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

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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]
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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

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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. The literature review focuses 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 Static Model

Becker's early work introduced an economic model of fertility and treated children as durable goods that provide utility to parents but impose costs (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.

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

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.

Intergenerational Models: Altruism and Child Endowments

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. The main 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.

One of the earliest and most influential models of this kind was proposed by Becker and Tomes (1976). In their formulation, each child enters the world with an exogenous endowment E, which may reflect factors such as cognitive ability (e.g., measured IQ or language acquisition speed), early health status (e.g., birth weight or incidence of neonatal complications), genetic predispositions (e.g., risk for chronic illness, temperament, or neurodevelopmental traits), or family background characteristics (e.g., parental education, household stability, or neighborhood conditions). Furthermore, parents can augment this endowment by investing resources q in the form of education, nutrition, and other quality-enhancing inputs. The effective adult human capital of the child might be expressed as $H = E + f(q)$ (in a simple additive form) or a multiplicative variant $H = E \cdot f(q)$, where $f(q)$ is an increasing concave function of parental investment.

Becker and Tomes (1976) emphasized that variation in endowments E can shape how parents allocate investments q across children. When the productivity of investment increases with endowment, parents may concentrate resources on children with higher E, who are more likely to convert additional investment into future success. In other cases, parents may attempt to compensate for lower endowments by directing greater investment toward disadvantaged children. Put simply, child-specific variation in initial conditions affects not only outcomes but also strategic parental choices. Because of this, the relationship between income and the demand for child quality is not uniform. The income elasticity of demand for quality may differ across households, depending on the distribution of endowments within the family and across the broader population.

Furthermore, Becker and Tomes (1976) showed that at low income levels, much of what constitutes child quality comes from exogenous endowments, i.e., factors like public education, neighborhood environment, or access to basic healthcare that are not privately purchased. In these settings, small increases in parental income may not lead to significant changes in fertility or investment behavior. Since most of the child's future outcomes are determined by the fixed endowment component, marginal investment plays a smaller role. However, as income rises, private resources become a larger part of what determines quality, and the classic Q–Q trade-off begins to shape behavior. Parents begin to allocate more income toward fewer children in order to enhance quality through direct investment. Under certain theoretical conditions, such as equal utility elasticities for quantity and quality, this framework produces a non-monotonic relationship between income and fertility. Fertility may decline as income rises at first, which reflects the desire to invest more intensively per child. However, beyond some point, once the marginal return to investment begins to flatten or saturate relative to the fixed endowment, fertility may increase again.

The U-shaped prediction emerges only under specific assumptions, and its validity depends on both the shape of the utility function and how endowments relate to parental background. More broadly, Becker and Tomes (1976) enriched the Q–Q framework by incorporating elements that reflect real-world variation. They argued that not all differences in child outcomes are the result of deliberate parental choice. Random factors, biological traits, and socioeconomic settings play a role. In this light, public policies, such as subsidized schooling, early childhood programs, or universal healthcare, can influence private fertility and investment decisions by shifting the effective value of E across the population. If government programs raise the floor for child endowments, then even low-income parents can achieve better outcomes without large private sacrifices. These policy-induced shifts in E alter the perceived return to having more children or investing more per child.

Becker and Tomes (1976) also considered the possibility that endowment is not randomly assigned but may vary systematically with income. Higher-income households may produce children with higher E due to better maternal nutrition, access to prenatal care, lower exposure to environmental risk, or assortative matching on traits associated with educational or occupational success. In these families, not only are the resources available for investment greater, but the potential gains from investment may also be higher, because children are better positioned to benefit from those inputs. This interaction deepens the divide between high- and low-income households, making it harder for disadvantaged families to catch up. As a result, inequality can persist or even widen across generations.

Finally, the model provides a mechanism for understanding how imperfections in credit markets can lead to persistent disadvantages. If parents with low income and low-E children cannot borrow to finance quality-enhancing investment, then the next generation begins life with the same disadvantage. Without external intervention or structural change, this loop continues, which results in a pattern where poor families remain poor and rich families accumulate further advantage. The Becker-Tomes framework thus connects household-level decisions to bigger questions about the intergenerational transmission of human capital.

Parallel to Becker and Tomes's static analysis of endowments, another strand of the literature developed a fully dynamic version of the Q-Q model by incorporating parental altruism toward children's welfare. In this framework, introduced by Barro and Becker (1989), parents care not only about the number and quality of their children but also about the utility their descendants will enjoy in the future. Altruism in this context means that parents treat their children's utility as part of their own, thus extending the household's objective across generations. For example, a parent may reduce personal consumption to pay for a child's schooling, motivated not just by the child's immediate benefit but by the satisfaction the parent gains from the child's long-term success. This leads to a formulation of dynastic utility, where the household's objective spans infinitely many periods and takes the form of a recursive altruistic structure. A representative formulation is

$$U_0 = \sum_{t=0}^{\infty} \beta^t \, u(c_t, n_t),$$

where c_t denotes the consumption of the t-th generation, n_t the number of children, and $\beta \in (0,1)$ the intertemporal discount factor. Given this structure, having an extra child n_t enters utility positively, but each child is assumed to receive the same utility as the parent if raised at a comparable standard of living. As a result, parents confront an intertemporal trade-off: having more children expands the number of future utility streams but also stretches current resources, since each child requires support. This trade-off gives rise to an Euler equation for optimal fertility choice, analogous to an optimal growth condition.

