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**Article**

## The quantity–quality fertility–education trade-off

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# The quantity–quality fertility–education trade-off

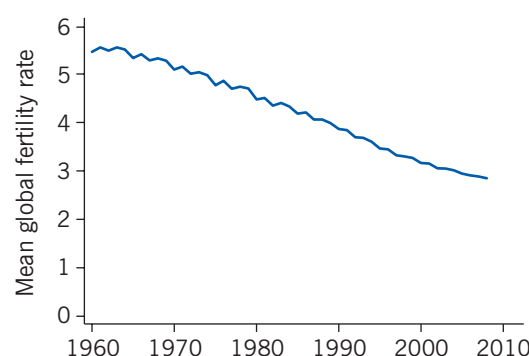
## Policies to reduce fertility in developing countries generally boost education levels, but only slightly

Keywords: demographic transition, fertility, education, child quality, quantity–quality trade-off

### ELEVATOR PITCH

At the national level, it has long been observed that a country's average education level is negatively associated with its total fertility rate. At the household level, it has also been well documented that children's education is negatively associated with the number of children in the family. Do these observations imply a causal relationship between the number of children and the average education level (the quantity–quality trade-off)? A clear answer to this question will help both policymakers and researchers evaluate the total benefit of family planning policies, both policies to lower fertility and policies to boost it.

Global fertility has fallen considerably since 1960



Source: Calculations based on data from <http://data.worldbank.org/topic>

### KEY FINDINGS

#### Pros

- + Lower fertility, or fewer children per family, is associated with more years of schooling.
- + Smaller families can invest more in each child, which boosts measures of child quality such as health, education, and cognitive ability.
- + A planned increase in a family's number of children has less impact on per child expenditures than an unplanned increase because parents can adjust their finances in anticipation of having another child.
- + In developing countries, family planning policies could raise child quality.
- + In developed countries with very low fertility rates, pro-fertility policies may not negatively affect quality.

#### Cons

- Negative correlations between the number and quality of children might reflect a spurious relationship.
- The average cost of raising children is higher for smaller families as they cannot take advantage of economies of scale, such as sharing of rooms or clothes.
- An unplanned increase in the number of children might have a strong negative effect on child quality.
- Policies to reduce fertility in order to enhance child quality might not be effective when education is heavily subsidized and the school leaving age is regulated.

