Why is Fertility on the Rise in Egypt? The Role of Women's Employment Opportunities

By Caroline Krafft[1]

Abstract

Can declining employment opportunities for women reverse the fertility transition? This paper presents new evidence that the demographic transition has not just stalled, but in fact reversed in Egypt. After falling for decades, fertility rates are increasing. The drivers of rising fertility rates are examined, with a particular focus on the role of declining public sector employment opportunities for women. By using unique data with detailed fertility and employment histories, the effects of public sector employment opportunities on women's fertility are estimated. Estimates are calculated by examining the effect of public sector employment on the spacing and occurrence of births using discrete-time hazard models, the results of which are then used to simulate total fertility rates. The potential endogeneity of employment is addressed by incorporating woman-specific fixed effects, incorporating local employment opportunities rather than women's own employment, and using local employment opportunities as an instrument. Results indicate that the decrease in public sector employment, which is particularly appealing to women, has contributed to the rise in fertility.

Keywords: Fertility, Female labor supply, Employment and Fertility, Egypt, Middle East and North Africa

JEL classifications: J13; J16; J21; J22; O12

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1 Introduction

The demographic transition—the shift from a high mortality, high fertility pattern to low mortality, greater life expectancy, and lower (replacement) fertility—leads to dramatic changes in the structure of societies and economies. The period prior to and during the transition, characterized by rapid population growth, presents a particular challenge. Rapid population growth tends to place serious pressure on public services, natural resources, and the labor market, but the demographic transition can also provide a "demographic dividend" to accelerate growth and generate a variety of other benefits for society (Canning & Schultz, 2012; Reher, 2011). Thus, the pattern and progress of a country's demographic transition has critical implications for its economy and society.

The determinants of the demographic transition generally, and fertility in particular, are complex. As well as the relatively obvious health and demographic factors that affect fertility, social and economic forces also shape fertility (Schultz, 1969). Past research has primarily focused on how different factors could speed or stall the fertility transition (Bongaarts, 2006). This paper demonstrates that the fertility transition has not just stalled but in fact has started reversing in Egypt, where fertility rates have risen. Although a number of different factors are likely to be contributing to the rise in fertility, this paper specifically tests whether the changing landscape of employment opportunities for women, namely the decline of the public sector as an employer, has contributed to rising fertility.

Evidence in Egypt indicated that, despite some stalls, overall fertility had been declining through 2008 (Bongaarts, 2008; El-Zanaty & Way, 2009). The most recent evidence, however, indicates that the crude birth rate has been rising in Egypt, from a low of 26 (births per thousand people) in 2003-2006 to a high of 32 in 2012 (Central Agency for Public Mobilization and Statistics, 2015). These rising birth rates could be due to an increase in fertility or to the changing age structure of the population. Egypt has a substantial youth bulge, and as of 2012 the peak of the youth bulge was in the 25-29 age range (Assaad & Krafft, 2015a), the prime childbearing age. This paper demonstrates that the rising tide of births is because fertility has increased in Egypt.

Rising fertility in Egypt has coincided with substantial changes in the structure of the economy, and in particular changes in the types of employment available. The share of employment in the public sector has declined substantially, while informal private sector employment has increased. Informal and private sector employment opportunities are substantially less appealing and available to women than public sector jobs (Nassar, 2003). In part due to the changing structure of the economy, the female employment rate has decreased in recent years. This decline in female employment is particularly surprising given that factors associated with higher female labor force participation, such as female education, have been increasing (Assaad & Krafft, 2015a, 2015b).

That changes in the structure of employment may have increased fertility is consistent with economic theories that recognize that one of the costs of children is an opportunity cost—the value of parents' time. If, for women, employment opportunities decrease, then the relative cost of childbearing will decrease, potentially increasing fertility. However, at the same time household income will fall, and the net effect of these income and price effects is theoretically ambiguous (Becker, 1960; Schultz, 1997). The global evidence to date on the impact of employment on fertility is primarily focused on rising relative wages increasing women's employment and decreasing fertility (Galor & Weil, 1996; Heckman & Walker, 1990; Schultz, 1985). There are also a few studies directly examining the impact of increasing employment opportunities for women on their fertility (Fang, Eggleston, Rizzo, & Zeckhauser, 2013; Jensen, 2012). However, papers on employment opportunities have addressed fertility behaviors primarily for young women, not lifetime fertility. In contrast, this paper estimates the impact of economic opportunities for women on the timing and occurrence of births over the full range of women's childbearing years, demonstrating how economic opportunities have contributed to the recent rise in fertility.

This paper investigates, for the case of Egypt, both how the fertility rate has evolved over time and how childbearing responds to women's economic opportunities, specifically public sector employment. The paper proceeds as follows: Section 2 reviews the theoretical and empirical evidence on fertility and work. Section 3 presents the conceptual model for understanding how work opportunities may impact fertility. Section 4 discusses the methods required to estimate fertility and its relationship with employment. Section 5 describes the data used to estimate the relationship between fertility and employment opportunities. Section 6 shows the descriptive results, in terms of patterns of fertility and related phenomena. Section 7 presents the estimated hazard models for the relationship between fertility and employment opportunities. Discussion and conclusions are provided in section 8.

2 Theories and Evidence on Fertility and Work

2.1 Demographic Transition Theories

Demographic transition theories provide the over-arching framework for understanding long-term trends in fertility and their relationship with social and economic forces. Demographic transition theories specifically provide insight into the link between declines in fertility and increases in female labor force participation (Bloom, Canning, Fink, & Finlay, 2009; Canning & Schultz, 2012; Kim, 2010; Kirk, 1996). The forces that bring about fertility declines and subsequent increases in female labor force participation can be broadly dubbed “modernization,” an umbrella term that has been associated with a variety of factors, including improvements in health and decreases in mortality, changing norms and values, and a changing economic landscape. Increases in (female) education may play a key role in modernizing changes, due to education’s links with wages (returns to education), work, and contraceptive use. Essentially, “modern” economic arrangements lead to increases in female labor force participation and reductions in childbearing.

The relationship between fertility and female labor force participation that is usually posited is that rising economic opportunities for women can cause decreases in fertility. This paper investigates an alternative form of this relationship—whether declining opportunities for women in Egypt increased fertility. While demographic transition theories recognize that socioeconomic changes raise the costs and decrease the benefits of children, and theorize that this relationship drives declines in fertility (Bongaarts, 2006), these theories have limited insight into stalls in fertility declines (Bongaarts, 2006, 2008) and have not taken up potential reversals in fertility trends.

2.2 The Economics of Fertility

Early economic theories of fertility can be called the “new home economics” (Kirk, 1996), a school of thought led by Becker (1960) and Schultz (1973), which extended traditional economic theories of consumer choice to institutions such as the family. In this basic framework for the economics of fertility, a household (married couple) decides how many children to have by solving a utility maximization problem into which children enter as a source of utility

(Becker, 1960; Willis, 1973). As well as being sources of satisfaction, children have a cost in terms of time and money. The cost of the child is characterized as a function of (the mother's) time,[1] as well as more explicit costs (Schultz, 1973; Willis, 1973). These costs have implications in terms of the allocation of women's time. If the cost of a mother's time increases (i.e. women's wages increase), there may be a decrease in the number of children. This relationship is the main mechanism through which women's economic opportunities can impact fertility, particularly in societies, like Egypt, where the household division of labor allocates child-rearing responsibilities to women (Hoodfar, 1997).

Early formulations of the economics of fertility suffered from a variety of problems. They tended to be static models and did not incorporate uncertainty (Schultz, 1973; Willis, 1973). Additionally, they relied heavily on the unitary household model, where individual members' utility could be readily aggregated, perhaps because an altruistic household head maximizes the household's utility (Willis, 1973). The unitary household model's assumptions are questionable (Birdsall, 1988) and have not held up to empirical scrutiny (Udry, 1996). As an alternative, models that allow for bargaining between spouses over fertility decisions show substantial promise (Rasul, 2008). Although theoretical approaches to the economics of fertility vary, it is difficult to dispute that there is an opportunity cost, in terms of women's time, of raising children.

2.3 Empirical Evidence on Fertility and Work

The empirical literature from both developed (Angrist & Evans, 1998; Jacobsen, Pearce,

[1] An implicit assumption in such theories is that women are responsible for child care.

