The tradeoff between child quantity and child quality: testing Becker's Q-Q model and long-terms effects on women using data from Egypt

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Abstract

Drawing on consumer demand theory, this study examines fertility as a microeconomic decision influenced by household socioeconomic characteristics, focusing on Egypt. This research hypothesizes that increased family size inversely affects child quality and long-term female labor outcomes. Utilizing data from the Egypt Labor Market Panel Surveys (ELMPS) over 20 years, the analysis employs a two-stage least square instrumental variable approach, with the number of non-singleton children as an instrument to address endogeneity in fertility decisions. Results suggest no significant effect of family size on child schooling or female employment outcomes, challenging the presence of a child quantity-quality tradeoff in Egypt despite significant socioeconomic transitions. This highlights potential limitations in policies that solely target family planning to improve educational and labor outcomes. The study's findings contribute to the ongoing debate on fertility economics in developing countries, providing insights into the complex interactions between family size, education, and labor market participation, particularly for women in the MENA region.

JEL Classifications: J13: Fertility; Family Planning; Childcare; Children; Youth. J16: Economics of Gender; Non-labor Discrimination. J22: Time Allocation and Labor Supply. O12: Microeconomic Analyses of Economic Development.

Keywords: Quantity-Quality Tradeoff; Fertility Decisions; Child Education; Female Employment; Egypt; Becker's Q-Q Model; Family Economics; Development Economics; Gender

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1 Introduction

Building on consumer demand theory, fertility is studied as a microeconomic choice driven by parental preferences, where preferences are shaped by the households' socioeconomic characteristics (Becker 1960; Guinnane 2011). Within this framework, responsiveness of fertility preferences to income changes is detrimental to fertility choices and female labor (Krafft 2020) and marriage (Assaad and Krafft 2015) market outcomes. That is, the higher the income households earn, the less likely they would maximize their utility from having more children, and the more likely they would from having higher quality children (Becker 1960). Similarly, in developing countries, poorer households would experience higher returns to the quantity of children rather than quality, due to prevalent child labor and low returns to education, in turn reducing the cost of fertility. This dilemma is commonly referred to as the child quantity-quality (Q-Q) tradeoff. In exploring fertility as a microeconomic choice, this paper engages in the debate over how household socioeconomic characteristics, particularly in developing countries, shape parental preferences towards family size and child quality, ultimately influencing female labor market outcomes.

I test and quantify the Q-Q tradeoff in Egypt, hypothesizing that increasing family size inversely affects the quality of child outcomes, namely education, and has consequential long-term impacts on female employment. I present quasi-experimental evidence on how family size affects the number of schooling years for children, gender differentials in human capital investment decisions by parents, and the probability of employment for females.

The Q-Q model is largely affected by parents' income, marriage market dynamics, female employment and female returns to education (Becker 1981; Doepke 2015; Schultz 1997). Factors that are uniquely different within households in the Middle East and North Africa (MENA), compared to developing countries from other regions. Girls and young women in a country like Egypt are mostly educated not necessarily to enter the labor force, given their increasing levels of education attainment, yet stagnant employment rates (Assaad et al. 2020), a paradox that is yet to be unriddled. The study of family formation and its implications on female employment, within the Q-Q model, can contribute to explaining this paradox.

If the Q-Q tradeoff exists in Egypt, it can influence outcomes in the marriage market. Examining the relationship between fertility decisions by the parents and their daughters' marriage market outcomes as an adult, particularly age at first marriage, can also help explain labor market outcomes for females. In large families, with existing gender differentials in human capital investment, young girls are positioned to potentially early marriages and worse chances in the labor market. That is, given a sizeable Q-Q tradeoff exists, if males are looking for higher quantities of children, they are more likely to have female spouses who are younger and are less educated. This is to ensure that the selected female spouse has a lower opportunity cost to childbearing (as she is less likely to have a higher paying job), and a longer reproductive cycle.

Quantifying the effect of fertility on such short- *and* long-term outcomes can also explain the influence of fertility on intergenerational mobility and inequality of opportunity for females in education and the labor market. By quantifying the causal effect of family size on child quality, differentials in expenditure on female and male children within the same family can be estimated. If there exists a gender differential in human capital investments (child education) in large families, daughters in such families would grow up with less education and thus worse chances in the labor market, reducing their opportunity cost of childbearing and in turn having larger families of their own.

The relationship between fertility and human capital formation is highly endogenous and establishing a causal relationship largely depends on measuring an exogenous shock to fertility. This exogenous source of variation can also be used to measure long-term effects on labor market outcomes for females. To identify a causal effect, I use a two-stage least square instrumental variable (TSLS-IV) estimation approach. As an instrument, I use the number of non-singleton children (twins) to predict family size, arguing that it proxies a random shock to fertility, all else equal (J. Angrist, Lavy, and Schlosser 2010; Black, Devereux, and Salvanes 2005; H. Li, Zhang, and Zhu 2008; Mogstad and Wiswall 2016; Rosenzweig and Wolpin 1980).

Using nationally representative data from the Egypt Labor Market Panel Surveys (ELMPS) from 1998 to 2018, I track individuals across four survey rounds, covering several modules including fertility, labor market dynamics, and education. Using the relationship to the household head in the data, the month and year of the child's birth, and the mother's identifier, I am able to identify 2,227 twins (2.61 percent) out of a total sample size of 85,217 sons and daughters in all four rounds. The analytical sample used to estimate the effect of fertility on education is restricted to families with two or more children who are 4-17 years old.

In the first stage of the IV-TSLS, I obtain an estimate of an exogenous shock to fertility, by estimating the effect of having non-singleton sons and daughters (related to the household head and hereafter referred to as children) on the number of sons and daughters in the household. In the second stage, I first estimate the effect of the predicted exogenous shock (from the first stage) on child education to establish and quantify the Q-Q tradeoff in Egypt. This estimation is also done for both genders, to investigate the existence of any gender differentials. I then change the outcome in the second stage to measure the effect on the probability of female employment in both the repeated cross-section and the panel samples. Estimates from the panel sample investigate whether fertility has long term effects on female employment.

The two main threats to this identification strategy are first having low sample size (or variation) of non-singleton children and thus less predictive power of family size, and second is the potential correlation between having non-singleton children and other family characteristics such as household wealth. An example of the latter threat is the cost of in-vitro fertilization (IVF) procedures that may not be affordable to poorer households, and its correlation with having non-singleton children. To address the first threat, I show that there is enough variation across households and years in the probability of having non-singleton children and I also implement the Montiel Pflueger weak instrument test which is robust to heteroskedastic errors, errors that are autocorrelated, and errors that are clustered. As for the second threat, I find no correlation between household wealth and the probability of having non-singleton children that is not significantly different from zero. I also control for the natural log of the total wages earned within a household in all model specifications estimating the effect of fertility on child education.

The first stage results show that the twins instrument is strongly relevant to family size and significantly predicts a 0.497, 0.605, and 0.369 increase in the number of siblings in the rounds 2006, 2012, and 2018, respectively, consistent with other similar estimates of the first stage of family size on twins (J. D. Angrist and Evans 1998; J. Angrist, Lavy, and Schlosser 2010). The Montiel Pflueger effective F-statistic for the instrument in the 2006 and 2018 rounds rejects the null that the twins instrument is weak with potential asymptotic bias between 5-20 percent. In the

2012 round and both the pooled cross-section samples (with and without the 1998 round), the Montiel Pflueger effective F-statistic for the instrument rejects the null that the twins instrument is weak with potential asymptotic bias less than 5 percent.

