Nutritional Deficits and the Quantity-Quality Trade-off: Evidence from an Exogenous Fertility Shock in Low-Income Urban Settings in the Philippines

By Erika Salvador
Caroline Theoharides*

This paper examines whether increased fertility affects early-life nutritional outcomes in low-income urban households. I exploit a natural experiment created by a 1990 policy in Manila, Philippines, which banned modern contraceptives from city-run health facilities. Using a difference-in-differences framework and nationally representative data from the Philippine Demographic and Health Surveys, I estimate the reduced-form impact of the policy on child height-for-age and weight-for-height. [Will add more after data analysis]
JEL: J13, I15, O15
Keywords: fertility shocks, child nutrition, quantity-quality trade-off, urban poverty, Philippines

I. Introduction

The trade-off between child quantity and child quality is a foundational concept in the economics of the family. First articulated by Becker (1960) and extended in subsequent models of household behavior (Becker and Lewis, 1973; Becker and Tomes, 1976), this framework posits that parents allocate finite resources—both financial and non-financial—across children. An increase in fertility reduces the resources available per child and, under binding constraints, may lead to lower investments in health, education, and other forms of human capital. This mechanism has served as an explanatory model for changes in fertility behavior and the evolution of population structures in low- and middle-income countries.

Empirical investigations of the quantity–quality trade-off have focused primarily on educational outcomes. Studies in both high-income and low-income settings have examined the effects of fertility on school enrollment, grade progression, test scores, and completed years of schooling (Rosenzweig and Wolpin, 1980; Black, Devereux and Salvanes, 2005; Angrist, Lavy and Schlosser, 2010). These

* Salvador: Amherst College, esalvador28@amherst.edu. Theoharides: Amherst College, ctheoharides@amherst.edu. This research was made possible by the Schupf Fellowship at Amherst College. I am indebted to my faculty adviser, Professor Caroline Theoharides, for her mentorship and support throughout the development of this project. I also wish to thank Faculty Director Professor Amelie Hastie and the campus partners whose institutional support enabled this work. I am further grateful to the Departments of Economics and Mathematics & Statistics for their academic support. The views expressed and any errors contained herein are entirely my own responsibility.

outcomes serve as accessible proxies for long-run human capital accumulation, but they represent only one dimension of child quality. Other outcomes, such as nutritional status, are early-onset or biologically constrained. They also tend to be less responsive to remediation later in life. A child who suffers from chronic malnutrition may exhibit permanently reduced cognitive capacity and face limits in physical development that affect long-run productivity regardless of subsequent educational access (Hoddinott et al., 2013*a*; Grantham-McGregor et al., 2007).

The exclusion of nutritional outcomes from much of the empirical literature leaves an important dimension of the trade-off untested. Nutritional investments in early childhood are essential to early childhood development and long-term outcomes (Victora et al., 2008; Hoddinott et al., 2013*a*). They shape brain development, immune system functioning, and physical stature, and they have been shown to predict later-life earnings and health outcomes across a wide range of settings (Grantham-McGregor et al., 2007; Alderman, Hoddinott and Kinsey, 2006). The biological irreversibility of early-life nutritional deficits further distinguishes them from other forms of investment. Educational deficits may be partially remediable; nutritional failures often are not. A credible estimate of the trade-off between fertility and child quality must account for nutrition if it aims to assess the full set of consequences associated with fertility shocks.

This study addresses this gap by examining the nutritional effects of a localized, exogenous increase in fertility in the Philippines. In 1990, the mayor of Manila implemented an executive policy that prohibited the provision of modern contraceptives in all city-run health facilities. The order removed access to pills, condoms, intrauterine devices, and related public health materials and instructed healthcare providers to offer only natural family planning methods. This policy remained in place for nearly a decade and affected only the jurisdiction of the Manila city government. The national government did not implement a comparable restriction, and surrounding cities within Metro Manila continued to provide access to modern contraceptives. The policy thus created a spatial and temporal discontinuity in contraceptive access that was uncorrelated with underlying fertility preferences or concurrent shifts in household income or governance. As a result, the Manila ban serves as a quasi-experimental source of variation in fertility exposure among poor urban households.