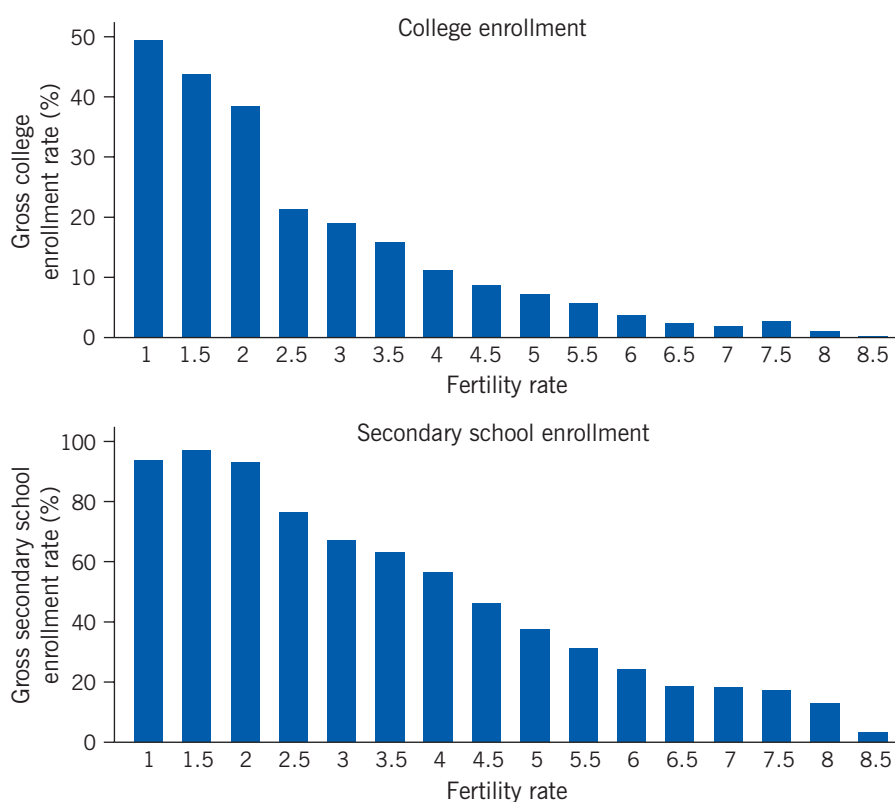
### AUTHOR'S MAIN MESSAGE

Policies aimed at reducing fertility will likely increase parents' education spending per child, particularly in developing countries that need to curb rapid population growth rates. However, while policies that encourage couples to have fewer children could stimulate parental investment in children's health and education, empirical studies find that the impact is likely to be small. In developed countries, where the policy concern is more likely to be low (below-replacement) fertility rates, policies to encourage families to have more children are unlikely to have a negative impact on child quality.

## MOTIVATION

Both college and secondary school enrollment rates are strongly and negatively correlated with fertility rates (Figure 1). For instance, Niger, with the highest fertility rate (7.57) in 2012, had a gross college enrollment rate of only 2% and a secondary school enrollment rate of just 16%. South Korea, with the lowest fertility rate (1.3%), had a gross college enrollment rate of 98% and a secondary school enrollment rate of 97%. The correlation coefficient—the degree to which changes in the value of one variable predict changes in another, with values from +1 to –1—between fertility and enrollment is –0.68 for college enrollment and –0.84 for secondary school enrollment. The question that naturally follows is whether reducing the fertility rate leads automatically to higher school enrollment rates. Answering that question is not as simple as Figure 1 would suggest, because some variables affect fertility and education simultaneously.

Figure 1. Fertility rates and school enrollment rates have a negative relationship, 1970–2009



Source: Calculations based on data from the World Bank World Development Indicator data set. Online at: <http://data.worldbank.org/topic>

## DISCUSSION OF PROS AND CONS

Countries with lower fertility rates tend to be more affluent, with higher per capita income (Figure 2). They spend more, both as a percentage of gross national income and in absolute dollar terms, on education than countries with higher fertility rates. So, it is not evident a priori whether the higher college and secondary school enrollment

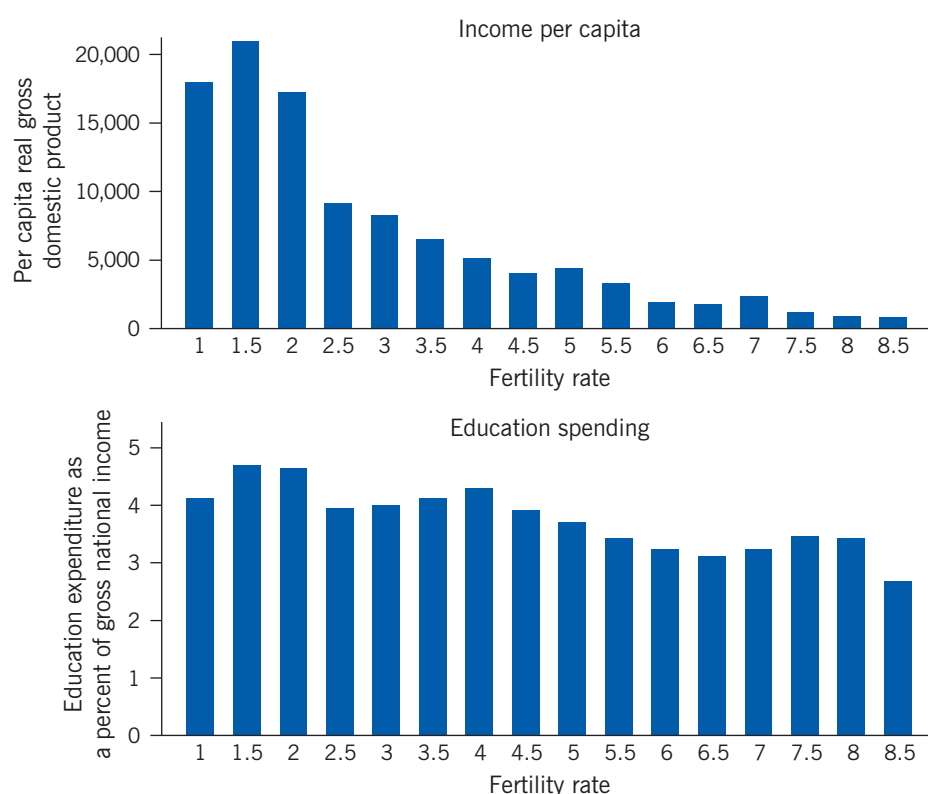
rates in high-income countries are driven by lower fertility or by national income, educational expenditure, or other factors, such as parental preferences.