In the repeated-(and pooled)-cross-section sample between 1998 and 2018, I find that on average an increase of one child in a household does not affect child schooling. I also find no gender differentials in child schooling due to family size. Women growing up in larger families, in terms of number of siblings, had no significantly different probabilities of being employed. The results are consistent with other findings in the literature (J. Angrist, Lavy, and Schlosser 2010), where the Q-Q tradeoff does not seem to exist. The results obtained suggest that fertility has no significant effect on child schooling in Egypt between 1998 and 2018. Adding to the debate on whether the Q-Q tradeoff exists in developing countries (Aaronson, Lange, and Mazumder 2014; Åslund and Grönqvist 2010; Black, Devereux, and Salvanes 2005; Cáceres-Delpiano 2006; Hanushek 1992; Mogstad and Wiswall 2016).

The contribution of this paper is threefold: first, I estimate the effect of one extra child in a family on child schooling; second, I investigate whether this effect is different for girls than for boys; and third, I estimate the effect of parent fertility decisions on the female child's employment. The lack of significant impacts from family size on child schooling, gender differences, and women's employment in Egypt, a developing country, raises interesting parallels with developed nations where strong welfare systems lessen the Q-Q tradeoff. This paper highlights that simply addressing family size may not effectively improve educational and labor market outcomes.

Considering the political instability in the aftermath of the Arab Spring[i], and economic stagnation due to the Covid-19 pandemic, Egypt is facing major challenges in achieving its development agenda. Studying the determinants of family size informs ongoing government efforts in family planning by quantifying the returns to such policies in terms of human capital. In a developing country with limited fiscal capacity, informing governments on the returns to family planning on health or education can have significant effects on long-term development goals. Along with addressing such questions in Egypt, results from this research fills the gap of measuring the long-term effects of family size on child quality and delve into gender disparities in human capital investment and inequality of opportunity. Results from this research will also instigate further inquiries into how family size during childhood affects female labor force participation and marriage outcomes during adulthood.

The following section explains the theoretical framework used to model the effect of fertility on child education. Section 3 presents the data, sample, and empirical framework used in the research design. Section 4 summarizes the results and section 5 concludes.

2 Conceptual framework

This section explains the Quantity-Quality theoretical framework, developed by Becker and Lewis (1973) and Becker and Tomes (1976) to analyze fertility choices and how fertility may affect child quality outcomes. The Q-Q model is largely affected by parents' income, the marriage market, female employment and female returns to education (Becker 1981; Doepke 2015; Schultz 1997). Factors that are uniquely different within households in MENA compared to Western Europe and the US[†]. The demand for children can be studied within the framework of consumer durables', children can be either a consumption good (increasing utility), a production good (help increase household income after a certain age), or both (Becker 1960; Guinnane 2011). A deciding factor in what households do to maximize their utility from having children, is their quantity- and quality-income elasticity. Children in this model are considered home-produced consumer durables and are normal goods, and thus richer parents have smaller quantity-income elasticity and a larger quality-income elasticity to the demand of children. That is, the higher the income households earn, the less likely they would maximize their utility from children by having more, and the more likely they would from having higher quality children (Doepke et al. 2022).

Parents seeking to have children, do so to maximize their utility from this "good", and that utility is not only dependent on the number of children, but also on the quantity *and* quality of their children. The parents' utility is also a function of other commodities. Let equation (1) be the utility function of households in terms of child quantity (n), the expenditure on each child – child quality (q), and other consumed commodities (Z) for all other commodities (1, …, m), as follows:

$$U = U(n, q, Z_1, \dots, Z_m) \tag{1}$$

For simplification the above parent utility ignores changes during the child's life cycle as well as changes from timings and durations between each birth. Also, the budget constraint to the utility function in (1) will be assumed to have constant child quality among all children a family can have. Then this utility is said to be constrained by the following budget:

$$I = p_n n + \pi_z Z \tag{2}$$

Households maximize their utility function in (1), subject to income (I) which in turn is a sum of the products of the cost of childbearing and childrearing (p_n) by the number of children (n), and the amount of commodities (Z) by their associated costs (π_z). With this setup in (1) and (2), the marginal utility conditions would be:

$$\frac{\partial U}{\partial n} \Big/ \frac{\partial U}{\partial Z} = \frac{MU_n}{MU_Z} = \frac{p_n}{\pi_Z} \tag{3}$$

Thus, regardless of child quality, the demand for the number of children (n) is determined by the marginal utility from the number of children relative to the marginal utility from consuming other goods. In other words, with constant income, as the relative price of childbearing increases, the demand for children decreases and the demand for other commodities increase. The determinants of the marginal utility conditions in (3) – cost of childbearing , demand for other commodities, and

[†] A historical overview of the fertility transition in Western Europe and the US is in Guinnane (2011).

demand for children – are influenced by child and household characteristics as well as other macroeconomic indicators. For example, households with working mothers will expectedly experience higher costs of childbearing. That cost would further increase if the survival of the child required more healthcare expenditure. In developed countries with generous child support, households would incur less of such costs[‡]. Further, agricultural households would experience higher returns to the number of children, in turn reducing their associated costs. The size of the effect of agricultural activity within households on the cost of childbearing, can be significantly reduced due to economic reforms and structural transformations (Feng, Cai, and Gu 2013).

The utility function in (1) can be modified to account for child quality. The cost of one unit of child quality (p_c) and a measure of child quality (q) can be added to the budget constraint in (2):

$$I = p_c q n + \pi_z Z \tag{4}$$

As such, the utility maximization conditions for (1) subject to (4) would be:

$$\begin{cases} \frac{\partial U}{\partial n} = MU_n = \lambda p_c q = \lambda \pi_n \\ \frac{\partial U}{\partial q} = MU_q = \lambda p_c n = \lambda \pi_q \\ \frac{\partial U}{\partial Z} = MU_Z = \lambda \pi_Z \end{cases} \tag{5}$$

Where now the shadow prices of the number of children (*n*) and their quality (*q*) are (π_n) and (π_q), respectively. An important implication of this extended quality model is that the shadow price of child quality (π_q) is affected by both the price of child quality (p_c) and – expectedly – the number of children (n). Meanwhile, the shadow price of child quantity (π_n) is determined by the quality of children demanded (*q*) and the cost associated with this quality (p_c). Any exogenous increase in the number of children (*n*) would increase the shadow price (π_q) of child quality (*q*), where $\pi_q = p_c n$, thus decreasing the demand for child quality (*q*). Meanwhile, a decline in the demand for child quality (*q*), would reduce the shadow price (π_n) of (*n*), and further increase the demand for the number of children (*n*), since $\pi_n = p_c q$.

The greater the shadow price of child quantity (π_n), the greater the quality of children (*q*) demanded, and the greater the shadow price of child quality (π_q) the greater the number of children (*n*) demanded (Becker and Lewis 1973). These adjustments to the household shadow price of child quantity and quality would continue until a new equilibrium is reached. This interaction between child quantity and quality, in the demand for children in (Becker 1981), is what laid the ground for all the empirical research that followed on the Q-Q tradeoff.

[‡] The model for economic growth was first integrated with fertility in Barro and Becker (1989). There is also other research looking into the feedback from macroeconomic growth and technology and its effect on fertility (see Galor 2005a; 2005b; 2012; Galor and Weil 2000).

3 Research design

This section explains the data and the instrumental variable identification strategy used to first estimate the shadow prices of child quality and child quantity in Egypt, second, to investigate whether fertility causes any gender differentials in human capital investment, and third, to test whether exposure to fertility during childhood affects the daughter's probability to work. I use the number of non-singleton sons and daughters, as defined by their relationship to the household head and their birth date, as an exogenous shock to fertility.