I use this natural experiment to estimate the causal effect of increased fertility on child nutrition. The analysis relies on nationally representative data from multiple waves of the Philippine Demographic and Health Survey (DHS), which provide data on household structure and maternal characteristics, as well as measurements of child anthropometry. The outcomes of interest are height-for-age and weight-for-height z-scores, which serve as standardized indicators of chronic and acute malnutrition, respectively. These outcomes are widely used in the global health and development literature and capture nutritional deprivation over both long and short time horizons (Victora et al., 2008). The empirical strategy follows a difference-in-differences design that compares child outcomes in Manila and comparable urban areas before and after the onset of the policy.

The identification strategy rests on two key assumptions. First, in the absence of the contraceptive ban, nutritional trends in Manila would have evolved in parallel with those in comparison cities. Second, any other policy or economic shocks affecting Manila during the study period must not coincide precisely with the timing and scope of the contraceptive policy. I test these assumptions using falsification checks, placebo comparisons, and robustness specifications that include city-specific time trends, maternal fixed effects, and controls for baseline demographic differences.

The analysis proceeds in three stages. I first replicate existing work (Dumas and Lefranc, 2019) to confirm that the contraceptive ban led to an increase in fertility among affected women. I then estimate reduced-form effects of policy exposure on nutritional outcomes for children under five years of age. Finally, I examine heterogeneity in effects across subsamples defined by maternal education, household wealth, and access to prenatal care. These dimensions serve as proxies for household resource availability and capacity to buffer the nutritional consequences of fertility increases.

This study contributes to the literature in several important ways. It provides new evidence on how increases in fertility—caused by policy restrictions on family planning—can affect child nutrition in poor, urban communities. Most past research has focused on education, but this study expands the idea of child quality to include biological measures such as stunting and wasting. It also adds to the small number of studies that use unexpected changes in reproductive health policy to examine long-term effects on children's well-being. More broadly, the results show that local restrictions on family planning can unintentionally harm children's health, especially in settings where families already face poverty, food insecurity, and limited public services.

II. Review of Related Literature

The quantity–quality (Q–Q) theory, a central idea in modern family economics, holds that parents face a trade-off between the number of children and the "quality" of investment—such as education or health—they can provide to each. Quality in this context refers to the human capital of each child: attributes like education, health, and nutrition that enhance a child's future productivity and well-being. The genesis of this idea traces back to Gary Becker's seminal work around 1960, which for the first time treated children as economic goods subject to parental choice and budget constraints (Becker, 1960). Becker argued that as families become wealthier, they may not simply want more children, but rather better-raised children, much as a household might prefer a higher-quality car or house over a greater quantity of them. This proposition led to a formal theory in which increases in income or changes in economic conditions cause parents to substitute child quality for quantity, consistent with historical patterns of lower fertility and higher educational attainment during economic development (Galor and Weil, 2000).

In what follows, I review the theoretical foundations of the Q-Q model and its evolution in the literature. I begin with the static models of Becker (Becker, 1960) and Becker–Lewis (Becker and Lewis, 1973), which first formalized the trade-off within a household utility maximization framework. We then examine extensions to dynamic, intergenerational settings, including the contributions of Becker and Tomes (Becker and Tomes, 1976) on child endowments and the altruistic dynastic model associated with Barro and Becker (Barro and Becker, 1989). Next, I turn to macroeconomic and unified growth models, notably Galor and Weil (Galor and Weil, 2000) and Galor and Moav (Galor and Moav, 2002), which integrate the Q–Q mechanism into a general theory of demographic and economic transformation.

Finally, I discuss more recent refinements that enrich the basic model by incorporating credit constraints (Doepke, 2004), intra-household bargaining (Doepke and Kindermann, 2019), and multi-dimensional child quality (Hoddinott et al., 2013*b*; Kalemli-Ozcan, 2002), with a special emphasis on health and nutrition. My focus is on how the Q–Q framework has been applied to understand fertility and child investment patterns, especially in developing country contexts where resource constraints and health outcomes are paramount.