To minimize the impact of differences in institutional settings across countries on the estimated relationship between the number of children and the quality of their human capital, most studies on this issue focus on individual-level data. However, even when the focus is on families living in the same country, the simple correlation between child quantity and quality does not necessarily imply a causal relationship. For instance, some parents might have a stronger preference than others for having highly educated children, and these parents may prefer to have fewer children as well. Consequently, the negative correlation between child quantity and quality could be due to a negative impact of quantity on quality, but it could also be due to differences in parental preferences about child quality. To address this issue, researchers have used variations in child quantity related to exogenous factors that should not affect quality, such as the birth of twins [1], [2], [3], [4], the gender of the first-born child [5], and the gender composition of the first two children [3], [4], [6].

## Differences in developed and developing countries

As shown in Figure 2, fertility rates are higher and educational expenditures are lower in low-income (developing) countries than in high-income (developed) countries. If

Figure 2. Fertility is negatively associated with income per capita and public education expenditure, 1970–2009



Source: Calculations based on data from the World Bank World Development Indicator data set. Online at: <http://data.worldbank.org/topic>

government spending on education is a substitute for private spending, then variations in private spending will have limited impact on children's schooling in countries where education is heavily subsidized. Since a major reason for the quantity–quality trade-off is that an increase in the number of children reduces private education spending per child, heavy public subsidies of education will weaken the quantity–quality trade-off in developed countries.

For instance, many developed countries provide not only free (compulsory) primary education, but also free school lunches to students from poor families. As a result, the direct private costs of primary education are virtually zero or even negative. In addition to government subsidies, developed countries tend to have better functioning credit markets than developing countries, which helps children from large families finance their college education. Therefore, parental resources and the number of children will have little direct impact on child education. In contrast, in many developing countries, even if there are no tuition fees for public primary schools, parents generally have to pay for textbooks, school uniforms, and school lunches, which can constitute a considerable financial burden. Therefore, it is not surprising that studies using data for developing countries tend to find a significant quantity–quality trade-off, while the findings for studies for developed countries are less conclusive.

### ***Using the birth of twins and the gender composition of children to explore variation in child quantity***

One of the most common exogenous variables (variables that mimic random assignment) used to study family size is twin births. Presumably in most cases, twin births are unanticipated, negating parents' perceived control over their preferred family size. For instance, parents who planned to have only three children would end up with four children instead if the third birth is twins. An early study that explored the exogenous variation in child quantity introduced by twin births to test the child quantity–quality trade-off theory used data from an Indian household survey conducted in 1969 and 1971 [1]. The study found that having twins increased the number of children in a family beyond the number the parents had planned on, which suggests that parents of twins cannot fully adjust the number of children in the family. The exogenous increase in family size induced by twin births led to lower educational attainment for all children in the household, though the impact was slightly weaker for non-twins.

Later studies of twin births generally focused on what impact having an additional, unplanned child had on the quality of children born before the twins rather than on the impact on all the children in the household. The twins were excluded from the analysis because twins are more likely to have lower birth weights and higher death rates than singleton children, which directly affects their educational attainment. Children born after twin births are also excluded because their education could be directly affected by the prior birth of the twins through such factors as birth spacing. Frequent births with short intervals between them, for example, are associated with low birthweight and small size for gestational age. By focusing on the impact on children born before the twins, one study for Brazil found that having an additional child had a significant and negative effect on school progression (defined as years of schooling divided by age minus six years, where six is the typical age at which children begin school) [7].