& Rosenbloom, 1999) and developing countries (Cáceres-Delpiano, 2012; Cruces & Galiani, 2007) provides substantial evidence that fertility impacts female employment. These studies make convincing causal arguments for fertility shocks affecting female employment based on instrumental variables methods, identifying the effect of fertility based on exogenous variation in child sex (Angrist & Evans, 1998; Cruces & Galiani, 2007), or the occurrence of multiple births (Cáceres-Delpiano, 2012; Jacobsen, Pearce, & Rosenbloom, 1999).

While the focus in the empirical literature has been on the impact of fertility on employment, there have also been investigations into reverse causality or interdependence. Lloyd (1991) recognizes the interdependence of women's work and fertility, and argues that the expansion of work opportunities for women can decrease their fertility. A substantial challenge, which Lloyd does not overcome, is identifying a causal impact from work to fertility. This challenge has long plagued even developed country research (Cramer, 1980). There are convenient instruments for fertility, such as child sex and multiple births, but there are not as many easily identifiable sources of exogenous variation in employment. A more popular alternative than studying the impact of employment on fertility is studying the impact of education on fertility, a relationship that is also often linked to work. In general, increases in (women's) education have been linked to decreases in fertility (Angeles, Guilkey, & Mroz, 2005; Bledsoe, Casterline, Johnson-Kuhn, & Haaga, 1999; Lavy & Zablotsky, 2015; Osili & Long, 2008), but there are exceptions (Bledsoe, Casterline, Johnson-Kuhn, & Haaga, 1999; McCrary & Royer, 2011).

The papers that do attempt to estimate the causal relationship between women's work and fertility suggest that women's employment decreases fertility. Fang et al. (2013) use the availability of bus stops as an instrument for women's (endogenous) current employment and its impact on fertility to date in China. They find that employment decreases fertility to date by 0.5 births. However, when they sub-divide their sample into those who are unlikely to have more children and those who may still have additional children, the reduction in fertility drops to 0.17 for younger women and there is no effect on fertility for women who are unlikely to have more children, effectively no effect on completed childbearing. That their original result disappears when they sub-divide their sample casts substantial doubt on their initial result and their identification strategy.

Jensen (2012) solves the identification problem with an experiment, randomly providing employment recruiting services to young women (15-21) in villages in rural India. After three years, young women in treatment villages were more likely to be employed, were 5-6 percentage points less likely to be married or have children, and expressed, on average, a desire for 0.35 fewer children. Due to the short time span of the study, it is unknown whether delays in marriage, decreased early childbearing, and lower desired fertility will translate into decreases in completed fertility.

One key strand of the literature linking women's employment and fertility theorizes that it is changes in women's wages (relative to men's) that increase their employment and thus decrease fertility, potentially due to changes in the technology of production (Galor & Weil, 1996; Schultz, 1997). Schultz (1985) empirically demonstrates how wages might affect fertility based on increases in the price of butter relative to grains in the 1880s in Sweden, which changed the relative wages of women, since dairy processing was women's work. This increase in the value of women's time (relative to men's) is shown to be responsible for a quarter of the decline in fertility over several decades in Sweden. Similar relationships have been found for a more recent study in Sweden, as well as examinations of Thailand and India (Heckman & Walker, 1990; Mukhopadhyay, 1994; Rosenzweig & Evenson, 1977). However, there continue to be debates about the (female) income and fertility relationship and whether the results are robust. One strand of the literature discusses whether, after a certain point, rising female wages might increase fertility (Ahn & Mira, 2002; Kögel, 2004; Martínez & Iza, 2004). Overall, the evidence indicates that increases in the value of women's time will probably, but not definitely, decrease fertility. The reverse case, when the market value of women's time declines, to the best of the author's knowledge, has not been examined.

2.4 Division of Labor, Employment, and Childbearing in Egypt

The sexual division of labor within Egyptian households is such that men's roles are limited to providing for the family (Hoodfar, 1997), i.e. their primary responsibility is engaging in some type of employment. In contrast, women's primary responsibilities are attending to husband, children, and home. Women can work outside the home only if their domestic responsibilities can be performed at least as well—if not better—when combined with market work (Hoodfar, 1997). There is no decrease in married women's hours of domestic work (carework) if they also engage in market-based employment (Assaad & Krafft, 2014). So while women in Egypt can mix employment and child-production roles, the tradeoffs in doing so vary substantially by the nature of their work and its compatibility with domestic roles.

Public sector jobs are much easier to reconcile with marriage and childbearing than private sector employment. Married women with children are more likely to report that they worked during their last pregnancy if they were working for a wage in the public sector (79%) compared to the private formal sector (64%) or private informal sector (46%). One reason for this disparity across sectors is the substantially more generous maternity benefits for public wage workers. Among women working during their last pregnancy, 86% of those in public sector wage work had a six-week or longer paid maternity leave, in comparison with 47% of private formal wage workers and just 12% of private informal wage workers (Assaad & El-Hamidi, 2009). Women working in the government can also take up to two years of unpaid leave for each of their first three children, above and beyond their paid maternity leave (Hoodfar, 1997). In part due to the substantially different nature and benefits of public sector jobs, qualitative and quantitative studies demonstrate that there is a strong preference for public sector jobs in Egypt. Young women particularly value public sector benefits such as increased job security and pensions, as well as the shorter hours and lighter workload associated with public sector employment (Barsoum, 2015).

Structural adjustment programs and economic reforms have changed the employment opportunities available to women in Egypt. A key element of the initial structural adjustment program in 1987 was the reduction of the government wage bill (Nassar, 2003). Additionally, starting in the 1980s, there was a phase-out of a policy that had begun in the 1960s, when the government had guaranteed public sector jobs to all secondary and higher education graduates. This policy was no longer in effect as of the end of the 1990s. Since 1980, public sector hiring has declined. Substantial decreases in labor force participation rates for educated women have followed these reforms. Women who participate in the labor force are often unemployed, engaging in queuing behaviors whereby they register with the government as job-seeking in hopes of being appointed to a government job, but neither seek nor would accept a private sector job (Assaad & Krafft, 2015a; Assaad, 1997).

Women were and continue to be disproportionately dependent on the public sector for employment, with more than half (52%) of employed women working in the public sector in

2012, in contrast to just less than a quarter (24%) of employed men (Assaad & Krafft, 2015b). Rather than shifting to employment in the private sector, in the face of declines in public sector employment, women, especially educated women, have withdrawn from the labor force. Olmsted (2003) wondered whether the structural adjustment programs in Egypt, because they substantially reduced employment opportunities for women and the opportunity costs of having children, might cause stagnation or even an increase in fertility rates. This paper investigates that very question, looking at the impact of changing employment opportunities on fertility in Egypt.

3 Conceptual Framework

This paper models fertility as the outcome of a child production function and a household utility maximization problem, as have many others before (Becker, 1960; Birdsall, 1988; Schultz, 1997; Willis, 1973). Since decisions over fertility are likely to be made at the household level, this paper uses a unitary household model for simplicity. Specifically, the model of Schultz (1997) for the demand for children is modified for the context at hand. A couple's lifetime household utility, *U*, is a function of the number of children, *C*, the education and health of children, *E* and *H*, the leisure of the husband, L_h, and the wife, L_w, as well as a composite household consumption good, *G:*

$$U(C, E, H, L_h, L_w, G) \qquad (1)$$

Utility is assumed to be increasing in all these arguments. The goods in the utility function, namely *C*, *E*, *H*, and *G*, denoted generically as *S*, are produced through some constant returns to scale technology using market goods, *X*, and the time the husband and wife spend in production, T_{hS} and T_{wS}:

$$S = f_S(X_S, T_{hS}, T_{wS}, \mu_S) \qquad (2)$$

for *S* = *C, E, H, G.* The term $\mu_{!}$ is couple specific productivity that is known but not controlled by the couple. For the output of children this term can be thought of as fecundity.