A. *Theoretical Background*

Becker's early work introduced an economic approach to fertility, treating children analogous to "durable goods" that yield utility to parents but come at a cost (Doepke, 2015). In Becker's 1960 model, a household derives satisfaction from the number of children (n) and from the quality of each child (q), alongside conventional consumption of other goods (y). A simple representation is a utility function:

$$U = U(n, q, y),$$

with U increasing in each argument up to some satiation point. Here quality q can be thought of as the expenditure or investment per child (e.g. education spending, health care, nutrition), assumed for now to be the same for each child. Parents face a budget constraint that links quantity and quality: raising more children dilutes the resources available per child. A prototypical budget constraint (in static form) can be written as:

$$p_y y + p_n n + p_q n q = I,$$

where I is total family income (or full income), p_n represents baseline, non-discretionary costs associated with each additional child (e.g. expenditures on food, shelter, or clothing that are incurred irrespective of quality-enhancing investments), and p_q denotes the marginal cost of investing in one unit of quality per child.The term $p_q n q$ captures total expenditure on quality for all children and is linear in n. As the number of children rises, parents must extend any chosen level of q across a broader base, which amplifies the total cost of quality. Conversely, the term $p_n n$ implies that the cost of an additional child rises with the quality level q already chosen, since each child must meet a higher standard of care or investment. For instance, a household that chooses to provide more education or better health care per child incurs an additional burden when it expands family size, as each child must receive the same enhanced level of investment. Similarly, a larger family increases the cumulative cost of quality, even if q remains fixed, due to the need to replicate expenditures across more children. In short, the shadow price of child quality increases with n, and the shadow price of child quantity increases with q. The cost structure induces a mutual dependence between quantity and quality, such that any adjustment along one dimension alters the effective cost of the other.

Becker and Lewis (1973) formalize the mutually reinforcing nature of the quantity–quality cost structure. An increase in n raises the total cost required to sustain a given level of q for each child, while a higher level of q raises the marginal cost associated with having an additional child. For example, allocating more resources to education or health per child increases the financial burden of expanding family size. This interdependence links the two decisions directly. The household cannot choose n and q in isolation; each choice alters the marginal cost of the other.

Mathematically, the trade-off appears in the first-order conditions of the household's optimization problem. Let λ represent the Lagrange multiplier on the full-income constraint.

$$\mathcal{L} = U(n, q, y) + \lambda \left(I - p_y y - p_n n - p_q n q \right).$$

The first-order conditions are:

$$\frac{\partial \mathcal{L}}{\partial n} = U_n - \lambda(p_n + p_q q) = 0, \quad \frac{\partial \mathcal{L}}{\partial q} = U_q - \lambda p_q n = 0, \quad \frac{\partial \mathcal{L}}{\partial y} = U_y - \lambda p_y = 0.$$

Combining the first two yields:

$$\frac{U_n}{U_q} = \frac{p_n + p_q q}{p_q n}.$$

This condition equates the marginal rate of substitution between quantity and quality to the ratio of their full marginal costs. The numerator rises with q, and the denominator rises with n. As one choice increases, the relative cost of the other becomes higher. This relationship induces substitution toward the less costly dimension. The trade-off between quantity and quality arises from the structure of the budget itself. It does not rely on specific assumptions about utility curvature or intrinsic substitutability (Becker and Lewis, 1973).

This formulation implies two core predictions. Firstly, although both child quantity and child quality may rise with income, the household's budget constraint can generate a negative relationship between income and fertility. As income increases, total spending on children tends to rise, but the allocation often favors quality over quantity. Becker illustrated this with the analogy of durable goods: wealthier households tend to upgrade the quality of a house or a car rather than acquire additional units. In a similar way, higher-income families often direct additional resources toward education, nutrition, or health per child. Within the model, an income increase ($\mathrm{d}I > 0$) produces a direct effect that makes children more affordable and an indirect effect that discourages fertility. As q rises, the shadow price of an additional child also rises. If the marginal utility from higher quality exceeds that from larger family size, then the substitution effect outweighs the income effect, leading to a lower optimal n. This mechanism offers a structural explanation for the demographic transition: fertility tends to fall as households become richer, even when preferences remain unchanged.

Furthermore, a similar logic applies to changes in the cost parameters p_q and p_n. A decline in p_q, such as through a policy that lowers the price of education or health care, increases q and raises the marginal cost of quantity. This effect reduces optimal fertility. A rise in p_n, which may reflect higher child-rearing costs or a greater opportunity cost of parental time, reduces the appeal of larger families and can shift resources toward child quality. These outcomes follow from the structure of the budget constraint, without requiring any explicit preference for quality over quantity. Becker and Lewis noted that these comparative static results align with observed patterns. For example, increases in women's wages often reduce fertility more than they reduce educational spending per child. This asymmetry reflects the model's central feature: quantity and quality are linked through their cost structure. An increase in one raises the marginal cost of the other. The model explains how households make trade-offs between the number of children and investments in each.