Empirically establishing the causal effect of child quantity on child quality can be an arduous task. The number of children and child quality are endogenous to household characteristics and the parents' preferences. Having more children can be a financial burden, abating available resources away from investing in a child's education, or equally investing in all children in the same family. Meanwhile, investing more resources in children's education can deter parents from having more children. Thus, most empirical studies causally linking the number of children to child quality build their identification strategy on an exogenous source of variation in fertility[§]. The model used in this paper is a two-staged least squares (TSLS) regression, with the first stage instrumenting the effect of having twins (the instrument) on the number of sons and daughters in the household. The second stage regression estimates the effect of the predicted number of sons and daughters (i.e. fertility) from the first stage on child quality outcomes (years of schooling and the daughter's probability of working). The two main assumptions required for the IV-TSLS estimates to be consistent are the relevance criterion and the exclusion restriction. That is, the instrument (twins) must be a strong predictor of fertility (i.e. the relevance criterion). And the instrument (twins) must not affect the outcome (child schooling and work status) except through fertility (the exclusion restriction).

3.1 Data

Using the Egypt Labor Market Panel Surveys (ELMPS), I observe individuals over four rounds of surveys for 20 years (1998 to 2018). The ELMPS provides longitudinal and repeated cross-sectional, nationally representative data and is publicly available through the Open Access Microdata Initiative (OAMDI) from the Economic Research Forum (ERF). The data covers several modules including fertility, labor market, education, gender role attitudes, and agricultural and non-agricultural economic activity for both the refresher sample and the panel sample. The identification strategy employs the number of non-singleton children defined using the month and year of birth of individuals identified as sons and daughters by the household head.

Table 1 below shows the breakdown of the number of singleton and non-singleton sons and daughters in each of the four rounds in the ELMPS, in all households (not only households with

[§] There are two main approaches to achieve this in the Q-Q literature. First, is using exogenous family planning policies (Huang, Lei, and Sun 2020; Huang 2021; B. Li and Zhang 2017; Liu 2014; Qian 2009). Second, is by instrumenting the number of children using twin births (J. Angrist, Lavy, and Schlosser 2010; Black, Devereux, and Salvanes 2005; H. Li, Zhang, and Zhu 2008; Mogstad and Wiswall 2016; Rosenzweig and Wolpin 1980). Other studies looked into other sources of exogenous variation such as child height (M. H. Lee 2012) and newborn gender (J. Lee 2008; J. D. Angrist and Evans 1998).

two or more children). Overall, there are 2,227 twins (2.61 percent) out of a total sample size of 85,217 sons and daughters. Notably the number of non-singleton children has been increasing over the years, this could potentially be due to the availability and continuously reduced costs of the IVF technology over the years. Data from the 1998 survey had no fertility module, thus, there is a potential for lower data quality in the models using this sample, as the instrument used in the analysis depends primarily on fertility questions asked to the mother.

Table 1: Non-singleton sons and daughters in the ELMPS

	1998	2006	2012	2018	Pooled
Singleton sons/daughters					
N	12,530	18,063	23,143	29,254	82,990
Mean					
Household size	6.46	5.81	5.28	5.13	5.52
Son/daughter's years of schooling	7.13	7.51	7.16	6.93	7.16
Log of total household wages	5.88	6.44	7.05	7.7	6.94
Twin sons/daughters					
N	197	430	654	946	2,227
Mean					
Household size	6.76	6.36	5.86	5.7	5.97
Son/daughter's years of schooling	6.08	6.36	5.94	6.15	6.13
Log of total household wages	5.78	6.47	7.16	7.75	7.12
All children					
N	12,727	18,493	23,797	30,200	85,217
Mean					
Household size	6.46	5.82	5.3	5.15	5.53
Son/daughter's years of schooling	7.12	7.49	7.13	6.91	7.14
Log of total household wages	5.88	6.44	7.05	7.7	6.94

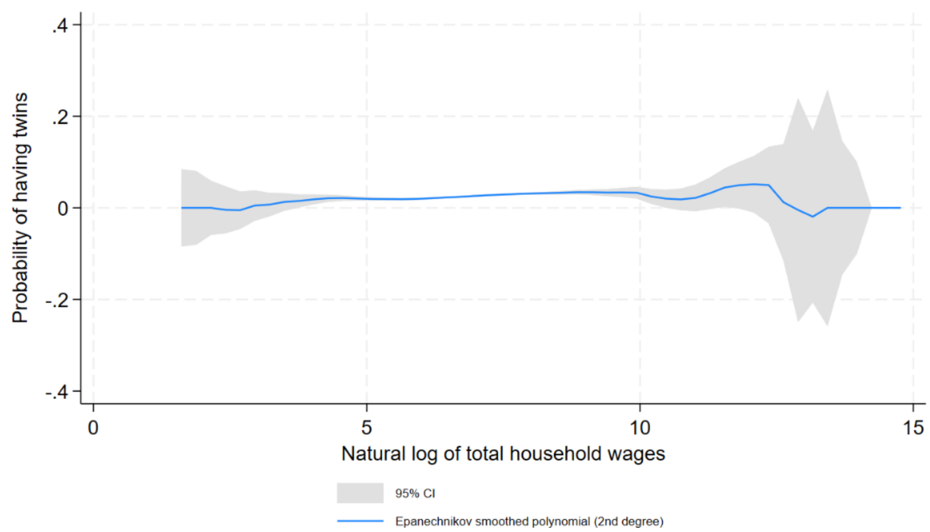
Notes: The ELMPS provides longitudinal and repeated cross-sectional, nationally representative data and is publicly available through the Open Access Microdata Initiative (OAMDI) from the Economic Research Forum (ERF). The table shows the breakdown of the number of singleton and non-singleton sons and daughters in each of the four rounds in the ELMPS, in all households. The 1998 survey round had no fertility module, which is later added starting in 2006. Household size includes all household members and total household wages is the sum of all monthly wages earned in the household from both primary and secondary jobs. Non-singleton sons and daughters are defined as per their relationship to the household head, and are children of the same mother born in the same month and year.

3.2 Analytical sample

The analysis in this paper restricts the sample to families with two or more children in all model specifications, as those are the families I expect the instrument to influence (having twins) their fertility decisions. The unit of analysis is children of the household head who are 4-17 years old. Using the relationship to the household head variable in the data along with the month and year of birth and the mother's identifier, I am able to identify non-singleton sons and daughters as children of the same mother born in the same month and year. The sample used to estimate the effect of fertility on the daughter's employment status (table 6 and 7), in both the panel and the repeated cross-section models, is restricted to daughters who are 6 years of age or older.

With only 2.67 percent of the sample being treated, there is potential for the non-singleton instrument to be weak. To address this, I implement weak IV tests to ensure the instrument satisfies the relevance criterion. Another threat to this identification strategy, pertaining to the exclusion restriction, is the correlation between household wealth and the probability of having non-singleton children in the household. This is mainly due to IVF being correlated with having non-singleton children and household wealth. To investigate this relationship, I plot the natural log of the total wages in a household on the probability of having twins. Figure 1 shows the predicted Epanechnikov function for the smoothed polynomial of second degree (i.e., total household wages and its square term). The figure shows that the relationship between household wealth and the probability of having twins is seemingly not significantly different from zero.

Figure 1: Probability of twins and household wealth



Notes: The figure shows the predicted Epanechnikov function for the smoothed polynomial of second degree (i.e., total household wages and its square term). Total household wages is the sum of all monthly wages earned in the household from both primary and secondary jobs.

To test for the relationship between household wealth and non-singleton children more formally, table 2 shows the OLS estimated regression results of regressing the linear probability of having twins on total household wages in the four rounds of the data and in the pooled sample. The models are estimated controlling for district fixed effects; and the standard errors are robust and clustered at the household level. The results in table 2 show that the relationship between household wealth and having twins in the household is not significantly different from zero.

Furthermore, in the pooled sample, I also present the interacted household wealth variable with the rounds of the survey to test for whether household wealth had any significant association with the linear probability of having twins over time. The coefficients from the estimated regression show that household wealth did not seem to affect the probability of having twins differently over time and is jointly insignificant. The rank of the child also did not seem to affect the probability of having twins in households with six or less children. Similarly, the mother's education and employment status does not seem to influence the probability of having twins, while age and age at first marriage only slightly seem affect the chances of having non-singleton children in the household. The results in table 2 provide support for the exclusion restriction assumption to hold.