An implication of the dynastic model is that fertility decisions are sensitive to macroeconomic conditions, such as the interest rate or the rate of return on capital. A rise in interest rates increases the opportunity cost of channeling resources into children rather than saving, which tends to reduce current fertility—a substitution effect across generations. At the same time, higher returns make future generations wealthier, and this anticipated prosperity enters the utility calculations of parents in more complex ways. Barro and Becker (1989) demonstrated that the model can account for observed fertility responses to economic fluctuations and policy interventions It can also explain historical phenomena such as postwar baby booms and subsequent fertility declines through shifts in returns or labor-market opportunities.

In many dynastic models, child quality appears indirectly, often through the child's future human capital or income. One variant assumes parents value the aggregate human-capital stock of their children. This specification, combined with altruism, produces a similar trade-off: concentrating resources in fewer children raises each child's human capital, which raises the dynasty's long-run welfare. These intergenerational extensions link micro-level fertility decisions to macroeconomic outcomes. By the late 1980s, work by Becker, Barro, and others had recast fertility as an endogenous choice that interacts with capital accumulation, income distribution, and policy. This laid the foundation for unified growth theories, which view the quantity–quality mechanism as central to demographic transition and long-run development.

Unified Growth Models

The unified growth theory, developed in the late 1990s and 2000s (notably by Oded Galor and co-authors), seeks to explain in one framework the entire sweep of economic development – from Malthusian stagnation, through the demographic transition, to modern growth. A central puzzle it addresses is why fertility rates, which were historically high and invariant to income in the Malthusian era, began to decline sharply in tandem with industrialization and rising incomes, eventually stabilizing at much lower levels in developed economies. The Q–Q trade-off provides a key part of the answer in these models. Galor and Weil (2000) and Galor and Moav (2002) explicitly incorporate parental choices about the quantity and quality of children and show how changes in the economic environment alter those choices and trigger demographic transitions.

In Galor and Weil (2000)'s model, for instance, technological progress gradually increases the return to human capital, especially in skilled occupations. In the early stages, when production relies on basic tools and techniques, unskilled labor holds more value. Under these conditions, parents have little reason to invest in formal schooling. Children are expected to contribute economically through agricultural work, domestic tasks, or low-skill jobs in workshops and factories. Fertility remains high because children impose a low financial burden and generate immediate returns. As technology becomes more advanced—such as during the Industrial Revolution—the earnings gap between skilled and unskilled labor widens. Education begins to offer significant advantages in the labor market. In response, parents adjust by having fewer children and placing greater emphasis on each child's development, including school attendance and better health care.

Evidently, industrialization raises the economic value of skilled labor, which alters household incentives. As returns to education increase, parents begin to favor investments in child quality over child quantity. This shift results in declining fertility because families choose to have fewer children and allocate more resources to each. The feedback effect is significant: higher educational investment raises productivity in the next generation, which in turn accelerates technological advancement and further increases the returns to human capital. Over time, the economy moves from a state of high fertility and low growth to one characterized by low fertility and sustained growth.

Furthermore, Galor and Moav (2002) introduced an evolutionary refinement to the unified growth framework by accounting for heterogeneity in parental preferences. During the Malthusian period, some families placed greater emphasis on child quality, such as education, while others prioritized quantity. In a stagnant economy with limited returns to education, high-fertility lineages maintained a numerical advantage and suppressed average human capital. As technological progress increased the returns to education, families that valued quality gained an economic edge. Their children acquired more human capital and achieved higher income and survival rates. These advantages allowed such families to grow in relative size. Over time, this process resembled a form of evolutionary selection, gradually favoring quality-oriented parental types and shifting the population toward greater emphasis on child human capital. These dynamics strengthened the shift from high-fertility, low-education regimes to low-fertility, high-investment family structures. In formal overlapping-generations models, Galor and Moav (2002) demonstrate that this evolutionary adaptation accelerates the demographic transition. Their framework accounts for the rapid and widespread drop in fertility once it takes effect. Higher returns to human capital push parents to favor quality, while preferences for quality begin to dominate within the population. These forces support the emergence of a low-fertility, high-investment equilibrium and establish a unified explanation for both economic development and demographic change.

Importantly, unified growth models identify several complementary mechanisms that reinforce the basic Q–Q trade-off during development. One is the decline of child labor. As the economy modernizes, the value of child labor falls, both because legal reforms often restrict child labor and because parents realize the earnings their children could make as unskilled laborers are paltry compared to the potential returns if those children instead spend time in school. Hazan and Berdugo (2002) formally show that when child labor becomes less profitable relative to adult (skilled) labor, parents further reduce fertility and invest more in each child's education. Historical evidence from England, for instance, indicates that during industrialization the wages of children (relative to adults) dropped significantly, especially in skilled families, and this was accompanied by parents pulling children out of work to send them to school. Galor and Moav (2006) even argue that capitalist industrialists supported public education laws and child labor bans as a way to increase the human capital of the workforce, inadvertently hastening the fertility transition.

Another mechanism is the rise in life expectancy and child survival. Improvements in sanitation, nutrition, and medical knowledge in developing societies led to more children surviving to adulthood. While the earliest unified growth models treated mortality as exogenous or ignored it, later research demonstrated that declining child mortality can trigger lower fertility as well– parents no longer need "extra" births for insurance once they are confident their existing children will survive. In other words, increased child survival and the quality–quantity trade-off are complementary explanations for fertility decline that operate in tandem. When fewer births are lost to disease, parents can achieve a desired number of surviving offspring with fewer total births, and they tend to reallocate effort into each child's health and education.

The overall effect is a reinforcing cycle: better health raises the returns to schooling (healthier children can learn more effectively and have longer working lives), which further encourages educational investments and reduces fertility. Indeed, Galor notes that human capital should be interpreted broadly to include health as well as schooling; in unified growth theory, improvements in nutrition and physical well-being were crucial to making labor more productive and thus were part and parcel of the rise in demand for human capital.