Individuals face a time constraint across market work (subscripted *m*), production work, and leisure:

$$\Omega_{!} = T_{!"} + \sum_{!} T_{!"} + L_{!} \qquad (3)$$

where $\Omega_{!}$ denotes the time budget constraint for *j* = *h, w* and *S* = *C, E, H, G.* The household's market income, *Y,* is based on its members' wages, W_j, and their market labor supply:

$$Y = T_{!!}W_{!} + T_{!"}W_{!} \qquad (4)$$

Under certain assumptions, or as a helpful heuristic, full income, *F*, can also be derived as:

$$F = \Omega_{!}W_{!} + \Omega_{!}W_{!} \qquad (5)$$

The household's utility maximization problem is therefore to choose *C, E, H,* L_h,, L_w, *G* to:

$$\text{Max } U(C, E, H, L_{!}, L_{!}, G) \qquad (6)$$

subject to (i) $T_{!!}W_{!} + T_{!"}W_{!} = Y = PX$

(ii) $S = f_{!}(X_{!}, T_{!!}, T_{!"}, \mu_{!})$ for *S* = *C, E, H, G*

and (iii) $\Omega_{!} = T_{!"} + \sum_{!} T_{!"} + L_{!}$

for *j* = *h, w*

where *P* is the price of market goods. While utility is increasing in *C, E, H,* L_h,, L_w, and *G*, there are tradeoffs between these goods, as mediated through the constraints.

The tradeoffs facing women considering different jobs are not solely captured by the market wage rate. Women's wages are at parity with men's in the public sector but there is a wage gap in the private sector (Said, 2015). Commute time and child care responsibilities are major considerations that are going to be weighed against wages, particularly for women (Assaad & Arntz, 2005; Hoodfar, 1997). As mentioned above, there are also non-wage benefits to jobs, which tend to be substantial in the public sector (Assaad, 1999; Barsoum, 2015). Rather than having reservation wages, women may also have reservation working conditions in terms of reputation (Dougherty, 2014; Groh, McKenzie, Shammout, & Vishwanath, 2014).

Additionally, only some types of jobs (such as self-employment or family employment) allow for a continuous division of time. Wage jobs tend to have fixed hours of work that are closely related to the type of work, especially public sector versus private sector (Assaad & Krafft, 2015b; Hoodfar, 1997). Ultimately, women's choice of market labor supply, T_{wm}, is going to take all of these factors into account. For modeling simplicity, assume that all of these different factors can be monetized into what is now the effective wage rate facing women, W_w. Since for women both the wage and non-wage benefits of public sector jobs are greater than private sector jobs, a decrease in government employment is essentially a decrease in W_w or in expected W_w.

Consider now the issue of how changes in this broad concept of W_w, for instance decreases in public sector employment decreasing "wages," might affect childbearing. Start with a case that simplifies the above model to allow only tradeoffs in terms of child quantity, *C*, versus the composite consumption good, *G*. Assuming an interior solution and given the assumption of a constant returns to scale production function for both the goods, utility will be maximized when the marginal rate of substitution equals the relative prices for *C* and *G* (BenPorath, 1974):

$$\partial U/\partial C \; \frac{T_{!"}W_{!}+T_{C!!}W_{!}+PX_{!}}{} = \pi^{!} \qquad (7)$$

$$\partial U/\partial G = \frac{T_{!"}W_{!}+T_{!!}W_{!}+PX_{!}}{G}\pi_{!}$$

where $\pi_{!}$ is hereafter shorthand for the full (shadow) price of a unit of good *S* (*C* or *G*). With this notation, demand for children can then be denoted in price and (full) income terms as $C(\pi_{!}, \pi_{!}, F)$.

Let there be a change in the availability of public sector jobs, denoted by *B*, which affects women's wages, W_w. To determine how the change in public sector employment affects childbearing define both full price effects:

$$\frac{\partial \pi_{!}}{\partial B} = \frac{\partial W_{!}}{\partial B} * \frac{T_{!"}}{C} \qquad (8)$$

$$\frac{\partial \pi_{!}}{\partial B} = \frac{\partial W_{!}}{\partial B} * \frac{T_{!"}}{G}$$

and a full income effect:

$$\frac{\partial F}{\partial B} = \frac{\partial W_{!}}{\partial B}\,\Omega_{!} \qquad (9)$$

The impact of changing *B* on fertility is then:

$$\frac{}{\partial B} = \frac{\partial C}{\partial \pi} \; \frac{\partial C \; \partial \pi_{!}}{} + \frac{\partial C \; \partial \pi_{!}}{\partial \pi_{G}} \; \frac{\partial C}{\partial B} + \frac{\partial F}{\partial F} \; \frac{}{\partial B} \; * \; * \; * \; {}_{!}\partial B \qquad (10)$$

$$\partial C \; \partial W_{!} \; \partial C \; T_{!"} \; \partial C \; T_{!"} \; \partial C$$

$$\overline{\partial B} = \overline{\partial B\ \partial \pi_!}\left(\overline{* C} + \overline{\partial \pi_! *}\ G\ + \overline{\partial F} * \Omega_! \right)$$

To sign all the terms it is helpful to, first, decompose the price effects into compensated price effects and income effects, where compensated price effects are denoted by the symbol ° below. Recall that by the Slutsky equation we know:

$$\frac{\partial C}{\partial \pi_!} = \frac{\partial C^\circ}{\partial \pi_!} - C\frac{\partial C}{\partial F} \tag{11}$$

$$\frac{\partial C}{\partial \pi_!} = \frac{\partial C^\circ}{\partial \pi_!} - G\frac{\partial C}{\partial F}$$

As a result, (10) becomes:

$$\underline{\partial C}\ \partial W_!\ \underline{\partial C^\circ}\left(T_{!"}\ \underline{\partial C}\ \ T_{!"}\ \underline{\partial C^\circ}\ T_{!"}\ \underline{\partial C}\ \ T_{!"}\ \underline{\partial C}\ (12)\ \underline{\partial B} = \underline{\partial B}\ \partial \pi_! \underline{*\ C} - \underline{C \partial F} *\ \underline{C} + \partial \pi_! * G \right) - G \partial F * G + \partial F * \Omega_!$$

$$\overline{\partial C}\ \partial W_!\ \overline{\partial C^\circ}\left(T_{!"}\ \overline{\partial C^\circ}\ \overline{T_{!"}}\ \partial C\ \text{—}\ \text{—}\ \text{—}\ (\qquad)\right)$$
$$\partial B = \partial B\ \partial \pi_! * C + \partial \pi_! * G + \partial F\ \Omega_! - T_{!"} - T_{!"}$$

An important fact to keep in mind in is that, since compensated demand is homogenous of degree zero in prices, by Euler's formula:

$$\pi_! * \frac{\partial C^\circ}{\partial \pi_!} + \pi_! * \frac{\partial C^\circ}{\partial \pi_!} = 0 \tag{13}$$

$$\frac{\partial C^\circ}{\partial \pi_!} = - \frac{\pi_!}{\pi_!} * \frac{\partial C^\circ}{\partial \pi_!}$$

Substituting (13) into (12) yields:

$$\partial C\ \partial W_!\ \partial C^\circ\ T_{!"}\ \pi_!\ \partial C^\circ\ T_{!"}\ \partial C \tag{14}$$
$$\overline{\partial B} = \overline{\partial B\ \partial \pi_!}\left(\overline{* C} - \overline{\pi_! * \partial \pi_!} * \overline{G} + \overline{\partial F} * T_{wm} \right)$$

This equation can be transformed into elasticity terms in a series of steps as follows. First, multiply both sides $\frac{B}{C}$ by and the right hand side by !!:

!!

$$\partial B \partial C / / CB = \partial W \partial B ! / / BW ! \Big(\quad \underline{\qquad} \quad \underline{\qquad} \quad \Big)$$
$$\partial C \partial \pi^{\circ} / C * TC !" * W ! - \pi\pi !! * \partial C \partial \pi^{\circ} / ! C * TG !" * W \; + \partial C \partial F / C \quad (15)$$
$$! * T !" * W !$$

!