Table 2: Repeated cross-section of twins on household and mother characteristics

	Twins in 1998	Twins in 2006	Twins in 2012	Twins in 2018	Pooled
Child schooling	-0.000	-0.001	-0.001*	-0.001	-0.001**
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)
Log total HH wages	-0.024	0.012	0.022	-0.002	-0.002
	(0.023)	(0.021)	(0.024)	(0.019)	(0.019)
Log total HH wages squared	0.002	-0.001	-0.001	0.000	0.000
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Mother’s education: read & write	-0.002	-0.018***	-0.002	0.011	-0.003
	(0.006)	(0.005)	(0.008)	(0.012)	(0.004)
Mother’s education: primary	-0.013***	0.003	0.018	-0.015	0.001
	(0.004)	(0.015)	(0.013)	(0.010)	(0.007)
Mother’s education: preparatory	-0.016***	0.049	-0.025*	-0.024**	-0.013
	(0.006)	(0.039)	(0.015)	(0.011)	(0.009)
Mother’s education: secondary	-0.008*	0.011	0.063	-0.008	0.003
	(0.004)	(0.025)	(0.064)	(0.038)	(0.015)
Mother’s education: > intermediate	-0.009	-0.021	0.019	-0.023	-0.002
	(0.007)	(0.014)	(0.039)	(0.023)	(0.018)
Mother’s education: higher institute	-0.013	-0.010			-0.023**
	(0.009)	(0.015)			(0.011)
Mother’s education: university		-0.019			-0.025***
		(0.013)			(0.010)
Mother’s employment: waged irregular job	-0.014	-0.021	0.043	-0.019	0.004
	(0.010)	(0.018)	(0.060)	(0.012)	(0.022)
Mother’s employment: employer	-0.018*	-0.015	-0.001	-0.020	-0.009
	(0.010)	(0.016)	(0.025)	(0.018)	(0.013)
Mother’s employment: self employed	0.054	-0.000	-0.007	-0.006	-0.002
	(0.063)	(0.020)	(0.017)	(0.015)	(0.010)
Mother’s employment: family-non-waged	0.011	0.010	0.002	-0.005	0.002
	(0.021)	(0.019)	(0.016)	(0.012)	(0.008)
Mother’s employment: no job	0.007	0.003			-0.003
	(0.006)	(0.015)			(0.010)
Mother's age	-0.000*	-0.001*	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Mother's age at first marriage	-0.000	0.001*	0.002***	0.001**	0.001***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)
Married mother	-0.007	0.000	0.002	-0.004	-0.001
	(0.007)	(0.006)	(0.006)	(0.010)	(0.004)
Child rank =2	-0.006	-0.005	0.005	-0.000	-0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.003)
Child rank =3	-0.005	-0.011**	0.004	-0.001	-0.002
	(0.006)	(0.006)	(0.006)	(0.006)	(0.003)
Child rank =4	-0.003	-0.001	0.007	0.016	0.006
	(0.007)	(0.009)	(0.008)	(0.012)	(0.005)
Child rank =5	-0.013*	-0.011	0.014	0.001	-0.002
	(0.007)	(0.010)	(0.016)	(0.018)	(0.006)
Child rank =6	0.006	-0.016	0.043	-0.029***	0.005
	(0.017)	(0.014)	(0.036)	(0.006)	(0.011)
Child rank =7	-0.017***	-0.029***	0.062	-0.029***	-0.007
	(0.004)	(0.006)	(0.078)	(0.007)	(0.013)
Child rank =8	-0.018***	-0.028***	-0.039***	-0.012	-0.019***
	(0.005)	(0.009)	(0.015)	(0.011)	(0.004)
Child rank =9	-0.020***	-0.018*	-0.079**		-0.019***
	(0.007)	(0.010)	(0.038)		(0.005)
Child rank =10	-0.024**				-0.016***
	(0.011)				(0.005)
Child rank =11	-0.013				-0.015***
	(0.008)				(0.005)
Child rank =12	-0.019**				-0.012**
	(0.010)				(0.006)

Table 2 (continued: Repeated cross-section of twins on household and mother characteristics

	Twins in 1998	Twins in 2006	Twins in 2012	Twins in 2018	Pooled
Child rank =13	-0.025*				-0.009
	(0.013)				(0.007)
Log HH wages X 1998					-0.013
					(0.030)
Log HH wages X 2006					0.015
					(0.028)
Log HH wages X 2012					0.017
					(0.031)
Log HH wages square X 1998					0.001
					(0.002)
Log HH wages square X 2006					-0.001
					(0.002)
Log HH wages square X 2012					-0.001
					(0.002)
Round of the survey=2006					-0.082
					(0.095)
Round of the survey=2012					-0.119
					(0.111)
Round of the survey=2018					-0.040
					(0.102)
Constant	0.104	-0.014	-0.113	0.006	0.053
	(0.069)	(0.070)	(0.088)	(0.077)	(0.070)
Prevalence of twins (%)	0.014	0.021	0.023	0.030	0.023
N	7,107	9,309	10,817	11,729	38,962
R-squared	0.015	0.012	0.017	0.011	0.008

Notes: Robust clustered standard errors at the district level are reported in parentheses. All models include controls for district fixed effects. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Total household wages is the sum of all monthly wages earned in the household from both primary and secondary jobs.

3.3 *Empirical framework*

There is currently no consensus in the empirical literature causally linking the number of children with child quality outcomes in developed countries, or on the size of such effect if existent (Aaronson, Lange, and Mazumder 2014; J. Angrist, Lavy, and Schlosser 2010; Åslund and Grönqvist 2010; Black, Devereux, and Salvanes 2005; Cáceres-Delpiano 2006; Hanushek 1992; Mogstad and Wiswall 2016; Doepke et al. 2022). Huang (2021) and H. Li, Zhang, and Zhu (2008), both hypothesize that such mixed findings in richer countries can be attributed to their adequate welfare systems. Currently 28 out of 30 OECD countries provide some sort of tax or transfer incentives to families with children (Mogstad and Wiswall 2016). Furthermore, developed countries typically provide subsidized high-quality education and child support. This in turn can drastically reduce the cost of childbearing and thus potentially eliminating the existence of a Q-Q tradeoff. Also, such government support can drive higher female labor supply as the opportunity cost of childbearing is significantly reduced. In fact, this latter effect can ambiguously influence the tendency to have more children, as child care is a variable cost of working for females, thus invoking both substitution and income effects that often work in opposite signs on the labor supply (Aaronson, Lange, and Mazumder 2014; Doepke 2015). As government support relaxes the household budget constraint in Becker's Q-Q model, the relationship between the number of children and child quality can be ambiguous, depending on labor market outcomes for the mothers.

Aside from egalitarian policies in the developed world, one would expect the quantity-quality tradeoff to be more nuanced in poorer countries. Lower labor market prospects for women and higher chances of child labor in the developing world reduce the opportunity cost of childbearing and increase the returns to having more children, respectively (Schultz 1997). With more out-of-pocket expenditure on children's education, diminished opportunity costs of childrearing and increasing returns to child labor, the quantity-quality tradeoff would be more apparent in the developing world. Estimating the shadow price of child quantity and child quality is key in understanding these relationships.