The unified growth literature places the Q–Q model within a more general account of economic and demographic change. In this framework, higher income or stronger returns to child quality reduce fertility and help shift economies from stagnation toward sustained growth. Several mechanisms support this transition, such as a fall in child labor, a drop in child mortality, and a shift in parental priorities. These models explain not only the presence of a quantity–quality trade-off but also its rising influence at a specific point in history. The evidence supports these claims: countries that saw earlier increases in returns to education experienced earlier fertility decline, while delays in reforms, such as public education or health access, corresponded to prolonged high fertility. As a result, the Q–Q mechanism forms a key component of unified growth theory.

B. Recent Refinements to the Q-Q Model

Contemporary research has further refined the quantity–quality model by relaxing some of its initial simplifying assumptions. Three important extensions involve (1) capital market imperfections that constrain parents' ability to invest in child quality, (2) intra-household conflict and bargaining between mothers and fathers over fertility choices, and (3) recognition that child quality is multi-dimensional, which extends beyond schooling to include health, nutrition, and other facets of human capital.

To begin, I examine how credit constraints can give rise to poverty traps. The canonical quantity–quality (Q–Q) framework assumes that parents can reallocate resources freely; borrowing against future earnings to finance schooling or health investments whenever the expected return is high. In practice, especially in low-income settings, credit markets function imperfectly: poor households typically cannot secure loans to cover children's education or medical costs even when such investments would yield substantial future gains. This market failure magnifies the Q–Q trade-off. Becker, Lewis, and Willis–already noted by Grawe (2008) as emphasizing "resource limitations"–implicitly recognized this issue, but contemporary models make it explicit by imposing a borrowing constraint. Parents must fund childrearing from current income alone; they cannot collateralize a child's future wages to pay today's school fees. Consequently, when income is low, each additional birth directly reduces the attainable quality per child, potentially trapping families in a low-income–high-fertility equilibrium.

Formal models show that "the quality–quantity trade-off arises from a binding credit constraint that prevents parents from borrowing against future child income." Empirical work supports this mechanism. Kremer and Chen (2002) and De La Croix and Doepke (2003) document that countries facing tighter liquidity constraints tend to display higher fertility and lower educational attainment, consistent with liquidity-constrained parents favoring quantity over quality. Cross-country evidence likewise indicates that where financial frictions are more severe, the negative correlation between fertility and schooling is stronger. Theoretically, introducing a borrowing limit can generate multiple steady states: one with low fertility and high investment when incomes suffice to cover quality costs, and another with high fertility and minimal investment when they do not. Policy instruments such as education subsidies or conditional cash transfers effectively relax these constraints, which nudge households toward the low-fertility, high-investment equilibrium. In short, incorporating credit market imperfections deepens the explanatory power of the Q-Q model: economic growth alone may not reduce fertility if households remain too cash-poor to afford schooling, whereas targeted quality-enhancing transfers can catalyze both demographic and human-capital transitions.

A further refinement of the quantity–quality (Q–Q) model considers the question of *who* within the household makes fertility and child investment decisions. The original Beckerian framework adopts a unitary model of the family, and assumes a single utility function and complete agreement between spouses over optimal fertility n and child quality q. In practice, however, empirical evidence reveals significant heterogeneity in preferences between household members along gender lines. According to Oppenheim Mason (1987); Thomas (1990), for instance, men often desire more children than women and may differ in their willingness to invest in each child's education or health. These discrepancies have motivated gametheoretic models of intra-household bargaining, in which fertility and investment outcomes reflect the relative influence of each parent's preferences.

In such models, the mother is typically assumed to have a stronger preference for child quality—such as health and schooling—while the father may favor either more children or alternative uses of household resources. The resolution of these conflicting preferences depends on bargaining power, which can be shaped by income contributions, legal rights, cultural norms, or access to external resources. When the mother's bargaining power increases, theoretical models predict a shift toward lower fertility and higher per-child investment, holding other factors constant. This prediction is consistent with empirical findings: Iyigun and Walsh (2007); Doepke and Kindermann (2019) show that greater female empowerment—via education or labor force participation—correlates with reduced fertility and increased investment in child human capital.

Mathematically, the household's first-order condition for fertility in a bargaining model can be written as:

$$\alpha\frac{\partial U_{\text{wife}}}{\partial n} + (1-\alpha)\frac{\partial U_{\text{husband}}}{\partial n} = \lambda(p_n + p_q q),$$

with a corresponding condition for q. Here, $\alpha \in [0, 1]$ represents the wife's bargaining weight. When α increases, the composite marginal utility of additional children typically decreases—especially if the wife prefers fewer children—leading to lower equilibrium fertility and a shift along the Q–Q frontier toward higher quality.

Recent work also explores dynamic bargaining, in which spouses negotiate sequential decisions over time, potentially leading to strategic behavior (e.g., one partner may accelerate or delay subsequent births). Although these models introduce complexity, their core implication for the Q–Q framework is clear: household power dynamics fundamentally shape the trade-off between child quantity and quality. In societies where women have limited decision-making autonomy—due to lack of access to contraception, or social norms—fertility tends to remain high and per-child investment low, which stalls demographic transition. Conversely, when women gain bargaining power—through legal reforms, labor market participation, or targeted transfers—the household often reallocates resources toward fewer but higher-quality children.

This theoretical insight is corroborated by policy experiments. For instance, cash transfer programs directed to mothers consistently lead to greater spending on children's health, education, and nutrition compared to equivalent transfers given to fathers (Duflo, 2003; Thomas, 1990) . Such outcomes support the hypothesis that mothers place higher weight on child quality, and that who controls the purse strings matters deeply. In sum, introducing intra-household bargaining into the Q–Q model enriches its explanatory scope: it highlights how family structure and power asymmetries—not just income levels or prices—generate variation in fertility and human capital outcomes across and within societies.