With further manipulation this becomes:

$$\frac{\partial C / C}{\partial B / B} = \frac{\partial W ! / W !}{} \partial C^{\circ} / \Bigg(\frac{C \, W ! T !"}{\partial B / B} \partial C^{\circ} / C \, W ! T !" \partial C / C \, T !" * W ! \; (16) \quad * \quad * - \underline{\qquad} * \quad * + \quad \underline{\qquad} \Big(\underline{\qquad} \Big) \Bigg)$$
$$\partial B / B \; \partial \pi ! / \pi ! \pi ! \, C \; \partial \pi ! / \pi ! \pi ! \, G \; \partial F / F \qquad F$$

which can be denoted in elasticities (an elasticity is denoted by η) after gathering together terms as:

$$\eta !! = \eta !!! \, \eta !^{\circ} !! \Bigg(\Big(\underline{\quad} \; \underline{\quad} \; \underline{\quad} \; \underline{\quad} \Big) \; W\pi !! * TC !" - W\pi !! * TG !" + \eta !" \Big(\frac{T ! \; " \; W !}{F} \Big) \Bigg) \qquad (17)$$

It is now possible to define the elasticity of interest, η!", the (percentage) change in childbearing resulting from a (percentage) change in public sector job opportunities. The predictions of the model in terms of how households' fertility (*C*) responds to changes in job opportunities are ambiguous. In (17), η!!! denotes how women's wages change as public sector employment opportunities change, which we can readily sign as positive. Then the question is the sign of the term within the first set of parentheses. Since children are considered a normal good (η!" >0), there is a positive income effect in terms of the number of children.

Since the compensated price elasticity must be negative ($\eta_{!°!!}$<0), a key question for the price effect is then in regards to the relative time intensity of children and other goods. It is generally assumed that children are more time intensive for women than other goods (Galor & Weil, 1996; Willis, 1973), i.e.:

$$\frac{W_! T_{!"}}{\pi_C} \frac{}{C} \quad \frac{W_! T_{!"}}{} > * \quad \pi_! G \qquad (18)$$

$$\frac{T_{!"} W_!}{T_{!"} W_! + T_{!!} W_! + P X_!} > \frac{T_{!"} W_!}{T_{!"} W_! + T_{!!} W_! + P X_!}$$

Under this assumption, once multiplied by $\eta_{!°!!}$ the overall price effect term is negative. Empirically, increases in W_w tend to decrease fertility (Borg, 1989; Schultz, 1985, 1997), which means the net effect of what must be a negative price effect and positive income effect is itself negative, but this is not pre-determined from this theory.

The case becomes more complex when "child quality," in terms of child education and health (*E*, *H*), and leisure (L_h,, L_w) are restored to the model. Empirically, child quantity and quality have been shown to be substitutes (Hanushek, 1992; Schultz, 1997). Thus an increase in W_w could have ambiguous effects on *C*, *G*, *E*, and *H* depending also on dimensions such as the relative time intensity of *E* and *H*. Rather than make any assumptions about how individuals respond in this ambiguous case, this paper empirically investigates the relationship between economic opportunities for women and fertility.

Despite the shortcomings of the unitary household model, it provides a helpful starting point for conceptualizing how individuals make decisions or allocate goods within the household, particularly in terms of the impact of W_w. If either the husband or the wife were the sole decision-maker, as long as the decision-maker derived utility from both children and other goods, the model's implications would be the same. The issue becomes more complex in considering a bargaining model, since changes in women's employment opportunities might also affect their bargaining power. The implications for fertility would therefore also depend on the variation in preferences of husbands and wives for children. In Egypt, on average women report that their husbands would like more children than they themselves would prefer (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015), suggesting another potential mechanism through which declining public sector employment might lead to increases in fertility is through decreases in women's bargaining power.

4 Methods

The ultimate goal of this paper is to estimate the impact of employment opportunities, particularly government employment, on fertility, and to shed light on whether decreases in government hiring might have contributed to the recent rise in fertility in Egypt. There are two important econometric steps in this task. First, estimates are generated of the effect of employment on the probability of childbearing. For reasons that are discussed below, this requires estimating survival analysis (also known as hazard, duration or time-to-event) models parameterizing the relationship between employment and the annual probability of giving birth. Endogeneity of employment is a serious problem in estimation, as explained in more detail below. Second, the estimated survival analysis parameters are used to simulate how the relationship between employment and the probability of giving birth affects fertility rates.

This section describes the methods used to model these relationships. The first subsection describes summary measures of fertility. The second sub-section discusses the need for and implementation of survival analysis methods. The third and fourth sub-sections describe instrumental variable and fixed effect methods to account for the endogeneity of own employment. The fifth sub-section discusses the transformation of survival analysis results into summary measures of fertility.

4.1 Describing Fertility

There are many ways of measuring fertility and different measures do not necessarily move together. Each measure has its advantages and drawbacks, both conceptually and in empirical implementation based on survey data. Completed fertility rates (CFRs) are, in one sense, the best measure of fertility. These rates are the number of births to women who have completed their childbearing, and represent the essential concept of fertility, the number of children a woman will have over her lifetime. However, these rates only can be calculated for women past their childbearing years, and as such, are essentially decades out of date for the purpose of studying current childbearing (Bongaarts & Feeney, 1998). Other measures must be used to assess the behavior of women currently bearing children.

There are two common measures that underlie alternative calculations of fertility rates, one based on recent childbearing across ages (age-specific fertility rates) and one based on parity (births to date) and duration-specific birth probabilities (the parity progression ratio) (Ní Bhrolcháin, 1992). Different combinations of these approaches have been used in modeling the impact of covariates on fertility measures (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010; Van Hook & Altman, 2013). Elements of both are used in the paper, as explained below, so both are described, along with additional summary measures such as the crude birth rate.

Age-specific fertility rates (ASFRs) are calculated for age groups from age x to $x+n$ (i.e. 15-19) as in Palmore and Gardner (1994):

$$ASFR_{!,!,!} = \frac{B_{!,!,!}}{P_{!,!,!}} \quad (19)$$

Here the numerator, $B_{!,!,!}$, is the number of (live) births that occurred within *s* years or months preceding the survey, for women who were *x* to *x*+*n* years of age at the time of the birth. The denominator of the ASFR, $P_{!,!,!}$, is the number of woman-years lived in the age bracket from age *x* to age *x*+*n* in the *s* years or months preceding the survey (El-Zanaty & Way, 2009; Palmore & Gardner, 1994). ASFRs therefore represent the annual probability of childbearing at a specific age. These statistics are typically presented multiplied by 1,000 since probabilities at a given age may be low.

There are a number of important details to note about estimating these rates. Women's age at the time of birth is used to categorize women rather than their current age so that statistics are not driven by the length of *s*.[2] Age groups are usually five-year brackets, and *s* is typically the three years preceding the survey, conventions this paper follows. The women-years included in the ASFR estimate are for all women in the age bracket, regardless of marital status. Since fertility questions are typically asked for women in a specific age range, such as women aged 1549, fertility for the oldest age group surveyed, in this case the group aged 44-49, is necessarily truncated. For instance, if one looks back two years one has data only on women aged 44-47 two years ago, since the women aged 48-49 two years prior to the survey were 50-51 years old at the time of the survey and thus were not asked the fertility questions.

[2] If current age at the time of the survey were used instead of age at the time of birth, increasing *s* would erroneously attribute increasing numbers of births to later ages.

The advantage of ASFRs is that they are relatively up-to-date, in reflecting the behavior in recent years of a specific age group. They also are useful for information on when, in a woman's lifetime, childbearing is taking place. The disadvantage of ASFRs is that they do not convey meaningful aggregate information about population trends. They do not directly indicate the number of children a woman will bear over her lifetime, an essential fact about fertility.

However, estimated age-specific fertility rates can be used to calculate the total fertility rate (TFR). Because later an alternative method for calculating the TFR, based on parity progression ratios, is presented, denote the TFR based on the ASFRs as the TFR_{ASFR}. The TFR_{ASFR} is essentially the cumulative lifetime fertility implied by the ASFRs. The TFR_{ASFR} is calculated as the sum of the ASFRs over each age, *x*, (Palmore & Gardner, 1994):

$$TFR_{!"\#\$} = \sum_{!} ASFR_{!,!} \qquad (20)$$

When five-year age group ASFRs are estimated, it is assumed that the rates for each single year are the same as throughout the age bracket. The TFR_{ASFR} measure represents the number of children a woman would have during her childbearing years if she bore children at the ASFRs during those years and survived until the end of her child-bearing years (Palmore & Gardner, 1994).

A number of challenges occur in calculating these rates from survey data. One is the issue of recall; asking women about their lifetime childbearing is subject to substantial recall bias, particularly for older women or women with high fertility. By restricting the period under investigation in the ASFR (and therefore the TFR_{ASFR}) to the past few years, this issue is diminished, although not necessarily eliminated, since, for instance, infants who died may be overlooked. Accurate reporting of ages for women may also be a problem; certainly heaping at five and ten year ages is observed empirically in many datasets. The five-year age brackets may help with this age heaping, since over-represented ages will be grouped with under-represented ones.