To model the shadow prices of child quantity (π_n) and child quality (π_n) in equation (5), I estimate the effect of fertility on completed number of school years, using a TSLS estimator, with a pooled repeated cross-section. Building on Becker and Lewis (1973) and Mogstad and Wiswall (2016), equations (6) and (7) below summarizes the main specification used:

$$N_{md} = \gamma_d + \gamma_{mb} + \alpha_1 Z_{md} + \alpha_2 W_{md} + \alpha_X' X_{md} + \varepsilon_{md} \tag{6}$$

Equation (6) is the first stage, and the unit of analysis is the mother (m) in a given district (d). N_{md} is the number of children the mother has had by the time she is 49 years old, the age at which almost all mothers have completed their fertility. The explanatory variables include two sets of fixed effects: district fixed effects (γ_d), and year of birth of the mother fixed effects (γ_{mb}). The key identifying variable is Z_{md}, a dummy variable indicating whether the mother has ever given birth to twins. W_{md} is the wealth of the household in which the mother resides, as measured by the household wealth index in the survey data. X_{md} is a vector of time-invariant control variables, including mother and father characteristics, and ε_{md} is a residual that represents unobserved variables that affect N_{md}.

$$Y_{imd} = \delta_d + \delta_{mb} + \beta_1 \widehat{N}_{md} + \beta_2 W_{md} + \beta_X' X_{imd} + v_{imd} \tag{7}$$

Equation (7) is the second stage, which focuses on children who are 24 years or older and so have finished their schooling. Y_{it} is the years of completed schooling of child i of mother m who lives in district d. The δ_d and δ_{mb} terms are district and year of mother's birth fixed effects, respectively. $\widehat{N}_{md}$ is the predicted number of children of mother m from the first stage in equation (6). X_{imd} are characteristics of child i and of his or her parents, and v_{md} is a residual that represents unobserved variables that affect Y_{imd}.

As the instrument Z (twins) and treatment N (number of sons and daughters to mother m) vary at the household level, the estimated standard errors in both equations 6 and 7 are robust and clustered at the household level to allow for correlation between unobservables within a household, producing asymptotically valid inference. Controlling for district fixed effects would help reduce bias from unobserved district-level characteristics such as school quality, infrastructure, and labor market conditions for the parents.

The TSLS model in equations 6 and 7, estimates local average treatment effects (LATE) of fertility for children in families with 2 or more children, as the treatment is whether the family has twins or not. That is, this model estimates the siblings' weighted average response to the birth of one more child in the family, in terms of schooling years, only for those children whose parents were induced to have an additional child due to the instrument. In this model it is reasonable to expect that the number of children in household h at time t to be autocorrelated with the number of children in the same household at time $t+1$. Furthermore, the unobserved characteristics between households are not homoscedastic. Knowing that the twins instrument used may suffer from weak relevance, the standard Stock and Yogo (2005) test for weak instrument is not valid. I thus opt for the robust test for weak instruments in Olea and Pflueger (2013). This test is robust to heteroskedastic errors, errors that are autocorrelated, and errors that are clustered.

The dependent variable Y_{it}, in the second stage (equation 7) is estimated twice for male and female children. Thus, I am able to test whether there exists significant gender differentials in human capital investments made by parents due to fertility. Also, to investigate whether the Q-Q tradeoff has long term effects, the model in equations (6) and (7) is re-estimated with daughters' employment status as the dependent variable in the second stage. This specification tests if an exogenous shock to family size would affect labor market outcomes for the daughters. With the public sector being the employer of choice for women in Egypt (Assaad and Barsoum 2019), and to help understand the relationship between public sector jobs and fertility, I also control for the share of workers employed by the public sector at the district level, as a proxy for public sector jobs' available nearby to the daughter.

To estimate the effect of fertility during childhood on the daughter's employment status, in the panel sample, the first stage regression estimates the effect of having a twin in the household on the number of sons and daughters at the round the daughter is first observed. The first stage regression sample is restricted to daughters who are 4-17 years old at the time of the first round. The second stage estimates the effect of the predicted number of sons and daughters in the first round on the daughter's employment status in the last round she is observed. The panel sample used in this estimation is broken down into six groups. Daughters who were surveyed in two rounds only, 1998 and 2006, 2006 and 2012, and 2012 and 2018. Daughters who are surveyed in three rounds, 1998, 2006, and 2012; and in 2006, 2012, and 2018. Lastly, daughters who are observed in all four rounds, 1998, 2006, 2012, and 2018.

4 Results

In this section I present results for the first and second stage using the non-singleton child instrument for families with two or more children. Table 3 shows the results from estimating equations (6) and (7). The first column in each of the samples shows the estimated results from the first stage (equation 6). The coefficient on households with twins ("HH with twins") is the estimated $\hat{\alpha}_1$ in equation (6). The coefficient on the natural log of total wages earned within the household ("Log total HH wages") is the estimated $\hat{\alpha}_2$ in equation (6). The second column in table 3 shows the estimated results from the second stage (equation 7). The coefficient on the number of sons and daughters in a family ("N children") is $\hat{\beta}_1$.

The last two columns in table 3 show the estimated results using the pooled sample. Robust standard errors, clustered at the household level (as treatment and the instrument vary at the household level), are reported in parentheses. All the models include controls for the mother's education, employment status, age at first marriage, the birth rank of the child, and district fixed effects. The pooled sample includes time fixed effects. Table 3 also includes the mean of the dependent variable in the second stage (son or daughter schooling years), the number of observations in the regressions, number of households and number of districts. The effective F-statistic for Montiel Pflueger robust weak instrument test is also reported at the bottom of the table, along with different asymptotic bias fractions (Tau).

4.1 The Q-Q tradeoff

In all rounds of the ELMPS in table 3 (and in other tables with different specifications), the first stage results show that the twins instrument is a strong predictor of the number of sons and daughters in a family (satisfying the relevance criterion). The Montiel Pflueger effective F-statistic for the instrument in 1998 shows that the predicted effect of twins on family size is at least 30 percent biased. In fact, in all other specifications of equations (6) and (7) the twins instrument in the 1998 round suffers from the similar bias. This is possibly due to the data quality issues in the 1998 round, mainly because it did not include a fertility module.

In other rounds, however, the twins instrument is strongly relevant to family size and significantly predicts a 0.497, 0.605, and 0.369 increase in the number of siblings in the rounds 2006, 2012, and 2018, respectively. The first stage results are consistent with other similar estimates of the first stage of family size on twins (J. D. Angrist and Evans 1998; J. Angrist, Lavy, and Schlosser 2010). The Montiel Pflueger effective F-statistic for the instrument in the 2006 and 2018 rounds rejects the null that the twins instrument is weak with potential asymptotic bias between 5-20 percent. In the 2012 round and both the pooled cross-section samples (with and without the 1998 round), the Montiel Pflueger effective F-statistic for the instrument rejects the null that the twins instrument is weak with potential asymptotic bias less than 5 percent.

The second stage results of child schooling on the predicted number of siblings show a seemingly negative relationship. The estimated negative $\hat{\beta}_1$, however, is not significantly different from zero in any of the rounds and the pooled samples, at the 90 percent confidence interval. Results from table 3 show that the Q-Q tradeoff in families with two or more children who are 4-17 years old is not statistically significant in Egypt. The results obtained suggest that fertility has no effect, significantly different from zero, on child schooling in Egypt between 1998 and 2018.

4.2 Gender differentials in human capital investment

Tables 4 and 5 show the estimated Q-Q tradeoff for sons and for daughters separately, respectively. The first stage results for both sons and for daughters support the relevance of the twins instrument, except for boys in 1998 (the first column in table 4). Similar to the findings in table 3, I find not significant effect of fertility on the schooling years of sons or daughters. It is important to interpret the gender heterogeneity results with caution. The effective F-statistic for the twins instrument for sons and for daughters in tables 4 and 5, shows that the instrument is predicting family size with increasing bias, albeit significant coefficient. Also, the sample size for the models predicting gender differentials is halved compared to the full sample in table 3.