Besides twin births, the gender composition of earlier-born children can also affect the number of children [8]. Many parents want to have at least one son, and they tend to have another child if their earlier-born children are all girls. For girls aged 12–17 from indigent rural households in Mexico, having an additional sibling, whether because of the gender composition of earlier-born children or the birth of twins, has no significant impact on their primary school completion or school enrollment [8]. One possible explanation for the different outcomes in Brazil and Mexico is that in Mexico basic education is compulsory through a defined education level (lower secondary school, or roughly to age 17), while in Brazil it is compulsory based on age (to age 14, or roughly through the second stage of primary school). Presumably, parental spending would have a weaker impact on the schooling of 15-year-old children in Mexico, who are still legally required to attend school, compared with 15-year-old children in Brazil, who are not.

A limitation that is shared by all three studies discussed here is that they do not control for children's physical endowments [1], [7], [8]. Since singletons are generally heavier than their twin siblings at birth, parents might invest more in their non-twin children if investments in their children are positively correlated with children's physical endowments. The estimates analyzing outcomes of singletons only might either underestimate or overestimate the true magnitude of the quantity–quality trade-off depending on whether parental investments are positively or negatively correlated with children's endowments.

To address this issue, one study compared the estimated impacts on singletons and twins with and without controlling for birthweight, thus calculating lower and upper bounds for the magnitude of the quantity–quality trade-off [9]. Using the Chinese Child Twins Survey, the study found that parents invested more in their heavier offspring. After controlling for birth-endowment effects associated with birthweight, the study found that an extra child led to significantly reduced school progression, lowered expected college enrollment, and worsened child health. However, while adding birthweight helps to control for the impact of child endowments, it can introduce more endogeneity since birthweight might be correlated with the number of children. Having more children—or too closely spaced births—may negatively affect the mother's nutritional intake and hence her child's birthweight.

While studies using data for developing countries tend to support the quantity–quality trade-off theory, the evidence for developed countries is less supportive. Linking data from the Israeli population censuses of 1983 and 1995 with population registry data, a study found that the number of children in a household did not affect child education [3]. This conclusion held even when the study focused on a group of individuals of Asian and African origin whose fertility rates are comparable to rates in developing countries. The study also found that the estimated impact of child quantity on child quality was not sensitive to whether the variation in child quantity was due to twin births or to the sex composition of earlier-born children (parents are more likely to have a third—or more—child if their earlier-born children are all of the same gender). Another study used similar identification strategies and information on Norwegians aged 16–74 between 1986 and 2000, and who were at least 25 years old in 2000. The study found that the variation in the number of children caused by twin births did not affect the educational attainment of the first-born child [4]. These findings are consistent with those of the Israeli study [3] but are inconsistent with the results of studies for developing countries.

## First-born and later-born children

While the number of children in a family did not affect the quality of first-born Norwegian children, it had a significant negative impact on the educational attainment of second- and third-born children, an impact that was attributed to birth-order effects [4]. The confluence theory posits that a family's intellectual environment (which is positively correlated with the average mental age of parents and children within the family) deteriorates as more children are born into the family because of the lower mental development of younger children [10]. Since older (earlier-born) children grow up in a more favorable intellectual environment than their younger siblings, they tend to be better educated. Moreover, older children also have an opportunity to teach their younger siblings, which stimulates the growth of their intellectual capabilities.

Since low birth-order children are likely to have fewer siblings than high birth-order children (which implies that the child is from a large family), the observed negative correlation between children's education and their birth order could also be driven by the number of children. If this is the case, the estimated birth-order effect should disappear once the impact of child quantity is accounted for. The large sample constructed for the Norwegian study made it possible to accurately separate the impact of birth order from that of the number of children [4]. The study found that higher birth-order children always had fewer years of schooling, and the size of the difference across birth orders did not depend on the number of children in the family. The study concluded that “there is little if any family size effect on child education,” which implies that first-born children will benefit little from a decline in fertility. However, since a decline in fertility reduces the number of higher birth-order children, the average education level would still be negatively correlated with fertility at a national level.