Certain assumptions are also made in terms of who is asked questions about fertility. The DHS surveys in Egypt ask ever-married women ages 15-49 about their birth histories. Fertility among never-married women is therefore assumed to be zero (El-Zanaty & Way, 2009). Responses about marital status among young women may not be accurate; the legal age of marriage in Egypt for women is now 18, and this may discourage accurate reporting of the marital status for women 15-17. Selective mortality can be an issue if women who have more children are more likely to die early, a potential problem given the relationship between childbirth and maternal mortality.

An alternative measure of the total fertility rate that can be used to assess lifetime fertility is based on probabilities assessed across parities (number of children already born). This parity progression ratio (PPR) measure has the advantage of assessing the probability of whether there is a birth based on the number of children already born, likely the driving factor in childbearing, rather than a woman's age (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010). Denote as p_M the probability of ever marrying and p_B as the probability of progressing from marriage to first birth. Denote p_i as the ratio for progression from i to i+1 birth, the probability of birth i+1 after birth i. The TFR based on the PPR (TFR_{PPR}) can then be calculated as the sum of the probability of each birth, where the probability of each birth is based on multiplying out the PPRs:

$$TFR_{PPR} = p_M p_B + p_M p_B p_1 + p_M p_B p_1 p_2 + \cdots \qquad (21)$$

In practice, since high parities are difficult to estimate past a certain point, an estimate of p_{x+} is used for births numbered x and higher. This approach assumes that all higher order PPRs at x and higher equal p_{x+} and then a geometric series is implied from x onwards. As was the case with ASFR measures, PPR measures of fertility can be limited to a certain period preceding the survey, or analyses can be done for different cohorts. The resulting estimates of TFR from ASFR and PPR measures can vary, given the different methods for calculation (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010).

Although ASFRs and PPRs are typically contrasted as separate approaches to estimate the total fertility rate, their elements can also be combined. Age-specificity along with parity and duration dimensions may best capture fertility measures (Ní Bhrolcháin, 1992; Van Hook & Altman, 2013). Because the comparator statistics for time trends, from the DHS, are based on ASFRs (El-Zanaty & Way, 2009), equivalent TFR_{ASFR} measures are reported for this paper's descriptive statistics. However, as discussed in detail below, the multivariate models used incorporate dimensions of age, parity, and duration since last birth but the simulated fertility measures are more akin to the TFR_{PPR}.

As well as examining ASFRs and TFRs, this paper also discusses estimates of crude birth rates (CBRs). Crude birth rates are calculated as the (annual) number of live births, *B*, per 1,000 population, *P*, (Palmore & Gardner, 1994):

$$CBR = 1{,}000 \frac{B}{P} \tag{22}$$

CBRs can be calculated either from survey data or based on national reporting and registration of births. CBRs have the advantage of being available in the interim between surveys, based on vital statistics systems. However, they are also sensitive to the distribution of the population, especially if there are differential population growth rates across fertile and other ages.

ASFRs, TFR_{ASFRs}, and CBRs are all measures to quantify births and fertility. However, these quantity outcomes are also the product of the timing of births. The demography literature distinguishes between quantum, the amount of births, and tempo, the timing of births (Bongaarts & Feeney, 1998). Measures based on ASFRs can suffer from tempo distortions. All else being equal, if the mean age at childbearing is rising (falling) then the TFR_{ASFR} will always under- (over-) estimate the true CFR the same cohort will ultimately attain. This is because, as the mean age of childbearing rises (falls), bearing the same number of children is spread out over a longer (shorter) time period.

4.2 Discrete-Time Survival Analysis Using the Logit Model

The relationship between childbearing and employment is of interest in this paper. However, modeling fertility is not straightforward, as many women have not yet completed their childbearing. These women are right-censored in terms of whether they will have another birth. The timing and occurrence of childbearing, accounting for right censoring, is best modeled using survival analysis (Van Hook & Altman, 2013). Specifically, this paper uses survival analysis models to estimate the effect of employment and employment opportunities on the probability of having a child. Discrete-time methods are used,[3] since the data analyzed are annual.

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[3] Quite commonly continuous-time models such as the Cox proportional hazard model are used even when the data are discrete. However, because of how Cox estimates are undertaken without a direct estimate of the baseline hazard, simulation of outcomes in relation to a time-varying covariates is problematic and “extreme caution” (Therneau & Grambsch, 2000, p. 272) advised. Because discrete-time methods, as shown below, estimate the hazard directly, incorporating time varying covariates in simulations is more tractable.

This paper specifically uses a discrete-time logit (logistic) model to estimate the probability of a birth occurring at a point in time (year). Either complementary log-log models or logit models can be used in discrete-time survival analysis (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010; Van Hook & Altman, 2013). The complementary log-log model is a proportional hazards model, like the Cox proportional hazards model. The discrete-time logit model estimates a proportional odds model and odds ratios (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010). Both models have been used in applications simulating fertility data (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010; Van Hook & Altman, 2013). Empirically, results of the logit and complementary log-log model are similar, particularly when probabilities are small. A study estimating TFRs from survival models in the Philippines which compared the two models found similar results out to the second decimal place (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010). Because it is amenable to the incorporation of fixed effects (Allison, 2009), one of this paper's identification strategies, the logit model is used.

Controlling for individual characteristics such as place of residence, education, and age, logit models can be used to measure the effect of employment opportunities on the spacing and probability of sequential births (giving birth once married, having a second birth after a first, a third birth after a second, etc.). The dependent variable underlying these models is essentially the time, in years, from one birth to the next (or from marriage to the first birth). For estimation, this duration is transformed into the probability of having a birth in each year if that birth has not yet occurred.[4] Having a birth at a particular time, t, can be denoted as T_t. Then the probability of interest is the discrete-time hazard function, h_{it} (Jenkins, 1995):

$$h_{it} = \Pr(T_t | T_t \geq t) \tag{23}$$

The logit estimates the relationship between this hazard and covariates, X_{it}, as (Jenkins, 1995):

$$h_{it} = \frac{1}{\{1 + \exp[-\theta(t) - \beta X_{it}]\}} \tag{24}$$

or

$$\log\left(\frac{h_{it}}{1 - h_{it}}\right) = \theta(t) + \beta X_{it} \tag{25}$$

The term $\theta(t)$ is a series of dummies for the different years.[5] The estimated coefficients, β, can be exponentiated to generate odds ratios, the relationship between a one-unit increase in a covariate and the odds of failure (giving birth). When the covariates are set to zero, equation (24) can be used to estimate the baseline hazard function from $\theta(t)$, the probability of having a birth at each point in time for the reference case (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010). To accommodate this modeling, the analyzed data is structured so that an observation is essentially a person-parity-year. This also facilitates the inclusion of time-varying covariates, such as employment opportunities changing over time or the year itself varying.

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[4] An alternative approach to estimating events in survival analysis is the split-population model, which relaxes the assumption common to survival models that every observation eventually experiences the event. Split-population models divide the population into those that will never experience an event and those that will. Then essentially two models are estimated, one for the probability of ever experiencing an event and one for the timing of an event (BoxSteffensmeier & Jones, 2004; Schmidt & Witte, 1989). Such separate modeling is required when a model erroneously assumes everyone eventually fails (has the event), primarily a problem in parametric models. Because the empirically estimated baseline probability of an event can go to zero in the models implemented in this paper, split-population models are not required.

[5] Year here in the sense of years from last birth or marriage, not calendar year.

Since fertility is generally a repeated event, i.e. a single woman has multiple births over her lifetime, adjustments are made for the repeated nature of these events. The data are structured such that a woman is not at risk for birth *N* until birth *N-1* has occurred. Controls are included to account for the fact that the baseline hazard will vary over different births (Prentice, Williams, & Peterson, 1981). Models incorporate a fully interacted set of parity (number of children already born) and time ($\theta(t)$) dummy variables as controls to account for any potential heterogeneity in baseline hazards. Essentially the baseline hazard (probability) of each parity (first, second, third, etc.) at each year (0-1 year since last birth (or marriage), 1-2 years since last birth (or marriage), etc.) is estimated. Additionally, models include clustered standard errors to allow for potential correlation across years within parities, across parities for specific women, or among women in the same PSU.

