (Rosenzweig and Wolpin 1980, 2000; Glick et al. 2006).

Schultz, (2008) argues that a within-family consequence of fertility could arise if the number of siblings affects the consumption, productivity and welfare of a child as hypothesized by the quantity-quality of child model. Thus women who are subsidized to have fewer children may also invest more on average in the human capital of their children and thereby improve the health and lifetime opportunities for each of their children. The inability of mothers to care for their newborns greatly increases the risk of child mortality or other adverse health events which can have long lasting consequences (Meyerhoefer and Sahn, 2007).

The relationship between fertility and child mortality is interdependent. Reduction in mortality rates affects fertility through both biological and behavioural mechanisms. On the biological side, infant death abbreviates lactation and hastens the resumption of ovulation. The behavioural mechanism operates largely through experience with and fear of child mortality, which motivates parents to replace lost children or have many children as insurance against expected death. On the other hand, child mortality has been shown to increase with order of birth and the age of the mother at birth. The health status of the mother deteriorates with successive births, further increasing the risk of child mortality.

Empirical estimation issues

Two major estimation issues arise in modeling the relationship between mortality and fertility. One, the endogeneity of fertility which arises from the fact that fertility is subject to preferences/choices of the household. Failure to account for this would lead to biased estimates. Instrumentation is further necessitated by the complex relationship between child mortality and fertility, which present the empirical approach with serious identification issues. First, mortality may affect fertility through the replacement effect, where mothers whose children die at birth or at an early age are likely to have more births and vice versa. This implies a direct link between fertility and mortality. Second, children of multiple births, more so of first multiple births are more likely to face mortality than non-multiple birth children, due to low birth weight. A key issue for empirical analysis is therefore the specification and measurement of an instrumental variable (IV) which impacts fertility and yet is unrelated to the preferences or unobserved endowments and constraints affecting child mortality (Schultz, 2008). The challenges of finding suitable instruments are widely discussed in the literature. Two variables are used as instruments: occurrence of a first born multiple birth and the utilization of family planning services.

A second estimation issue is heterogeneity bias arising from unobserved preferences and health endowments of individuals that influence their choice of health inputs. The fact that health inputs are choice variables introduces heterogeneity in the health of individuals. Even with valid instruments, it is difficult in practice to separate out the impact of endogenous variables from the effect of unboservables in a structural model .Failure to take into account heterogeneity will lead to unreliable estimates and could mask a significant impact on child health of say early prenatal medical care. In health production functions, heterogeneity springs from the presence of exogenous health factors that can be known to the individual household but are unobserved by the researcher (Rosenzweig and Schultz, 1983).

To take into account heterogeneity, the identification condition is explored through a control function (Florens et al., 2008). This would involve addition of a reduced form fertility residual to a mortality equation so as to purge the observed relationship between mortality and fertility of any effect of the unobservables by allowing fertility to be treated as if it were exogenous during estimation. Assuming the unobserved component is linear in the fertility residual, addition of an interaction term of the fertility and it's residual as a second control variable is sufficient to eliminate endogeneity bias even if the reduced form fertility is heteroscedastic. This controls for the effects of neglected non-linear interactions of unobservable variables with determinants of mortality.

4. Results

The paper argues that both mortality and fertility are proxies of child health. High child mortality and fertility rates are indicators of poor child health which could result from low health care inputs. Though fertility is a direct measure of maternal health, it is an indirect measure of child health because high fertility will be associated with poor infant health; such as low birth weight, neonatal and infant mortality. High fertility may also lead to poor child health through competition for nutrients among siblings resulting in malnutrition among under-fives. The paper explores the relationship between fertility and child health using the methodology discussed in the previous section. The paper presents a series of results: A mortality model with endogenous fertility as a control variable; the IV and control function approach estimates. The instrumental variable model focuses on child mortality for non-multiple birth children and uses occurrence of first multiple births and the cluster level use of modern contraception as instruments for fertility. The first stage is a fertility model, which tests for the impact of the presence of a first multiple birth (a fertility shock) in a household, controlling for other factors. It also shows how health care inputs affect fertility, controlling for other covariates such as child, maternal and household characteristics. The second stage equation tests the effect of exogenous fertility on child mortality controlling for other covariates. The control function approach model includes both the fertility residual and an interaction of the residual and fertility. Further controls interacting fertility, the residual and the instruments are also introduced.