## Planned and unplanned children

Using a comprehensive matched administrative data set of Norwegian men born between 1967 and 1998, a study found that variations in child quantity resulting from the birth of twins had a significant negative effect on the IQ scores of first-born children, while variations in the number of children motivated by parents' concern about the gender composition of earlier-born children had no significant impact on children's IQ [11]. These results suggest that the impact of child quantity on child quality depends on whether the increase in the number of children is unplanned or planned. If the increase is driven by the gender composition of earlier-born children, and therefore is planned, parents might be able to reduce family expenditures before giving birth to the additional child in order to prepare financially for the birth of another child. Therefore, having an additional child might not significantly affect expenditures per child. Moreover, having several children of the same sex at low birth orders might strengthen the economies of scale in raising children because children of the same gender can easily share clothes and rooms.

To check whether the differences between the earlier [4] and the later [11] Norwegian studies are due to the fact that the earlier studies used educational attainments while the later one used IQ as the quality measure, the later study also examined the impact of child quantity on educational attainment. Sensitivity analysis showed



that the impacts on educational attainment were similar to those on IQ. From this evidence, the authors deduced that the impacts of child quantity were stronger for the recent cohorts of Norwegian men (born between 1967 and 1998) than for the earlier cohorts (born between 1902 and 1975). Given that the findings of the earlier Norwegian study [4] were consistent with those of the Israeli study [3] that used similar identification strategies on individuals of similar birth cohorts (an average person in the Israeli study was born in the mid-1960s), it is not clear whether the evidence for recent birth cohorts in the later Norwegian study [11] can be generalized to other countries. Moreover, whether parents can adjust financially in anticipation of having an additional child and thus lessen or avoid any potential negative impact on child quality depends on whether parents have adequate resources to do so.

### Other measures of child quality

Besides examining the impact of child quantity on educational attainment, studies have also examined its impact on other measures of child quality such as anthropometric indicators (measures of the human body) and on inputs to child quality, such as educational expenditure, private school enrollment, mother's labor force participation, and child labor. The advantage of examining inputs is that these variables are directly linked to parental decisions. As one study asserts, "focusing on inputs is a more powerful test than using outcomes since inputs are one step closer to assessing the effects of family size in the causal chain" [2].

Two studies examined the impact of child quantity on anthropometric indicators, such as height-for-age and body mass index for age (an indicator of body fat) [12], [13]. These anthropometric indicators reflect children's long-term nutritional status. Because these indicators are closely related to children's mental development, mortality, and adult wages, these indicators should be strongly and positively correlated with other quality measures, making them valid quality measures in their own right. Since adult stature is largely determined during gestation and early childhood, these indicators should be more sensitive to parental decisions than education, which depends on both parental investment and children's own efforts. Another extension made by these two studies is that they analyzed the impact of child quantity on the entire distribution rather than only on the mean.

Using the 2000 Indonesia Family Life Survey, one study found that the height-for-age distribution of children with at most one sibling was different from that for children with more than one sibling [9]. For the distribution of body mass index for age, the difference between smaller and larger families is significant only at the tails of the distribution. These findings suggest that it may be wrong to reject the quantity–quality trade-off theory simply because the trade-off is not significant at the mean or for some particular quantiles.

Drawing on data from the China Health and Nutrition Survey and taking advantage of the variation in the number of children resulting from the relaxation of China's one-child policy, the second study found that an additional child had a significant negative impact on height-for-age at the mean for both boys and girls [13]. As in the Indonesia study [12], the impact was not uniform. For boys, the impact of an additional child on height-for-age was stronger among families that tend to have



shorter children. The impact declined gradually with child height and was no longer significant among families that tend to have taller children. For girls, the impact was strongest for children in median-size families and weaker for children in families that tend to have either shorter or taller children. To test whether the results are sensitive to the choice of child quality measures, the study also examined the impact of family size on educational attainment. The impact was never significant for boys, and it was significant for girls only at the mean.