C. Health and Nutrition in the Q–Q Model

The original Q–Q models often used a single catch-all variable for child quality, typically thought of as education or "expenditure per child." Recent work emphasizes that child quality is multi-faceted, and that parents make trade-offs along several dimensions of investment—cognitive development, health, nutrition, etc. This is particularly salient in developing countries, where basic health and nutrition are pressing concerns alongside schooling.

The theoretical question is how these dimensions interact with the quantity decision. If parents allocate a budget across, say, schooling q_{edu} and nutrition/health q_{health} for each child, then having more children forces cutbacks in both dimensions (unless parents reallocate across them). In some models, health and education are complementary: a healthier child benefits more from education, and an educated mother might raise a healthier child. This complementarity can amplify the Q–Q trade-off—investing in one dimension (health) increases the returns to investing in the other (education), so a high-quality strategy becomes more focused on fewer children.

On the other hand, if one dimension has diminishing returns more quickly than another, parents might prioritize achieving a threshold level of health for all children before adding more education, which creates a nonlinear effect on fertility. One especially important aspect of health in the Q–Q framework is child survival. The probability that a child survives to adulthood effectively multiplies the utility of having that child. Historically, high child mortality led to a strategy of "quantity for insurance," where parents had additional births to ensure survivorship. As mortality falls due to public health improvements, parents can shift toward quality without risking childlessness (Kalemli-Ozcan, 2002; Kalemli-Ozcan, Ryder and Weil, 2000).

Kalemli-Ozcan (2002) developed a stochastic model in which fertility choices are made under uncertainty about child survival. Her results show that declining mortality causally reduces fertility and increases educational investment per child, in line with the Q–Q trade-off. In unified growth models, declining child mortality reinforces the demand-for-human-capital channel of the demographic transition (Galor and Moav, 2004).

Beyond survival, nutritional status is a critical indicator of quality in many low-income settings. Parents often face choices about how to allocate food or medical care, especially under resource scarcity. Empirical evidence supports the Q–Q model in this context: children with many siblings often exhibit poorer nutritional outcomes. A recent study using Vietnam Young Lives data finds that an additional sibling reduces height-for-age and weight-for-age z-scores by about 0.3 standard deviations on average (Chen, 2021) This effect is substantial, suggesting that children in larger families tend to be shorter and lighter than their peers from smaller families, likely due to the more limited distribution of healthcare and parental attention

Similar patterns emerge in sub-Saharan Africa (Bishwakarma and Villa, 2019) and South Asia , where first-born children experience slower growth once younger siblings arrive—again pointing to intrahousehold trade-offs. Theoretically, one can extend the Becker model with a nutrition production function, where a child's health H depends on food F and medical care M, such that:

$$H = g(F, M)$$

and H enters either utility directly or the child's future productivity. Parents then choose n, F, M, and possibly schooling per child. Larger n reduces F and M per child, lowering H; if parents place high value on H, or if H enhances returns to education, they will opt for smaller families.

Importantly, improvements in nutrition (through income growth or public programs) can first lead to both better health and higher fertility (since healthier women can bear more children). But over time, as standards of living rise, better nutrition increases the returns to investing in fewer, healthier children. Economic historian Fogel (1994) argues that Europe's demographic transition was partly driven by better diets: improved nutrition raised the productivity of educated workers, which made education more valuable and shifted family preferences toward quality.

These propositions are important for modern development policy. Family planning programs that encourage lower fertility without improving child health and education may have limited long-term effects. Conversely, health and nutrition interventions—such as vaccinations or food supplementation—can enhance the returns to education and induce parents to reduce fertility voluntarily. The extended Q–Q framework thus serves as a unifying tool to understand how diverse interventions—ranging from school fees to nutrition programs—shape long-run development trajectories.

D. *Philippine Evidence on the Q–Q Trade-off*

Early empirical work in the Philippines provided suggestive support for this theory. For example, an influential study by Horton (1986) used Philippine household data to jointly examine fertility and child nutrition and treated nutritional status as a measure of child quality. Horton found that better-educated mothers and fathers tended to choose smaller families and achieved better-nourished children–evidence of substitution away from "quantity" toward child "quality." Notably, she observed strong birth-order effects on nutrition (first-born children faring better than later-born), which hint that parents may not evenly distribute quality investments among all children. This early work indicated a quantity–quality (Q–Q) trade-off in Philippine families, though it largely documented correlations rather than definitive causation.

Subsequent studies in the Philippines have tackled the critical issue of causality, using innovative research designs to isolate exogenous changes in family size. One seminal contribution is Orbeta Jr (2010), who examined the impact of family size on children's schooling using a nationally representative survey. Recognizing that family size is endogenous (parents' fertility choices may reflect unobserved preferences or constraints), Orbeta employed an instrumental-variable (IV) approach grounded in Becker's framework. Specifically, he used the sex composition of the first two children as an instrument for having additional children – an approach pioneered by Angrist and Evans (1996) – leveraging the fact that Filipino parents often desire a mixed-gender sibset (and are more likely to have a third child if the first two are the same sex) (Vicerra and Cruz, 2013). This strategy aims to generate random-like variation in family size uncorrelated with parental characteristics.