4.3 Fertility and the daughter's employment status

Table 6 shows the estimated results from the repeated cross-section and pooled samples of the effect of fertility on the probability of daughters (who are in the labor force) to be currently employed. The effective F-statistic in table 6 reflects similar instrument performance to the regressions in the tables 3-5. The estimated $\hat{\beta}_1$ in table 6, shows that there is not significant effects of family size on the probability of daughters being employed. This finding is consistent across all rounds of the ELMPS survey. Yet again, the results reported in table 6 must be interpreted with caution. The sample of daughters in families with two or more children who are currently in the labor force, includes only between 4 to 9% who are currently employed. Thus, this a sample of very unlikely to work females.

Table 6 also shows that the prevalence of public sector jobs at the district level is significantly associated with having less children. The first stage results in table 7 show that a 1 percentage point increase in the share of workers in the public sector is associated with a reduction in fertility by 2.0, 2.6, 1.5, and 1.03 children in 1998, 2006, 2012, and 2018, respectively. I also test for whether this effect is jointly significant across the years by interacting the share of public sector workers with the survey round in the pooled sample regressions. The results show that the effect of public sector jobs availability is also jointly significant and has been declining over the years. As for the estimated $\hat{\beta}_1$ in table 7, the results show that fertility has no significant effect on daughters' employment in any of the rounds.

Table 7 shows the model estimates of the daughter's employment status in 6 panel samples between 1998 and 2018. The first six columns show the model estimates for daughters who were surveyed in two rounds only, 1998 and 2006, 2006 and 2012, and 2012 and 2018. The seventh to tenth columns are for daughters observed in three rounds, 1998, 2006, and 2012; and in 2006, 2012, and 2018. The last two columns are for daughters observed in all four rounds, 1998, 2006, 2012, and 2018. All panel regressions in table 7 show that the instrument significantly predicts the number of siblings, except for the 2006/2012 panel. However, the instrument only performs well in the two three-round panels, 1998-2012 and 2006-2018, with asymptotic bias in the instrument around 5%. In all panel model estimated in table 7, the results show that exposure to larger families during childhood does not affect the probability that the daughter would be working later in time.

Table 3: Repeated cross-section of the child's education on family size in families with 2+ children

	N children	Child schooling	N children	Child schooling	N children	Child schooling	N children	Child schooling	N children	Child schooling	N children	Child schooling
	1998		2006		2012		2018		Pooled		Pooled without 1998	
HH with twins	0.410**		0.497***		0.605***		0.369***		0.473***		0.478***	
	(0.188)		(0.109)		(0.096)		(0.072)		(0.052)		(0.052)	
N children		-0.642		-0.124		0.112		-0.391		-0.201		-0.104
		(1.294)		(0.719)		(0.601)		(0.758)		(0.376)		(0.394)
Mean schooling	4.86		5.12		4.74		4.72		4.83		4.83	
Observations	4,237		4,846		6,296		8,072		23,451		19,214	
N households	1,857		2,342		3,259		4,031		11,489		9,632	
N districts	31		31		35		34		36		35	
Uncentered R-squared	-0.095		0.029		0.033		-0.014		0.005		0.019	
Montiel Pflueger robust weak instrument test:												
Tau = 5%	37.42		37.42		37.42		37.42		37.42		37.42	
Tau = 10%	23.11		23.11		23.11		23.11		23.11		23.11	
Tau = 20%	15.06		15.06		15.06		15.06		15.06		15.06	
Tau = 30%	12.04		12.04		12.04		12.04		12.04		12.04	
Effective F statistic	4.77		20.65		39.43		25.89		84.02		84.61	

Notes: The outcome in all regressions is the child's years of schooling at the time of the survey round. Robust standard errors clustered at the household level are reported in parentheses. All models include controls for the household's total monthly wage, birth rank of the child, the mother's age at first marriage, education, employment status, and district fixed effects. The pooled sample includes survey round fixed effects. The sample is restricted to sons and daughters who are 4-17 years old in households with 2+ children. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4: Repeated cross-section of the son's education on family size in families with 2+ children

	N children	Son schooling	N children	Son schooling	N children	Son schooling	N children	Son schooling	N children	Son schooling	N children	Child schooling
	1998		2006		2012		2018		Pooled		Pooled without 1998	
HH with twins	0.381		0.490***		0.526***		0.358***		0.442***		0.445***	
	(0.262)		(0.139)		(0.114)		(0.084)		(0.065)		(0.063)	
N children		-1.401		0.588		0.485		0.032		-0.008		0.248
		(1.818)		(0.841)		(0.898)		(0.983)		(0.504)		(0.535)
Mean schooling	4.94		5.21		4.76		4.73		4.87		4.86	
Observations	2,174		2,500		3,217		4,206		12,098		9,924	
N households	1,405		1,741		2,312		2,952		8,411		7,006	
N districts	31		30		35		33		36		35	
Uncentered R-squared	-0.418		0.083		0.041		0.048		0.034		0.052	
Montiel Pflueger robust weak instrument test:												
Tau = 5%	37.42		37.42		37.42		37.42		37.42		37.42	
Tau = 10%	23.11		23.11		23.11		23.11		23.11		23.11	
Tau = 20%	15.06		15.06		15.06		15.06		15.06		15.06	
Tau = 30%	12.04		12.04		12.04		12.04		12.04		12.04	
Effective F statistic	2.12		12.39		21.17		18.00		46.21		50.53	

Notes: The outcome in all regressions is the son's years of schooling at the time of the survey round. Robust standard errors clustered at the household level are reported in parentheses. All models include controls for the household's total monthly wage, birth rank of the child, the mother's age at first marriage, education, employment status, and district fixed effects. The pooled sample includes survey round fixed effects. The sample is restricted to sons who are 4-17 years old in households with 2+ children. * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 5: Repeated cross-section of the daughter's education on family size in families with 2+ children

	N children	Daughter schooling	N children	Daughter schooling	N children	Daughter schooling	N children	Daughter schooling	N children	Daughter schooling	N children	Child schooling
	1998		2006		2012		2018		Pooled		Pooled without 1998	
HH with twins	0.522**		0.467***		0.679***		0.368***		0.503***		0.501***	
	(0.241)		(0.132)		(0.130)		(0.104)		(0.069)		(0.071)	
N children		0.628		-0.944		-0.118		-0.885		-0.436		-0.506
		(1.447)		(1.027)		(0.709)		(1.045)		(0.468)		(0.504)
Mean schooling	4.78		5.02		4.72		4.72		4.79		4.80	
Observations	2,063		2,344		3,079		3,865		11,353		9,290	
N households	1,327		1,604		2,185		2,695		7,813		6,486	
N districts	31		30		34		33		35		34	
Uncentered R-squared	0.059		-0.149		0.015		-0.133		-0.040		-0.053	
Montiel Pflueger robust weak instrument test:												
Tau = 5%	37.42		37.42		37.42		37.42		37.42		37.42	
Tau = 10%	23.11		23.11		23.11		23.11		23.11		23.11	
Tau = 20%	15.06		15.06		15.06		15.06		15.06		15.06	
Tau = 30%	12.04		12.04		12.04		12.04		12.04		12.04	
Effective F statistic	4.68		12.57		27.34		12.38		53.81		49.32	

Notes: The outcome in all regressions is the daughter's years of schooling at the time of the survey round. Robust standard errors clustered at the household level are reported in parentheses. All models include controls for the household's total monthly wage, birth rank of the child, the mother's age at first marriage, education, employment status, and district fixed effects. The pooled sample includes survey round fixed effects. The sample is restricted to daughters who are 4-17 years old in households with 2+ children. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 6: Repeated cross-section of daughter's employment status on family size in families with 2+ children