A study for South Korea examined the impact of child quantity on educational expenditure [5]. In many Asian countries, parents prefer sons to daughters and therefore are more likely to have another child if the first-born child is a girl. Obviously, the gender of the first child is likely to only weakly affect the number of children if most parents want to have at least two children. However, considering Korea's low total fertility rate, the gender of the first child could have a significant effect on the number of children in a family. By exploring variations in the number of children induced by the gender of the first child, the study found that an additional child significantly reduced private education expenditure per child.

Once again exploiting the exogenous variation in child quantity induced by twin births, another study using data for the US found that having an additional child reduced the oldest child's probability of attending private school by 1.2 percentage points [2]. Having more children also reduced the mother's labor force participation and increased the probability that the parents would divorce. These findings suggest that even in wealthy countries such as the US, having an additional child could have a significant negative impact on spending on children's education. However, the study failed to find any significant negative effect on children's education as measured by grade retention (repeating a grade in school). Thus, while having more children reduces parental investment in each child, the reduction might not be large enough to generate discernable differences in child quality.

Another study, also using US data, drew a slightly different conclusion [6]. This study explored the variation in the number of children resulting from the gender composition of earlier-born children rather than twin births. For second-born boys in the US, an additional child had a significant negative effect on private school enrollment and increased the likelihood of grade retention. However, for first-born boys, the number of children did not have a significant effect on either the probability of attending private school or the probability of grade retention. One possible explanation for the difference between the first- and second-born sons is that "parents are poor planners and fail to smooth investment in children across their brood" [6]. An alternative explanation is the birth-order effect.

Yet another study, this one for Brazil, examined the variations in child quantity introduced by twin births and found that an additional child raised the labor force participation rate (working or actively looking for a job) of children aged 10–15 by 2 percentage points for boys and 1.4 percentage points for girls [7]. Under the assumption that children who work would have less time to study, and thus would accumulate less human capital, this evidence also supports the quantity–quality trade-off theory.

Thus the evidence indeed suggests that the choice of quality measure could play an important role in testing the quantity–quality trade-off theory.

## LIMITATIONS AND GAPS

Except for the two Norwegian studies [4], [11], and the Israeli study [3], which used administrative data, all the other studies used survey data. One limitation of using survey data is that researchers have information on children only if the children lived with their parents in the survey year. As older children tend to live on their own, these studies have to focus on the impacts of child quantity on the quality of relatively young children. Whether the impacts last to adulthood is still an open question, and further studies on this issue are needed.

## SUMMARY AND POLICY ADVICE

What do these seemingly conflicting results tell us about the hypothesized child quantity–quality trade-off? First, because of differences in institutional settings in different countries, the quantity–quality trade-off—if it indeed exists—is likely to take different forms. For instance, in countries like Norway, where all education, from pre-school through college, is free of charge, it is not surprising that the number of children does not affect educational attainment. However, in countries where attending even primary school is a financial burden for many families, like India in the 1960s, family size can have a significant negative impact on children’s education. In general, the trade-off is likely to be more pronounced in developing countries than in developed countries. Second, when quality is assessed by “inputs” into child quality, such as education expenditure per child or private school enrollment, or by measures that are heavily influenced by parental choice, such as child labor, the impact is likely to be significant.

Several policy implications can be drawn from these studies. First, government policies, such as increasing the availability of contraceptives, that encourage couples to have fewer children could stimulate parental investment in child health and education. Second, while a decline in fertility could boost expenditures per child on education and health care, these increases might not be big enough to generate discernable differences in child quality in developed countries. And third, in countries with very low fertility—which are much more likely to be developed countries—policies that seek to increase fertility, such as the discounted public transportation and large tax reductions for families with three or more children adopted by France, are unlikely to have any significant negative impact on child quality.

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## Competing interests

The IZA World of Labor project is committed to the *IZA Guiding Principles of Research Integrity*. The author declares to have observed these principles.

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