Discussion of Results

The key results include that child, household and community characteristics are significant covariates of child mortality in Kenya. Male child dummy, maternal education and the district level monthly rainfall are highly correlated with the likelihood of mortality. Except for Central,? all provinces? face higher mortality risks relative to Rift Valley?. The highest marginal impact is from Nyanza province?. Endogenous fertility has a positive significant impact on child mortality. An increase in the number of children ever born by 1 would increase likelihood of mortality by 1%, other factors held constant. Instrumenting for fertility suggests that treating fertility as endogenous overstates the estimated impact on child mortality and would lead to misleading policy conclusions.

Diagonistic tests suggest that: first, the instruments (occurrence of a first multiple birth and use of family planning services) are strong, exogenous and valid; second, fertility is endogenous and third; a structural model approach is the best estimation strategy to assess the impact of endogenous fertility on mortality. Reduced form approaches would yield biased parameter estimates. Specifically, the Sargan and Basmann tests of over identifying restrictions reject the null hypothesis of over identification and instead suggest that the excluded instruments are valid or uncorrelated with the error term and thus correctly excluded from the estimated mortality equation. The F test for excluded instruments suggests that the instruments have a non-zero and significant joint impact on fertility. The

strength of instruments is tested by considering the impact of the instruments on fertility. The coefficients for both instruments are large, positive and significant, suggesting that they are strong instruments. Finally, the Durbin-Wu-Hausman test for exogeneity of fertility rejects the null hypothesis of exogenous fertility, suggesting that a reduced form mortality model would yield biased estimates.

To control for heterogeneity of fertility, a model of mortality with only fertility and its residuals suggest that an increase in number of children born by 1 increases the likelihood of mortality by 3%, while the residual reduces the likelihood by about 2%. Introducing other control variables yield results which are consistent with the instrumental variable results. The marginal impact of fertility and its residual are however much larger (11% and 9%) compared to a model with no other controls.

Introduction of the interaction of fertility and the residuals into the model increases the magnitude of the coefficient of fertility marginally, but reduces that of the residual marginally. The interaction term has a negative significance, but small impact on mortality. The significance of the interaction of the residual and fertility suggest the presence of heterogeneity arising from interaction of fertility with unobserved determinants of child mortality such as the biological endowment of the mother and the environment that the mother and child live in. The significant impact of the residual and the interaction term between fertility and its fitted residuals further suggest that the IV estimates are unbiased and consistent. Introduction of further controls suggest that unobserved components are mean-independent of the contraception variable, but not of the multiple birth variable.

The first stage IV regression results for instrumented fertility shows that the instruments are significant determinants of fertility. The presence of a first multiple birth is positively correlated with fertility and such a shock increases fertility by 1 child, controlling for other factors. Use of family planning services (modern contraception) has a negative significant impact on fertility. Other factors that have an important significant impact on fertility include the household assets and share of health expenditure. The results for the asset variables show that fertility declines with household welfare (Walrasian effect). The results for age of the mother at birth and mother's age/first born interaction, suggests the importance of lowering teenage pregnancies as a way of reducing fertility. Access to adequate health care (dispensaries) including health education and family planning lowers fertility. Relative to Rift valley?, Central?, Nairobi and Eastern? Provinces? have significantly lower fertility rates. Western province? has relatively higher fertility rates than Rift Valley?, ceterius paribus.