4.3 Instrumenting for Own Employment

Although the logit model can allow for a rich set of covariates, estimates of the causal impact of employment on fertility are likely to be biased due to the potential endogeneity of employment. One potential cause of endogeneity in this context is omitted variables. For instance, unmeasured local cultural norms that discourage women's employment and encourage their childbearing could lead to estimates of the impact of women's employment on fertility that are biased in the direction of a large negative impact. Reverse causality or simultaneity, wherein women might leave employment or enter employment because they have had a child (rather than have a child because of employment) or might make a joint decision about employment and childbearing, are also likely to be problems. These problems are also likely to bias the impact of public sector employment on fertility in the direction of a large negative impact.

In general, there are several potential methods for overcoming endogeneity. Incorporating additional observable characteristics can help address the fundamental underlying problem of omitted variables. For instance, most of the models estimated include a full set of governorate of birth dummies interacted with urban/rural residence, which are likely to absorb a substantial share of the effect of local cultural norms. This paper includes a rich set of covariates, described in the data section below, to try to control for such differences. Identification of the impact of employment is unlikely to be achieved through controls alone, however, as unobserved individual tastes for work and children cannot be controlled for. Two methods might potentially alleviate these challenges and allow for causal identification: one is instrumental variables and the other is woman-level fixed effects.

A potentially viable instrument for women's own employment is urban/rural-governorate level employment opportunities (in a woman's place of birth, which is less likely to suffer from location endogeneity[6]). There is not, however, a well established practice for estimating a discrete-time duration model with instrumental variables. A number of challenges arise in instrumenting for employment, a binary variable, in the context of a nonlinear duration model. Predicting the endogenous variable in a nonlinear regression framework (i.e. using a logit, probit, etc.) in the first stage of instrumental variables estimation will only be consistent if the assumed functional form is exactly right (Angrist & Krueger, 2001). Problems may also arise in a nonlinear second stage.

The problems with the non-linear case suggest that linear approaches should be used, namely two-stage least squares (2SLS), since there are no restrictions in the assumptions of

[6] Most ever-married women (84%) currently reside in their governorate and urban/rural location of birth.

2SLS as to whether the endogenous variables or instruments are continuous or discrete (Angrist & Krueger, 2001; Wooldridge, 2002). However, the underlying model for 2SLS is additive, and it is quite obvious that duration models are not likely to be additive. Consider the case at hand, where the impact of public sector employment is of interest. The impact of employment is not simply going to be a 2 percentage point lower annual probability of birth, which is the sort of estimate that one would obtain from a 2SLS model that is essentially a pair of linear probability models for employment and childbearing. This 2 percentage point estimate averages over the effects of many years, ages, and parities, including at times when the baseline hazard is quite high, perhaps a 30% chance, to times when the baseline hazard is very near zero. A multiplicative functional form, such as a 95% chance of childbearing, is much more appropriate.

The preferred approach in inherently non-linear settings is an instrumental variables control function approach (Wooldridge, 2015), also called two-stage residual inclusion (2SRI) in the health literature (Terza, Basu, & Rathouz, 2008). This approach has been demonstrated to perform better than alternatives in simulations for a variety of non-linear outcomes (Terza, Basu, & Rathouz, 2008; Terza, Bradford, & Dismuke, 2008) and also shown to perform well in a survival analysis setting (Carlin & Solid, 2014). Additionally, alternative methods such as joint quasi-maximum likelihood estimation are problematic in a case with discrete outcomes or discrete endogenous variables, such as both childbearing and employment. Control function/2SRI methods provide a simpler approach in such contexts (Wooldridge, 2014).

Consider the case where the outcome of interest, y, is based on a nonlinear function, $M(\,)$, and the regressors, x, can be partitioned into those that are endogenous, e, observable (and observed) confounders, o, and unobservable confounders u (Terza, Basu, & Rathouz, 2008):

$$y = M(x_{!}\beta_{!} + x_{!}\beta_{!} + x_{!}\beta_{!}) + \varepsilon \qquad (26)$$

The unobservable confounders are correlated with the endogenous variables, specifically there is some auxiliary equation for the endogenous variables:

$$x_{!} = r(w\rho) + x_{!} \qquad (27)$$

where w includes both $x_{!}$ and instrument(s) z. Here the instruments, z, must satisfy the usual assumptions (Terza, Basu, & Rathouz, 2008):

- $x_{!}$ are not correlated with z
- z are sufficiently correlated with $x_{!}$ (no weak instruments)
- z have no direct influence on y and are not correlated with ε (exclusion restriction)

With this notation and these conditions, the control function/2SRI approach estimates a first stage of:

$$\hat{x}_{!} = r(w\hat{\rho}) \qquad (28)$$

Which yields residuals:

$$\hat{x}_{!} = x_{!} - r(w\hat{\rho}) \qquad (29)$$

The second stage estimator allows for a non-linear model:

$$y = M(x_{!}\beta_{!} + x_{!}\beta_{!} + \hat{x}_{!}\beta_{!}) + \varepsilon_{!!"\#} \qquad (30)$$

Here $\varepsilon^{!!"\#}$ is the error term from the second stage.

In the linear case, this is identical to 2SLS. In the non-linear case, the parameters of 2SRI characterize the conditional mean and are consistent, but 2SLS estimates are inconsistent (Terza, Basu, & Rathouz, 2008). Initially proposed as a specification test for endogeneity (Hausman, 1978), variations on residual inclusion approaches have been specified for count outcomes (Mullahy, 1997; Wooldridge, 1999, 2002) and binary outcomes (Rivers & Vuong, 1988). In the case at hand, 2SRI is used in the previously discussed survival analysis framework of logit estimation, with an instrument (a z) of governorate-urban/rural public sector employment for own employment in a particular year based on a linear probability model. Standard errors are bootstrapped, with clustering at the PSU level.

Public sector employment on an annual governorate-urban/rural basis merits some discussion as to its exogeneity and validity as an instrument. It is quite possible that public sector employment is correlated with some unobserved factors that do matter—such as the local availability of health services and general economic development—but these conditions are controlled for. In general, local government employment is centrally set (Assaad, 1997) and cannot be modified by individuals, so the instrument cannot be manipulated. Additionally, as discussed in detail in the data section below, there are 38 unique combinations of urban/rural and governorate and 21 years of annual local measures used, which provide variation in the instrument, an important element of identification. Overall, using local government employment to instrument for own employment should address both omitted variables and potential reverse causality or simultaneity of employment.

4.4 Incorporating Fixed Effects Using the Conditional Logit Model

Identification of the effect of own employment on fertility can also potentially be achieved using a survival analysis woman fixed effect model to difference out unobserved characteristics on the woman level. The survival analysis literature tends to address the issue of unobservable heterogeneity across individuals with what are referred to as “frailty” models, where frailty is an unobserved random effect for an individual or group. Frailities are included in the hazard function, and can be modeled with a variety of different distributions, including normal and gamma distributions (Moeschberger & Klein, 2003). However, as with random effect models in general, using frailty to account for unobserved heterogeneity in hazard models requires assumptions that the random effect is independent (Murphy, 1995) and therefore uncorrelated with the X_{it}. Also, in general, the distribution of the error has to be assumed to follow a specific functional form.

A better method for accounting for unobserved heterogeneity is a fixed effect model, specifically (Allison, 2009):

$$\log\left(\frac{h_{it}}{1-h_{it}}\right) = \alpha_i + \theta(t) + \beta X_{it} \tag{31}$$

with α_i being a fixed effect for a particular woman. Estimation using dummy variables for each woman tends to suffer from typical panel data incidental parameters problems (Chamberlain, 1980) and performs poorly in survival analysis applications (Duchateau & Janssen, 2007). The one model that performs well for discrete outcomes while incorporating fixed effects is the conditional logit model, which uses conditional maximum likelihood estimation such that the α_i themselves are not estimated (Allison, 2009; Wooldridge, 2002). Therefore, fixed effect logits (conditional logits) for individual women are estimated over different years and births. Fixed effects for multiple durations (births) on a single unit (an individual woman) remove biases related to time-invariant woman-specific effects and are especially important when the womanspecific effects are correlated with covariates. Essentially, this method creates woman-specific fixed effects across the timing and probability of different births.[7] Women act as their

[7] This approach is slightly different than that for continuous time in the Cox proportional hazard model, wherein individual strata can be used to simulate fixed effects. The individual strata allow each woman to have her own baseline hazard because the baseline hazards drop out in partial likelihood estimation (Allison, 2009). In the conditional logit, women have their own effects on the hazard, but not their own baseline hazards. For the case at hand, this is akin to assuming certain women have fewer, more spaced out births while others have more, more closely spaced births.

own controls. This method should be effective for removing unobserved characteristics that are constant for women over time, such as fixed preferences for children, other goods, and leisure/work.