While the early Q–Q models were static (one-period) representations, subsequent contributions extended the framework to consider fertility and child investment over multiple periods or even multiple generations. A central development in this literature was the incorporation of intergenerational human capital dynamics, where parents derive utility not only from the number and quality of children in the present, but also from the long-run outcomes of their offspring. These extensions allowed child quality to evolve endogenously across time, rather than being determined solely within a single period.

REFERENCES

Alderman, Harold, John Hoddinott, and Bill Kinsey. 2006. "Long Run Returns to Early Childhood Nutrition." *World Bank Economic Review*, 20(1): 97–118.

Angrist, Joshua D., Victor Lavy, and Analia Schlosser. 2010. "Multiple Experiments for the Causal Link Between the Quantity and Quality of Children." *Journal of Labor Economics*, 28(4): 773–823.

Barro, Robert J, and Gary S Becker. 1989. "Fertility choice in a model of economic growth." *Econometrica: Journal of the Econometric Society*, 481–501.

Becker, Gary S. 1960. "An Economic Analysis of Fertility." *Demographic and Economic Change in Developed Countries*, 209–240.

Becker, Gary S, and H Gregg Lewis. 1973. "On the interaction between the quantity and quality of children." *Journal of Political Economy*, 81(2, Part 2): S279–S288.

Becker, Gary S, and Nigel Tomes. 1976. "Child endowments and the quantity and quality of children." *Journal of Political Economy*, 84(4, Part 2): S143–S162.

Black, Sandra E., Paul J. Devereux, and Kjell G. Salvanes. 2005. "The More the Merrier? The Effect of Family Size and Birth Order on Children's Education." *Quarterly Journal of Economics*, 120(2): 669–700.

Doepke, Matthias. 2004. "Accounting for fertility decline during the transition to growth." *Journal of Economic Growth*, 9: 347–383.

Doepke, Matthias. 2015. "Gary Becker on the quantity and quality of children." *Journal of Demographic Economics*, 81(1): 59–66.

Doepke, Matthias, and Fabian Kindermann. 2019. "Bargaining over babies: Theory, evidence, and policy implications." *American Economic Review*, 109(9): 3264–3306.

Dumas, Christelle, and Arnaud Lefranc. 2019. ""Sex in Marriage Is a Divine Gift"? Evidence on the Quantity-Quality Trade-off from the Manila Contraceptive Ban." *The World Bank Economic Review*, 33(1): 259–285.

Galor, Oded, and David N Weil. 2000. "Population, technology, and growth: From Malthusian stagnation to the demographic transition and beyond." *American Economic Review*, 90(4): 806–828.

Galor, Oded, and Omer Moav. 2002. "Natural selection and the origin of economic growth." *The Quarterly Journal of Economics*, 117(4): 1133–1191.

Grantham-McGregor, Sally, Y.B. Cheung, Santiago Cueto, Paul Glewwe, Linda Richter, and Barbara Strupp. 2007. "Developmental Potential in the First 5 Years for Children in Developing Countries." *The Lancet*, 369(9555): 60–70.

Hoddinott, John, Harold Alderman, Jere R. Behrman, Lawrence Haddad, and Susan Horton. 2013*a*. "Adult Consequences of Growth Failure in Early Childhood." *American Journal of Clinical Nutrition*, 98(5): 1170–1178.

Hoddinott, John, Harold Alderman, Jere R Behrman, Lawrence Haddad, and Susan Horton. 2013*b*. "The economic rationale for investing in stunting reduction." *Maternal & Child Nutrition*, 9: 69–82.

Kalemli-Ozcan, Sebnem. 2002. "Does the mortality decline promote economic growth?" *Journal of Economic Growth*, 7: 411–439.

Rosenzweig, Mark R., and Kenneth I. Wolpin. 1980. "Testing the Quantity-Quality Fertility Model: The Use of Twins as a Natural Experiment." *Econometrica*, 48(1): 227–240.

Victora, Cesar G., Linda Adair, Caroline Fall, Pedro C. Hallal, Reynaldo Martorell, Linda Richter, and Harshpal Sachdev. 2008. "Maternal and Child Undernutrition: Consequences for Adult Health and Human Capital." *The Lancet*, 371(9609): 340–357.

% The appendix command is issued once, prior to all appendices, if any.

Mathematical Appendix