The results for rural areas are generally consistent with the full sample results. The results for urban areas however differ with those for full sample and for rural areas in terms of signs and magnitudes of coefficients. Most of the variables in the urban mortality model of the IV specification are insignificant. The mortality model with endogenous fertility shows that fertility is positively correlated with mortality for both rural and urban areas. For rural areas, treating fertility as endogenous understates the impact of fertility on mortality three folds but overstates the impact on urban mortality by about the same percentage. With

instrumentation, an increase in fertility by 1 child increases the likelihood of mortality by 5% in rural areas, but reduces the same by 2% in urban areas. The coefficient in urban areas is however insignificant.

Controlling for unobserved heterogeneity in fertility and mortality outcomes, the results are consistent with results for the IV mortality model for both rural and urban areas. Introduction of the control function approach variables increases the size of the coefficient for fertility from 0.01 to 0.06 in the rural sub-sample, while that of the urban sub-sample falls from 0.02 to 0.07. The fertility residual is negative and significant for the rural sample but positive and insignificant for the urban areas. Inclusion of the interaction term increases marginally the coefficient for fertility and its reduced form residuals for both urban and rural areas, but the interaction variable is negative and insignificant in specifications for both sub-samples. Furthermore, the sign of the coefficient for urban areas is reversed. The results suggest that heterogeneity and unobserved correlation are a problem in the rural but not in the urban sub-sample.

Results for covariates of fertility by area of residence are also consistent with those for the full sample. Occurrence of a first multiple birth is positively and significantly correlated with fertility for both rural and urban areas. The magnitude for rural areas is much higher than for the full sample and for urban areas. Cluster level usage of modern contraception has a large significant negative impact on fertility in rural areas, but is insignificant for urban areas. The two instruments however pass tests for validity of instruments, though the test statistics are weakly significant in urban areas. Consistent with the full model results, the models by area of residence also pass other diagnostic tests.

5. Conclusions and Policy Implications

This paper investigated the consequences of fertility for child health in Kenya using the 2003 Demographic and Health Survey data. The study took into account endogeneity of fertility, heterogeneity and complementarity arising from unobservable determinants of child health, which may be correlated with fertility. Reduced form models, instrumental variable methods and the control function approach are used to achieve the study objectives.

The results show that boys, older children and children of higher birth order are more likely to face mortality than their counterparts. There is therefore need for deliberate efforts to target these vulnerable groups. This can be done by educating mothers on the need to pay special attention to the health of these children, such as exclusive breast feeding and ensuring that adequate supplementation is given for older children upon cessation of breastfeeding. The results further show that maternal characteristics, more so education and age have large significant effects of reducing child mortality. These results imply that, targeting women through secondary and post secondary education would make an enormous contribution towards mortality reduction. The amount of rainfall is positively correlated with child mortality, probably due to changes in temperature and outbreak of diseases associated with variations in rainfall patterns. This finding points at the importance

of special care for children in relatively wet areas/periods to shield them from mortality causing morbidity. The number of children ever born has a positive significant impact on child mortality. This calls for intensified family panning campaigns and education of mothers on the need for smaller families as postulated by the quantity-quality of children model.

The IV results suggest that treating fertility as endogenous understates the estimated effect on child mortality. The results also show that the presence of a first multiple birth is positively correlated with fertility, while use of modern contraception has a huge fertility reducing impact. Various diagnostic tests suggest that the instruments are valid identifiers of fertility and that fertility is an endogenous predictor of child health. The coefficients for household assets suggest that fertility declines with household welfare, reflecting a Walrasian effect. This effect implies the need to target poor households through provision of basic needs and mobilization into asset/income generating activities. Availability of health care facilities and use of modern contraception are inversely correlated with fertility suggesting the importance of health care in improving women's reproductive health and also child health.

Results from various specifications and models imply that failure to control for endogeneity of fertility, heterogeneity and complemetarity that would arise from the correlation of fertility with covariates of mortality is likely to yield misleading policy prescriptions in interventions for improving reproductive health outcomes.