Using own employment in a fixed effects model will likely not overcome problems of reverse causality. For instance, women may still exit jobs when they are planning to have a child, creating spurious results. However, variation in local employment opportunities can be considered exogenous after absorbing any time-invariant characteristics of women (and their birth locales) into a fixed effect. Government employment opportunities will be correlated with own employment but should not suffer from the remaining endogeneity problem, reverse causality or simultaneity, of own employment. Essentially, a reduced form of the instrumental variable model can be estimated using government employment opportunities directly along with woman fixed effects, in addition to the 2SRI models that instrument for employment directly.

4.5 From Multivariate Methods to Fertility Estimates

While survival models produce hazard estimates that indicate important relationships, of particular interest are changes in summary measures, such as total fertility rates. It is possible to translate hazard model coefficients into total fertility rates, since essentially probabilities are being modeled. Both Van Hook and Altman (2013) and Retherford et al. (2010) illustrate similar methods for estimating total fertility rates from discrete-time survival models. Once the discretetime hazard model has been fitted, predicted hazards, a_{jk}, are simulated for the probability of having a birth at each duration from the previous birth (or marriage), k, and parity, j. In order to translate the hazards into fertility measures like the TFR, the conditional probability represented by the hazard must be translated into the unconditional probability of a birth. For each parity and duration since last birth, the a_{jk} are multiplied by the proportion b_{jk} at risk of birth j at duration k, to produce an unconditional probability, c_{jk}:

$$c_{jk} = a_{jk} b_{jk} \qquad (32)$$

Since the models are specifically for the duration from marriage to the first birth, etc., the proportion at risk initially for a first birth is the proportion who ever marry.[8] The proportion at risk for b_{j0} after the first birth is the sum over k of c_{j-1k}, for example the group at risk of a third birth is the share of women who ultimately have a second birth.

The b_{jk} at risk evolve within a parity based on the probability of progressing from one parity to the next at each duration:

$$b_{jk} = b_{jk-1} - c_{jk-1} \qquad (33)$$

The parity-specific TFR can then be calculated as the sum of c_{jk} over all durations (Van Hook & Altman, 2013):

$$TFR_j = \sum_k c_{jk} \qquad (34)$$

After this calculation has been sequenced across each of the parities, then the overall TFR can be calculated as (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010; Van Hook & Altman, 2013):

$$TFR = \sum_j \sum_k c_{jk} \qquad (35)$$

This is the sum of the probabilities of births across all possible births and durations over the reproductive lifetime (assuming no mortality). As with other measures of fertility, these

[8] Implemented here based on the rates in the 2014 DHS (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015).

simulations provide the TFR for what would occur if women experienced all of the predicted probabilities from the hazard model over their reproductive lifetimes (Van Hook & Altman, 2013). The simulated TFRs can incorporate covariates, *x*, into the predicted hazards, a_{jk}, as a_{jkx}. The covariates, *x*, can be varied to simulate TFRs for different profiles, for instance for a publicemployment profile as compared to a no-public-employment profile. Standard errors can be generated around the TFR estimates for different profiles using bootstrapping (Van Hook & Altman, 2013).

5 Data

This paper uses the Egypt Labor Market Panel Survey (ELMPS), a rich panel data set that includes detailed information on individuals' labor market and demographic characteristics. The ELMPS is a household survey with three rounds to date: 1998, 2006, and 2012. The 2006 and 2012 rounds include both previous round households, split households, and a refresher sample. In 2012, the sample totaled 12,060 households and 49,186 individuals. Each round includes a detailed work history for all individuals 15-64 who ever worked, and the 2006 and 2012 rounds include detailed fertility data for ever-married women. The rounds are nationally representative at the time of fielding, and the data include weights that account for sample attrition processes.[9]

5.1 Outcomes

Fertility histories from 2006 and 2012 are used to identify the timing and number of births for descriptive measures of fertility. Birth history data are available for women aged 18-49 in 2012 and 16-49 in 2006, and they include the year and month of each live birth starting from

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[9] See Assaad and Krafft (Assaad & Krafft, 2013) for additional information on the ELMPS. Weights are used with this paper's descriptive statistics. Regressions do not use sampling weights since sampling is unrelated to the dependent variable and in such a case unweighted methods are preferred (Deaton, 1997; Winship & Radbill, 1994).
[11] Comparisons of annual fertility rates for the early 2000s indicate relatively comparable data for that period across the ELMPS 2006 and ELMPS 2012.

the first child. For the multivariate models, only the 2012 round is used to have the greatest time span of years incorporated.[11] The birth history data and the date of first marriage are used to construct the length of birth intervals in years,[10] that is the time from marriage to the first birth, the first birth to the second, the second to the third, the third to the fourth, etc., the underlying outcomes used in the analysis. These outcomes can be right censored if a birth has not yet occurred, or will never occur. As is common with duration outcomes, information on both the time until an event (birth) and whether it occurs are captured jointly by the length of the interval and whether it ends with another birth or is right censored.

5.2 Covariates

Labor market histories from all three rounds (1998, 2006, and 2012) are used to construct annual data on individuals' labor market statuses. The data include information on the start year of each status,[11] the type of employment (wage work, employer, self-employed, unpaid family work), and the sector of employment (public/private). An annual individual work history measuring participation in the public sector is constructed over time based on the 2012 data. Analyses comparing the contemporaneous (panel) data to the retrospective data across rounds suggest that the quality of retrospective reports of public sector employment is relatively high. Consistency of reporting across panel and retrospective data for public sector jobs was in the range of 85-89%, with slightly more consistent reporting among women than men (Assaad,

[10] Although data are collected for the month of birth, there is a substantial share (9%) of "don't know" responses for the month of a birth, making annual analyses preferable.
[11] Although data are collected for the month of status start, the large share of "don't know" responses makes annual analyses preferable as well as consistent with the use of annual birth history data.

Krafft, & Yassine, 2015). This suggests that while there may be some measurement error attenuating the coefficient on public sector employment, attenuation is likely to be small.

Since local employment opportunities are themselves of interest and, as an instrument, may address endogeneity problems, individuals' participation in public sector work is also aggregated into annual means at the urban/rural and governorate level based on place of birth[12] for individuals 25-39.[13] There are 21 governorates and 38 unique combinations of governorate and urban/rural (four governorates do not have any rural areas). Histories for the six (2012) to eight years (2006, 1998) from the date of each survey backwards in time are used, to minimize recall bias while providing a substantial time span of data.

All models include year dummies as well as a fully interacted set of parity and duration since last birth or marriage dummies, which account for duration and parity dependence. A number of other covariates are included in the analyses. See Table 1 for summary statistics on the covariates, as measured for each woman at each parity and year (duration) since last birth, which is the data structure used in the multivariate models. Since age has an important relationship with fertility, age groups are incorporated into the analyses. The categorical educational attainment of women is incorporated, given strong relationships in the literature between education and fertility. Place of birth is controlled for, as a fully interacted set of birth governorate and urban/rural dummies, since local cultural differences and other local factors may affect fertility. As potential measures of socio-economic status, the woman's parents' education (categorically

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[12] Women not born in Egypt or born in the Frontier governorates are excluded from the analyses since these areas are not covered by the ELMPS. Because the Luxor governorate was split from the Qena governorate during the period of study the two are combined as Qena throughout.

[13] This age range is to proxy prime childbearing years among those old enough to have finished all of their schooling.

for both her mother and father) is included in the analyses. Because son preference has been linked historically to childbearing in Egypt, with families with no living sons more likely to have children (Yount, Langsten, & Hill, 2000), an additional control is included for whether the woman has, as yet, borne any sons.[14] Because the data are women-years starting at marriage and many women in the sample are early in their childbearing, less than the majority of women-years (44%) have a son.