	N children	Daughter working	N children	Daughter working	N children	Daughter working	N children	Daughter working	N children	Daughter working	N children	Daughter working
	1998		2006		2012		2018		Pooled		Pooled without 1998	
HH with twins	0.323*		0.620***		0.403***		0.427***		0.444***		0.458***	
	(0.194)		(0.132)		(0.103)		(0.074)		(0.054)		(0.056)	
N children		-0.195		-0.021		0.039		-0.008		-0.008		0.006
		(0.137)		(0.036)		(0.043)		(0.024)		(0.018)		(0.019)
Daughter schooling	-0.004	0.005**	0.010	0.005***	0.028***	0.004***	0.031***	0.003**	0.017***	0.004***	0.022***	0.004***
	(0.009)	(0.003)	(0.007)	(0.002)	(0.005)	(0.001)	(0.005)	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)
Public sector jobs	-1.970***	-0.377	-2.580***	0.130	-1.544***	0.159*	-1.037***	0.010				
	(0.412)	(0.290)	(0.306)	(0.116)	(0.312)	(0.086)	(0.244)	(0.035)				
Public sector jobs, 1998									-2.183***	0.004		
									(0.382)	(0.073)		
Public sector jobs, 2006									-2.290***	0.103	-2.370***	0.136*
									(0.266)	(0.069)	(0.270)	(0.073)
Public sector jobs, 2012									-1.495***	0.118**	-1.539***	0.141***
									(0.262)	(0.048)	(0.268)	(0.050)
Public sector jobs, 2018									-0.963***	-0.006	-0.986***	0.014
									(0.218)	(0.031)	(0.220)	(0.032)
% daughters working	0.07		0.09		0.05		0.03		0.05		0.05	
Observations	4,002		5,325		6,127		7,599		23,053		19,051	
N households	2,295		3,186		3,904		4,902		14,287		11,992	
N districts	31		31		34		34		35		34	
Uncentered R-squared	-0.997		0.097		0.073		0.053		0.088		0.092	
Montiel Pflueger robust weak instrument test:												
Tau = 5%	37.42		37.42		37.42		37.42		37.42		37.42	
Tau = 10%	23.11		23.11		23.11		23.11		23.11		23.11	
Tau = 20%	15.06		15.06		15.06		15.06		15.06		15.06	
Tau = 30%	12.04		12.04		12.04		12.04		12.04		12.04	
Effective F statistic	2.75		22.01		15.30		32.98		66.80		66.44	

Notes: The outcome in all regressions is whether a daughter observed participated in any employment during the past seven days. Robust standard errors clustered at the household level are reported in parentheses. All models include controls for the daughter's years of schooling, her marital status, birth rank, and mother characteristics such as age at first marriage, education, and employment status and district fixed effects. The prevalence of public sector jobs is calculated as the mean share of workers in the public sector at the district level. The pooled sample includes survey round fixed effects. * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 7: Panel of the daughter's employment status on family size in families with 2+ children

	N children	Daughter working	N children	Daughter working	N children	Daughter working	N children	Daughter working	N children	Daughter working	N children	Daughter working
	1998	2006	2006	2012	2012	2018	1998	2012	2006	2018	1998	2018
	Two rounds		Two rounds		Two rounds		Three rounds		Three rounds		Four rounds	
HH with twins	0.683**		0.394		0.695**		2.544***		0.521***		0.794**	
	(0.309)		(0.280)		(0.270)		(0.338)		(0.093)		(0.369)	
N children		-0.111		0.369		0.080		0.016		0.036		0.347
		(0.100)		(0.369)		(0.089)		(0.036)		(0.065)		(0.314)
Daughter schooling	-0.043**	-0.003	0.126***	-0.049	-0.008	0.002	0.008	0.018**	0.023**	0.001	-0.059*	0.039
	(0.022)	(0.009)	(0.017)	(0.045)	(0.016)	(0.004)	(0.021)	(0.008)	(0.009)	(0.003)	(0.030)	(0.026)
Public sector jobs	-2.137***	0.202	-1.749***	0.559	-0.274	0.108	-3.016**	0.055	-0.766***	0.036	-1.793	1.782**
	(0.591)	(0.322)	(0.557)	(0.672)	(0.799)	(0.127)	(1.189)	(0.392)	(0.241)	(0.078)	(1.343)	(0.853)
% daughters working in last round	0.11		0.03		0.04		0.23		0.04		0.35	
Observations	444		392		710		210		1,580		176	
N households	383		304		537		191		1,198		155	
N districts	25		22		27		23		29		22	
Uncentered R-squared	-0.060		-2.388		-0.022		0.142		0.027		-0.476	
Montiel Pflueger robust weak instrument test:												
Tau = 5%	37.42		37.42		37.42		37.42		37.42		37.42	
Tau = 10%	23.11		23.11		23.11		23.11		23.11		23.11	
Tau = 20%	15.06		15.06		15.06		15.06		15.06		15.06	
Tau = 30%	12.04		12.04		12.04		12.04		12.04		12.04	
Effective F statistic	4.86		1.96		6.59		56.26		31.07		4.52	

Notes: The outcome in all regressions is whether a daughter observed in the earliest round, in each of the panels, participated in any employment during the past seven days at the latest round she is observed. The first stage regression runs the total number of the daughter's siblings at the earliest round she is observed, in each of the panels, on the presence of twin siblings at that time. In both the first and second stages the sample is limited to daughters who were less than 18 years old at the earliest round they are observed in each of the panels. Robust standard errors clustered at the household level in which the daughter is first observed are reported in parentheses. All models include controls for the marital status of the daughter, her birth rank, the mother's age at first marriage, education, employment status, and district fixed effects all at the first round the daughter is observed in each of the panels. The prevalence of public sector jobs is calculated as the mean share of workers in the public sector at the district level, all at the latest round the daughter is observed. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

5 Conclusion

In expanding the understanding of the Q-Q tradeoff, this paper uses evidence from Egypt to test for the existence of such tradeoff and aims to quantify the effect of fertility on education and labor market outcomes. The findings contribute to this discourse by explaining the nuances of family planning, education, and labor outcomes for females in Egypt. In this study, I find no significant impact of fertility on child schooling and no significant gender differentials in human capital investment. Contrary to expectations, increasing family size does not significantly affect child schooling in Egypt between 1998 and 2018. In the analytical samples of families with two children or more used in the model, sons and daughters had an already low average of 5 years of schooling. Fertility in Egypt does not appear to explain the low education outcomes in Egypt, nor does it contribute to female employment. Women from larger families did not show significantly different probabilities of being employed.

The absence of significant effects of family size on child schooling, gender differentials, and female employment in the context of a developing country is intriguing. Such results resonate with findings from developed countries where ample welfare systems diminish the Q-Q tradeoff, which is not the case in Egypt. The findings in this paper suggest that policies focusing solely on family size might not be sufficient to drive significant changes in educational and labor outcomes. Family size has already been steadily declining from 6.46 children in 1998 to 5.15 in 2018, yet the average schooling years has been declining within the same period from 7.12 years in 1998 to 6.91 in 2018. This insight is vital for shaping future family planning and educational policies in Egypt.

The Q-Q model is built on optimizing the household utility from child quantity and child quality, constrained by a household budget, assuming that sending children to school increases the household utility from child quality or employment prospects. The results in this paper, suggest that other binding constraints such as school quality and returns to education in the Egyptian labor market could be driving child education outcomes and female employment.

The negative significant effect of prevailing public sector jobs on fertility is expected, as public sector employment is the employer of choice for women in Egypt. This increases the opportunity cost of child bearing for women and thus reduces fertility. In fact, the naïve OLS estimates in the first stage results in table 7 for the effect of public sector jobs on family size, albeit likely overestimating, predicts a larger negative effect on family size than the twins instrument. Despite rising female education levels, the stagnation in female employment remains a paradox and this paper shows that it is not affected by fertility. This research opens new avenues to explore the role of educational investment in marriage markets and its impact on female labor force participation.