The IV estimates confirmed a significant negative causal effect of higher fertility on educational outcomes. Orbeta Jr (2010) found that each additional child in the household reduced the proportion of school-age children (6–24 years) attending school by roughly 19% of the baseline attendance rate. The trade-off was especially pronounced at higher education levels: for example, the estimated drop in school attendance was about 26% at the secondary level and 57% at the tertiary level for each additional sibling. These are sizable effects, implying that children from large families are substantially less likely to remain in school, presumably due to tighter household budget constraints or diluted parental attention. Moreover, the burden of the trade-off appeared regressive: Orbeta's results showed much larger schooling deficits from an extra child in poorer households than in richer ones. For instance, in the poorest quintile, an additional sibling reduced school attendance by an estimated 24% (for ages 6–24), compared to a 16% reduction in the richest quintile. This regressive pattern aligns with Becker's theory that resource constraints bind more tightly for low-income families, which makes the Q–Q trade-off more acute. In summary, Orbeta's study – the first in the Philippines to account for fertility endogeneity – provides robust evidence that increases in family size cause significant declines in child educational attainment and validates the quantity–quality trade-off in this context. Large family size thus emerges as one mechanism contributing to poverty, by impeding children's human capital accumulation in the Philippines.

Further compelling evidence comes from a natural experiment studied by Dumas and Lefranc (2019). They exploit a unique policy shock in metropolitan Manila to identify the trade-off. In 1998, the Mayor of Manila city imposed a sudden ban on modern contraceptives in public facilities, drastically curtailing access to family planning for residents of Manila city (but not in surrounding municipalities). Dumas and Lefranc use this policy as a quasi-experiment: comparing families in Manila city (treated by the ban) to similar families in other cities unaffected by the ban before and after 1998. This difference-in-differences design, coupled with the fact that older mothers were naturally less fecund during the ban, isolates an exogenous fertility increase.

The results are striking. The contraceptives ban led to a significant rise in births and family size in Manila city relative to the control areas. Correspondingly, children born in Manila during the ban era experienced a sizable decline in educational attainment – clear evidence of a Q–Q trade-off precipitated by the shock. In the authors' words, the policy-driven increase in family size "provide[s] evidence of a quality–quantity trade-off": larger families, forced by the ban, resulted in lower schooling outcomes per child. By leveraging an actual anti-contraception policy, this study offers causal confirmation that constraints on family planning can worsen child quality. Together with Orbeta's findings, it reinforces the relevance of Becker's hypothesis in the Philippine setting: whether via unintended fertility (Manila's case) or ordinary variation in sibling sex mix, more children mean fewer resources per child and thus worse education outcomes. Consistent with theory, Filipino parents facing exogenous increases in quantity were unable to maintain the same level of quality per child.

Beyond education, researchers have also examined health and other child outcomes in relation to family size. Evidence generally suggests the Q–Q trade-off extends to child health and nutrition. For instance, Horton (1986) already hinted that large families may compromise child nutrition for later-born siblings. More recent regional research resonates with this. Hatton et al. (2018) analyze the effect of fertility on child height (a long-run health indicator) using longitudinal data from Indonesia – a neighboring Southeast Asian country with comparable developmental challenges. They address endogeneity by exploiting Indonesia's family planning program rollout and exposure to mass media as instruments for fertility. The authors find a significant negative impact of family size on child health: each additional sibling is associated with about a one-third standard deviation reduction in a child's height-for-age Z-score, after controlling for other factors. This health penalty from having more children is strongest in low-education households and appears in both urban and rural areas. Such findings mirror the Philippine evidence that the harms of large family size are most pronounced among disadvantaged families. In economic terms, poorer parents with many children struggle to provide adequate nutrition and schooling to all, which highlight the equity dimension of the Q–Q trade-off.

E. Family Size and Child Outcomes in Southeast Asia

The Philippine experience is echoed in other ASEAN countries, where researchers have probed the quantity–quality trade-off with diverse outcomes and methods. In Vietnam, for example, rapid fertility decline alongside rising education led to questions about a Q–Q mechanism. Anh et al. (1998) documented a negative correlation between family size and children's school enrollment in Vietnam, though their analysis could not fully establish causality.

More rigorously, Dang and Rogers (2016) used distance to the nearest family planning center as an instrument to study Vietnamese households' investments in education. They introduced a novel measure of child quality—spending on private tutoring, a prevalent form of educational investment in Vietnam—alongside traditional indicators like schooling expenses. The IV estimates confirmed that children with more siblings receive significantly lower educational investments from their families. In particular, Vietnamese families of larger size spent less on each school-age child's schooling and tutoring, even after controlling for community factors. This effect was robust across different definitions of family size and model specifications, indicating that Vietnamese parents do indeed trade off quantity for quality when faced with resource constraints. Such evidence aligns squarely with Becker's model: as Vietnamese family size increases, per-child education spending falls; parents are prioritizing "quality" less when they have more offspring.

Indonesia and Thailand show similar patterns. Demographic research in Thailand during its fertility transition found that large families had markedly worse educational outcomes. Knodel, Havanon and Sittitrai (1990), studying Thai data in the 1990s, observed that once family size exceeded about 4–5 children, the likelihood of a child progressing to or staying in secondary school dropped precipitously compared to smaller families. Although these early Thai studies were based on correlations, they strongly suggested that limited family resources were being spread thin in big families and hurt children's schooling attainment.

In Indonesia, cohort analyses and natural experiments reinforce the trade-off. Maralani (2008) showed that the relationship between sibship size and schooling evolved from neutral or even positive for older cohorts (born when education opportunities were limited) to negative for more recent cohorts, consistent with a growing importance of education in a modernizing economy. More concretely, the aforementioned study by Hatton et al. (2018) in Indonesia provides causal evidence that mirrors the Philippine findings in health and nutrition. Likewise, an analysis of Indonesian census data (Feng, 2021) found that having additional siblings significantly lowers children's educational attainment once birth order effects are accounted for, paralleling results from China and Vietnam.

These regional studies share a commonality: in resource-constrained settings of Southeast Asia, increased child quantity tends to come at the expense of child quality, be it years of schooling, academic spending, or health status. The consistency of this pattern—across countries with different cultures and policies—highlights the fundamental economic logic identified by Becker and Lewis (1973). Parents with finite resources face difficult choices, and many appear to balance quantity and quality in a way that confirms the trade-off hypothesis.

Despite these similarities, there are some noteworthy nuances and gaps in the ASEAN literature. One is the role of public policy and development level. Evidence suggests that the Q–Q trade-off may be mitigated in contexts with strong public support for education and health. For instance, studies in developed countries (e.g. Israel, Norway) often find little or no trade-off once factors like birth order are accounted for (Black, Devereux and Salvanes, 2005; Kristensen and Bjerkedal, 2010; Angrist, Lavy and Schlosser, 2010). In Southeast Asia, however, public education quality and social safety nets are still developing, and the cost of raising children (education fees, food, etc.) is largely borne by families themselves (OECD, 2024). This may explain why the trade-off emerges so clearly in the Philippines, Vietnam, Indonesia, and Thailand.

Another nuance is methodological: more recent studies employ credible identification strategies (IVs, twins, policy shocks) and consistently find a causal negative effect of family size on child outcomes, whereas older studies without such controls sometimes found weaker effects or none at all. This highlights the importance of accounting for endogeneity.

Finally, there remain gaps for future research. Most ASEAN studies focus on education and early-life health indicators as measures of child quality; there is relatively little evidence on long-term outcomes such as children's eventual earnings or income in adulthood. It is not yet fully clear whether the schooling and health disadvantages observed in larger families translate into significantly lower adult productivity or income—a link that Becker and Tomes (1976) theorized but which could be explored further in this region.

Additionally, while the trade-off appears pervasive, its magnitude can vary: for example, the penalty of an extra child may be larger in poorer rural areas than in urban or wealthier settings, suggesting that local context (poverty, gender norms, access to services) can modulate the trade-off. Comparative studies across ASEAN are still somewhat limited, and a common challenge is disentangling related factors like birth order, sibling composition, and parental preferences.

Nonetheless, the prevailing evidence from the Philippines and its regional neighbors strongly supports Becker's quantity–quality conjecture. As families have fewer children, they appear to invest more in each child's education—investments crucial for human capital development and economic growth. Conversely, high-fertility households risk under-investing per child, which reinforces cycles of poverty and inequality. This literature thus provides an important empirical foundation for policies in the Philippines and ASEAN—from family planning programs to education subsidies—that aim to ease the quantity–quality trade-off and help families achieve both manageable size and better outcomes for the next generation.

III. Conceptual Framework and Hypotheses

This study builds upon the foundational framework of the quantity–quality (Q–Q) trade-off, as articulated in Becker (1960) seminal work and later refined by Becker and Lewis (1973). Within this theoretical model, fertility and child quality are jointly determined under a full-income constraint, such that any increase in the number of children—absent a commensurate expansion in resources—necessitates a reduction in the average investment per child. While prior empirical applications of this framework have largely centered on educational attainment, child quality may also be understood along biological dimensions, especially along nutritional status, which emerges earlier in the life course and may be less subject to later remediation.

The current analysis focuses exclusively on early-life nutrition as a proxy for child quality. Nutrition, unlike cognitive or educational outcomes, is characterized by low substitutability and a narrow temporal window during which investments are most productive. The trade-off is thus expected to manifest strongly in settings where fertility rises exogenously while household resources remain constrained. In such environments, families facing an unexpected increase in sibship size may be forced to reallocate scarce food, time, and health inputs across a larger number of dependents, potentially resulting in lower nutritional attainment for each child.

To formalize this relationship, consider a household with total income I, choosing nutritional investments κ_j for each of n children, along with consumption Z unrelated to child quality:

$$I = \sum_{j=1}^{n} \kappa_j + Z.$$

In the presence of a fertility shock, holding I constant, the average κ_j must fall unless offset by changes in parental behavior or external transfers. If nutritional investments per child decline, and if such inputs are critical for growth, observable deficits in height-for-age (HAZ) or weight-for-height (WHZ) may emerge. The first hypothesis emerging from this framework is that an exogenous increase in

fertility leads to a reduction in per-child nutritional investment, particularly in low-income, urban households where slack in the family budget is limited. A second, related hypothesis posits that this reduction in inputs translates into measurable nutritional deficits among young children, specifically in the form of lower anthropometric outcomes such as height-for-age (HAZ) and weight-for-height (WHZ) z-scores. These two hypotheses—concerning, respectively, the behavioral reallocation of resources and its biological consequence—jointly seek to identify a causal link between fertility shocks and early-life deprivation.

IV. Data and Empirical Strategy

This study constructs a harmonized, child-level analytic dataset using five rounds of the Philippine Demographic and Health Survey (DHS): 1993, 1998, 2003, 2008, and 2013. The DHS is a nationally representative, cross-sectional survey series conducted by the Philippine Statistics Authority in collaboration with ICF International. Each round follows a stratified two-stage cluster design and collects standardized information on child health, fertility, maternal characteristics, and household infrastructure. For each wave, I merge the child-level (KR), mother-level (IR), and household-level (HR) files using cluster, household, and maternal identifiers, ensuring that each observation corresponds to a live birth occurring within five years of the survey. The analytic sample is restricted to children aged 0–59 months to standardize developmental exposure windows and conform to the World Health Organization (WHO) reference growth standards.