6 References & Endnotes

Aaronson, Daniel, Fabian Lange, and Bhashkar Mazumder. 2014. "Fertility Transitions Along the Extensive and Intensive Margins." *American Economic Review* 104 (11): 3701–24. http://dx.doi.org/10.1257/aer.104.11.3701.

Angrist, Joshua D., and William N. Evans. 1998. "Children and Their Parents' Labor Supply: Evidence from Exogenous Variation in Family Size." *The American Economic Review* 88 (3): 450–77.

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.

Åslund, Olof, and Hans Grönqvist. 2010. "Family Size and Child Outcomes: Is There Really No Trade-Off?" *Labour Economics* 17 (1): 130–39. https://doi.org/10.1016/j.labeco.2009.05.003.

Assaad, Ragui, and Ghada Barsoum. 2019. "Public Employment in the Middle East and North Africa." *Institute of Labor Economics (IZA) World of Labor* ISSN 2054- (463). https://doi.org/10.15185/izawol.463.

Assaad, Ragui, Rana Hendy, Moundir Lassassi, and Shaimaa Yassin. 2020. "Explaining the MENA Paradox: Rising Educational Attainment yet Stagnant Female Labor Force Participation." *Demographic Research* 43 (September): 817–50. https://doi.org/10.4054/DEMRES.2020.43.28.

Assaad, Ragui, and Caroline Krafft. 2015. "An Empirical Analysis of the Economics of Marriage in Egypt, Morocco, and Tunisia." In *The Oxford Handbook of Africa and Economics: Policies and Practices*, edited by Celestin Monga and Justin Yifu Lin. Vol. 2. Oxford, UK: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199687107.013.54.

Barro, Robert J., and Gary S. Becker. 1989. "Fertility Choice in a Model of Economic Growth." *Econometrica* 57 (2): 481. https://doi.org/10.2307/1912563.

Becker, Gary S. 1960. "An Economic Analysis of Fertility." In *Demographic and Economic Change in Developed Countries*, edited by George B. Roberts, 209–40. Columbia University Press. http://www.nber.org/chapters/c2387.

———. 1981. "The Demand for Children." In *A Treatise on the Family*, edited by Gary S. Becker, 135–78. Harvard University Press.

Becker, Gary S., and H Gregg Lewis. 1973. "On the Interaction between the Quantity and Quality of Children." *Journal of Political Economy* 81 (2): S279–88.

Becker, Gary S, and Nigel Tomes. 1976. "Child Endowments and the Quantity and Quality of Children." *Journal of Political Economy* 84 (4): S143–62.

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." *The Quarterly Journal of Economics* 120 (2): 669–700.

Cáceres-Delpiano, Julio. 2006. "The Impacts of Family Size on Investment in Child Quality." *Journal of Human Resources* 41 (4): 738–54. https://doi.org/10.3368/jhr.xli.4.738.

Doepke, Matthias. 2015. "Gary Becker on the Quantity and Quality of Children." *Journal of Demographic Economics* 81:59–66. https://doi.org/10.1017/dem.2014.8.

Doepke, Matthias, Anne Hannusch, Fabian Kindermann, and Michèle Tertilt. 2022. "The Economics of Fertility: A New Era."

Feng, Wang, Yong Cai, and Baochang Gu. 2013. "Population, Policy, and Politics: How Will History Judge China's One-Child Policy?" *Population and Development Review* 38 (SUPPL.1): 115–29. https://doi.org/10.1111/j.1728-4457.2013.00555.x.

Galor, Oded. 2005a. "Chapter 4 From Stagnation to Growth: Unified Growth Theory." *Handbook of Economic Growth* 1 (SUPPL. PART A): 171–293. https://doi.org/10.1016/S1574-0684(05)01004-X.

———. 2005b. "The Demographic Transition and the Emergence of Sustained Economic Growth." *Journal of the European Economic Association* 3 (2): 494–504.

———. 2012. "The Demographic Transition: Causes and Consequences." *Cliometrica* 6 (1): 1–28. https://doi.org/10.1007/s11698-011-0062-7.

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): 806–28. https://doi.org/10.1257/aer.90.4.806.

Guinnane, Timothy W. 2011. "The Historical Fertility Transition: A Guide for Economists." *Journal of Economic Literature* 49 (3): 589–614. https://doi.org/10.1257/jel.49.3.589.

Hanushek, Eric A. 1992. "The Trade-off between Child Quantity and Quality." *Journal of Political Economy* 100 (1): 84–117.

Huang, Wei. 2021. "Family Size and Children' s Education: Evidence from the One-Child Policy in China." *Population Research and Policy Review*. https://doi.org/10.1007/s11113-021-09638-7.

Huang, Wei, Xiaoyan Lei, and Ang Sun. 2020. "Fertility Restrictions and Life-Cycle Outcomes: Evidence from the One-Child Policy in China." *The Review of Economics and Statistics*, no. March 2021, 1–41. https://doi.org/10.1162/rest_a_00921.

Krafft, Caroline. 2020. "Why Is Fertility on the Rise in Egypt? The Role of Women's Employment Opportunities." *Journal of Population Economics* 33 (4): 1173–1218. https://doi.org/10.1007/s00148-020-00770-w.

Lee, Jungmin. 2008. "Sibling Size and Investment in Children's Education: An Asian Instrument." *Journal of Population Economics* 21 (4): 855–75. https://doi.org/10.1007/s00148-006-0124-5.

Lee, Ming Hsuan. 2012. "The One-Child Policy and Gender Equality in Education in China: Evidence from Household Data." *Journal of Family and Economic Issues* 33 (1): 41–52. https://doi.org/10.1007/s10834-011-9277-9.

Li, Bingjing, and Hongliang Zhang. 2017. "Does Population Control Lead to Better Child Quality? Evidence from China's One-Child Policy Enforcement." *Journal of Comparative Economics* 45 (2): 246–60. https://doi.org/10.1016/j.jce.2016.09.004.

Li, Hongbin, Junsen Zhang, and Yi Zhu. 2008. "The Quantity-Quality Trade-off of Children in a Developing Country: Identification Using Chinese Twins." *Demography* 45 (1): 223–43. https://doi.org/10.1353/dem.2008.0006.

Liu, Haoming. 2014. "The Quality-Quantity Trade-off: Evidence from the Relaxation of China's One-Child Policy." *Journal of Population Economics* 27 (2): 565–602. https://doi.org/10.1007/s00148-013-0478-4.

Mogstad, Magne, and Matthew Wiswall. 2016. "Testing the Quantity-Quality Model of Fertility: Estimation Using Unrestricted Family Size Models." *Quantitative Economics* 7 (1): 157–92. https://doi.org/10.3982/qe322.

Olea, José Luis Montiel, and Carolin Pflueger. 2013. "A Robust Test for Weak Instruments A Robust Test for Weak Instruments." *Journal of Business & Economic Statistics* 31 (3). https://doi.org/10.1080/00401706.2013.806694.

Qian, Nancy. 2009. "Quantity-Quality and the One Child Policy: The Only-Child Disadvantage in School Enrollment in Rural China." *National Bureau of Economic Research* NBER Worki. https://doi.org/10.3386/w14973.

Rosenzweig, Mark R., and Kenneth I. Wolpin. 1980. "Testing the Quantity-Quality Fertility Model: The Use of Twins as a Natural Experiment." *The Econometric Society* 48 (1): 227–40.

Schultz, T. Paul. 1997. "Demand for Children in Low Income Countries." In *Handbook of Population and Family Economics*, *Chapter 8*, 1:349–430. https://doi.org/10.1016/S1574-003X(97)80025-6.

[i] The Arab Spring is a series of large-scale protests and uprisings in the Middle East and North Africa, in countries including: Tunisia, Egypt, Syria, Libya, and Yemen. The results of such events include the deposing of four regimes in Tunisia, Egypt, Libya, and Yemen.