The primary outcomes are height-for-age (HAZ) and weight-for-height (WHZ) z-scores, internationally recognized proxies for chronic and acute malnutrition, respectively. These anthropometric indicators are cleaned following DHS protocols: biologically implausible values are excluded, and remaining z-scores are rescaled from hundredths to continuous units. In addition to anthropometry, the child record includes a suite of health-related variables. These include indicators for whether the child has received basic vaccinations—such as BCG, DPT, polio, and measles—as well as whether the child experienced episodes of diarrhea, fever, or respiratory illness in the two weeks prior to the survey. These supplementary health measures serve as intermediate outcomes in secondary analyses to capture short-run morbidity and preventive health investment.

Maternal-level information is drawn from the individual recode file. Core covariates include maternal age, completed years of education, and total number of children ever born (parity), each of which captures socioeconomic status and fertility history. I additionally include maternal body mass index (BMI) and anemia status, which serve as both controls and potential mediators of child health. These indicators reflect the mother's nutritional status and physiological capacity to support healthy fetal and postnatal development. In robustness checks, I examine whether declines in maternal nutritional status following the fertility shock account for observed changes in child anthropometry.

Household-level characteristics are used to control for environmental and infrastructural determinants of health. Specifically, I include household size, urban residence, wealth quintile, access to electricity, type of toilet facility, whether the toilet is shared, and source of drinking water. These variables proxy for household-level resources and exposure to disease environments. In extension analyses, I interact treatment status with these environmental indicators to assess whether the nutritional consequences of the fertility shock are magnified under infrastructural deprivation.

The treatment is defined by exposure to Executive Order No. 003, which was issued by the Manila City government in January 2000 and effectively suspended the public distribution of modern contraceptives. This policy change resulted in a localized increase in fertility that was not mirrored in surrounding municipalities within the National Capital Region (NCR). Children born in Manila City after the implementation of the policy are classified as treated, while children in other NCR cities serve as the control group. This spatially and temporally bounded intervention provides quasi-experimental variation that facilitates identification of causal effects.

The empirical approach adopts a difference-in-differences framework that compares trends in child nutritional outcomes between treated and control cities before and after the policy change. The identifying assumption is that, absent the policy, nutritional trajectories in Manila and non-Manila NCR cities would have evolved in parallel. This assumption is supported by visual inspection and pre-trend placebo tests using the 1993 and 1998 waves. The 1998 DHS serves as the primary pre-policy baseline, while the 2003 survey captures short-run effects. The 2008 and 2013 waves are used in robustness checks to assess medium- and long-run persistence of nutritional deficits. All specifications include city and birth-year fixed effects, and standard errors are clustered at the city-year level to account for within-cluster correlation.

The empirical strategy exploits the 2000 issuance of Executive Order No. 003, which effectively banned the distribution of modern contraceptives in public health centers across Manila City. This abrupt and localized withdrawal of contraceptive access resulted in a fertility increase concentrated within the city, but did not affect surrounding municipalities within the National Capital Region (NCR). Children born in Manila following the policy are considered exposed to a fertility shock, while children in other NCR cities over the same period serve as the control group. The analytical sample is restricted to children under five years old at the time of each survey round to ensure accurate measurement of early-life nutritional outcomes.

I estimate the following difference-in-differences specification:

$$\text{Nutrition}_{ict} = \alpha + \beta \cdot (\text{Post}_t \times \text{Manila}_c) + X'_{ict}\gamma + \lambda_c + \tau_t + \varepsilon_{ict}$$

In this equation, Nutrition_{ict} refers to either height-for-age (HAZ) or weight-for-height (WHZ) for child i in city c born in year t. The indicator Post_t equals 1 if the child was born after the implementation of Executive Order No. 003 in 2000, and Manila$c$ equals 1 if the child resides in Manila City. The interaction term captures the effect of being born in Manila after the contraceptive policy was enacted. The vector $Xict$ includes controls for child age in months, sex, birth order, maternal age, education, parity, body mass index (BMI), anemia status, household wealth quintile, household size, electricity access, water source, toilet type, shared sanitation status, and urban residence. City fixed effects λ_c control for time-invariant characteristics at the locality level, while year fixed effects τ_t absorb aggregate time shocks. The coefficient of interest, β, represents the average treatment effect of the policy-induced fertility shock on child nutrition. Standard errors are clustered at the city-year level to account for potential autocorrelation within geographic units over time.

To support the internal validity of the design, I use Philippine Census microdata from 1990, 1995, 2000, 2007, and 2010 to confirm the magnitude and timing of the fertility shock. The 1995 and 2007 waves provide clean pre- and post-policy benchmarks, while the 2000 census—although temporally proximate to the policy—is retained for robustness checks that test the sensitivity of estimates to the exact onset of fertility changes. A placebo comparison between 1990 and 1995 shows no divergence in fertility trends between Manila and control cities prior to the policy, strengthening the credibility of the parallel trends assumption.

To supplement the DHS and Census data, I incorporate the Annual Poverty Indicators Survey (APIS), a nationally representative household survey that captures detailed information on food expenditure, maternal education, and living standards. Although the APIS lacks anthropometric data and has more limited geographic coverage, it enables exploratory analyses of treatment effect heterogeneity by income and education strata and helps triangulate changes in maternal resource constraints following the policy shock.

Finally, missing data are handled following standard practices in applied microeconometrics. Observations with missing or flagged anthropometric outcomes are excluded from the analysis. For other covariates with partial nonresponse—such as maternal BMI, anemia, or household infrastructure—I adopt the missing-indicator method: missing values are imputed with a constant, and a binary indicator is included in all regression models to control for the fact of missingness. This approach preserves sample size while allowing the data to inform whether nonresponse is systematically related to the outcomes of interest. As robustness checks, I estimate alternative specifications using multiple imputation and inverse-probability weighting to test the sensitivity of results to different missing data assumptions. All descriptive and inferential statistics are computed using DHS-provided sampling weights, and models account for the complex survey design by clustering standard errors at the primary sampling unit.

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, and William N. Evans. 1996. "Children and Their Parents' Labor Supply: Evidence from Exogenous Variation in Family Size." National Bureau of Economic Research, Cambridge, MA.

Angrist, Joshua, 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): 773–824.

Anh, Truong Si, John Knodel, David Lam, and Jed Friedman. 1998. "Family Size and Children's Education in Vietnam." *Demography*, 35(1): 57–70.

Barro, Robert J., and Gary S. Becker. 1989. "Fertility Choice in a Model of Economic Growth." *Econometrica*, 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.

Bishwakarma, Rajan, and Kira M. Villa. 2019. "First Come, First Served? Birth Order Effects on Child Height in South Africa." *Journal of Demographic Economics*, 85(1): 71–94.

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.

Chen, Qihui. 2021. "Population Policy, Family Size and Child Malnutrition in Vietnam—Testing the Trade-off Between Child Quantity and Quality from a Child Nutrition Perspective." *Economics & Human Biology*, 41: 100983.

Dang, Hai-Anh H, and F Halsey Rogers. 2016. "The decision to invest in child quality over quantity: Household size and household investment in education in Vietnam." *The World Bank Economic Review*, 30(1): 104–142.

De La Croix, David, and Matthias Doepke. 2003. "Inequality and Growth: Why Differential Fertility Matters." *American Economic Review*, 93(4): 1091–1113.

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.

Duflo, Esther. 2003. "Grandmothers and Granddaughters: Old-Age Pensions and Intrahousehold Allocation in South Africa." *World Bank Economic Review*, 17(1): 1–25.

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." *World Bank Economic Review*, 33(1): 259–285.

Feng, Naikang. 2021. "The Effect of Sibling Size on Children's Educational Attainment: Evidence from Indonesia." *ECNU Review of Education*, 4(4): 830–856.

Fogel, Robert W. 1994. "Economic Growth, Population Theory, and Physiology: The Bearing of Long-Term Processes on the Making of Economic Policy." National Bureau of Economic Research, Cambridge, MA.

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." *Quarterly Journal of Economics*, 117(4): 1133–1191.

Galor, Oded, and Omer Moav. 2004. "From Physical to Human Capital Accumulation: Inequality and the Process of Development." *Review of Economic Studies*, 71(4): 1001–1026.

Galor, Oded, and Omer Moav. 2006. "Das Human-Kapital: A Theory of the Demise of the Class Structure." *Review of Economic Studies*, 73(1): 85–117.

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.

Grawe, Nathan D. 2008. "The Quality–Quantity Trade-off in Fertility Across Parent Earnings Levels: A Test for Credit Market Failure." *Review of Economics of the Household*, 6: 29–45.

Hatton, Timothy J., Robert Sparrow, Daniel Suryadarma, and Pierre van der Eng. 2018. "Fertility and the Health of Children in Indonesia." *Economics & Human Biology*, 28: 67–78.

Hazan, Moshe, and Binyamin Berdugo. 2002. "Child Labour, Fertility, and Economic Growth." *Economic Journal*, 112(482): 810–828.

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.

Horton, Susan. 1986. "Child Nutrition and Family Size in the Philippines." *Journal of Development Economics*, 23(1): 161–176.

Iyigun, Murat, and Randall P. Walsh. 2007. "Endogenous Gender Power, Household Labor Supply and the Demographic Transition." *Journal of Development Economics*, 82(1): 138–155.

Kalemli-Ozcan, Sebnem. 2002. "Does the Mortality Decline Promote Economic Growth?" *Journal of Economic Growth*, 7: 411–439.

Kalemli-Ozcan, Sebnem, Harl E. Ryder, and David N. Weil. 2000. "Mortality Decline, Human Capital Investment, and Economic Growth." *Journal of Development Economics*, 62(1): 1–23.

Knodel, John, Napaporn Havanon, and Werasit Sittitrai. 1990. "Family Size and the Education of Children in the Context of Rapid Fertility Decline." *Population and Development Review*, 31–62.

Kremer, Michael, and Daniel L. Chen. 2002. "Income Distribution Dynamics with Endogenous Fertility." *Journal of Economic Growth*, 7: 227–258.

Kristensen, Petter, and Tor Bjerkedal. 2010. "Educational Attainment of 25-Year-Old Norwegians According to Birth Order and Gender." *Intelligence*, 38(1): 123–136.

Maralani, Vida. 2008. "The Changing Relationship Between Family Size and Educational Attainment Over the Course of Socioeconomic Development: Evidence from Indonesia." *Demography*, 45: 693–717.

OECD. 2024. "SIGI 2024 Regional Report for Southeast Asia: Time to Care." *https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/03/sigi-2024-regional-report-for-southeast-asia_d157077d/7fc15e1c-en.pdf*, Organisation for Economic Co-operation and Development.

Oppenheim Mason, Karen. 1987. "The Impact of Women's Social Position on Fertility in Developing Countries." Vol. 2, 718–745, Springer.

Orbeta Jr, Aniceto C. 2010. "Number of Children and Their Education in Philippine Households." *Philippine Review of Economics*, 46(2). Online ISSN 2984-8156.

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.

Thomas, Duncan. 1990. "Intra-Household Resource Allocation: An Inferential Approach." *Journal of Human Resources*, 25(4): 635–664.

Vicerra, Paolo, and Christian Joy Cruz. 2013. "Fertility Behavior, Desired Number and Gender Composition of Children: The Philippine Case."

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