An additional set of controls attempts to measure access to health care, especially family planning, a key factor that will affect fertility. Unfortunately, access to family planning is not readily measured directly—the common measure of family planning prevalence conflates both supply and demand for family planning. As a proxy for access to family planning, prenatal care coverage is used. Data were compiled from Egyptian Demographic and Health Surveys (DHSs) for 1992, 2000, 2003, 2005, 2008, and 2014 on prenatal care coverage on a governorate and urban/rural level for births in the five years preceding each survey. Linear interpolation was used to generate trends in years between DHS surveys.

Another set of controls on the governorate level measures mean life expectancy, adult (15+) literacy, and the GDP per capita (which was translated into real 2012 Egyptian pound (LE) terms using the CPI (World Bank, 2013)). These data were collected from the Egyptian Human Development Reports (HDRs) for 1995, 1998/1999, 2003, 2004, 2005, 2008, and 2010 (Institute of National Planning, 1995, 2000; UNDP & Institute of National Planning Egypt, 2004; UNDP & Institute of National Planning, 2003, 2005, 2008, 2010). Data were typically for one to two years prior to the report, but the date varied across indicators. These characteristics should

[14] Empirical testing determined that the binary of having a son was what mattered. Beyond having a son, whether a daughter had been born or the percentage of children that were male did not affect fertility.

control for general health and socio-economic conditions that might affect childbearing decisions. As with the prenatal care data, linear interpolation was used to generate local trends in years without data. Throughout the paper, although descriptive statistics are presented for the mean observed values of the incorporated continuous variables, all the continuous variables (prenatal care, life expectancy, adult literacy, and GDP per capita) are shifted to have a mean of zero in the multivariate analyses (the observed mean is subtracted from the observed values). This allows the baseline hazard across parities and births to be a more meaningful reference value.

A series of additional analyses are conducted controlling for spouse characteristics. Spouse data are not available for all women, as the husband may not be present due to death, migration, separation, or divorce. Approximately 89% of women included in the sample have a spouse present in the household at the time of the survey. The age group of the spouse at each year, his education (categorically, as with women), and his time-varying employment in the public sector (based on his retrospective labor market history data) are incorporated as controls in this subset of regressions. The regressions with these additional controls can help test the possibility that there are substantial fertility preference differentials among individuals and households who work in the public sector.

5.3 Time Period Analyzed

Given the restricted universe of fertility histories (ages 18-49) and local labor market histories (back to 1991), the analysis is limited to the period 1991 to 2011. The oldest women with fertility histories, age 49, would have been 28 in 1991, which is above the 75th percentile for age at first birth (as shown in Figure 5 below). The time frame therefore provides the largest time window possible with reliable coverage of fertility and labor market histories. Women enter this data once they have married, so long as they married between 1991 and 2011.[15] Restricting the analysis to women who married in 1991 or thereafter essentially restricts the data to entry cohorts into motherhood, which are ideal for survival analysis.

6 Descriptive Patterns of Fertility and Employment

6.1 Trends in Total Fertility Rates

An important initial result of the analysis is that fertility has risen recently in Egypt. Figure 1 presents fertility trends in Egypt, specifically the TFR (based on the ASFR) as measured by various surveys, primarily Demographic and Health Surveys over the period 1980-2014 (El-Zanaty & Way, 2009). Additionally, Figure 1 includes the TFR calculated from the 2012 ELMPS. In 1980, the TFR was quite high, at 5.3, and declined rapidly, falling to 3.6 by 1995. Since 1995, there have been moderate fluctuations in the TFR, but over the period 2000-2008 it declined from 3.5 to 3.0. The 2006 round of the ELMPS found a TFR of 3.0, consistent with the 2005 DHS (TFR of 3.1) and 2008 DHS (TFR of 3.0). However, the 2012 ELMPS indicates a substantial rise in fertility, to a TFR of 3.5. The trend of rising fertility has since been confirmed in the 2014 DHS, which found a TFR of 3.5 as well (Ministry of Health and Population, ElZanaty and Associates, & ICF International, 2015). This paper argues that one of the factors contributing to these patterns, especially the flattening and then rise in fertility, is diminishing economic opportunities for women in Egypt.

6.2 Trends in Age-Specific Fertility Rates

The ASFRs underlying the TFRs also present a number of important trends (Figure 2).

[15] In order to be able to simulate fertility, women do not leave this model if they become separated, widowed, or divorced. These events are, however, fairly rare during fertile years. For instance, just 2.9% of women 40-44 were divorced and 5.9% widowed (Salem, 2015).

The general decline in fertility over 1980-2000 was driven by particularly steep declines in ages 25-44, with smaller decreases at the youngest ages, consistent with women rapidly having a first child after marriage (which typically occurs in the 20-24 age bracket, as discussed below). The results for the ELMPS rounds of 2006 and 2012 are generally consistent with the DHS surveys. The recent uptick in fertility from 2008-2012 included substantial increases for age groups 2039. The 2014 DHS results suggest that fertility is continuing to shift to younger ages, even to the extent that it is decreasing at older ages.

6.3 Trends in Crude Birth Rates

There are a relatively finite number of data points for ASFRs and TFRs, since they depend on surveys; however, Egypt has a vital statistics systems that generates annual estimates of crude birth rates (CBRs), providing more frequently collected data. CBRs are births per thousand of population, and will be affected by the age structure of the population, as well as underlying fertility patterns. Figure 3 presents the CBRs for Egypt over the period 1988-2013. Starting in 1988, the CBR was 37.8 births per thousand population. It declined rapidly through the early 1990s, fluctuating in the 28-26 range from 1992 into the 2000s. Starting in 2007, the CBR began to rise substantially, reaching 31.9 in 2012, and 31.0 in 2013. The CBRs in Egypt track quite closely with the TFRs (Figure 1), which hit a low of 3.0 in 2008 based on data for the preceding 1-36 months, i.e. the low period of 2005-2007 in the CBRs, and have risen to 3.5 in 2012 and 2014, consistent with higher CBRs over 2009-2013.

6.4 Trends in Age at Marriage and Family Planning

Two key issues that must be examined in reference to fertility changes are patterns in the age of marriage and use of family planning. In Egypt almost all births occur within marriages, so the timing of marriage essentially determines when women are at risk of becoming pregnant.

Figure 4 displays the trends in the proportion of women married by various ages in Egypt by year of birth. For instance, among women born in the 1960s, less than 10% were married by age 15, a little more than 25% were married by age 18, more than 50% were married by age 21, and nearly 75% were married by age 24. The proportion of women married by ages 15 through 21 steadily declined for women born in the 1960s through about 1980. Starting around the 1980 birth cohort, while the proportion of women married by age 15 continued to decline, the proportion of women married by various older ages, particularly age 21, increased. Essentially, in Egypt, while marriage at younger ages was decreasing for the cohorts born in 1960 through the late 1970s, for cohorts born in the 1980s through 1990s, more women were marrying at younger ages, particularly in their early 20s. Marriage also remains nearly universal in Egypt; by their late 30s almost all women marry.

Additionally, first births follow closely the timing of marriage. The prompt arrival of a child subsequent to marriage is the norm; the 2014 DHS for Egypt found that just 2% of evermarried women age 15-49 consider it appropriate to use family planning before the first pregnancy, while 92% thought it was appropriate to use family planning after the first birth (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015). The timing of the first child is much less likely to be affected by access to family planning methods or socio-economic change. Only the age at marriage is likely to drive the timing of first births. Figure 5 demonstrates this empirically, tracing the distributions of age at first marriage and first birth over time in Egypt for the 25^{th}, 50^{th}, and 75^{th} percentiles of each distribution. As well a clear pattern of co-locomotion, the persistence of an approximately two year gap between marriage and first birth over time and over the distribution is evident. For example, 50% of women born in

1970 had married by age 21, and 50% had their first birth by age 23. The trends in age at marriage—rising and then falling—will inevitably shape measures of fertility.

Another key factor that intersects with fertility is the use of family planning methods. Use of family planning is an outcome of both supply and demand dimensions, including a couple's desired fertility, their knowledge of planning methods, and their access (including financial access) to such methods. The ELMPS does not ask about family planning behaviors. However, Egypt DHSs have detailed information on this topic. Figure 6 presents the percentage of currently married women (ages 15-49) using family planning methods (modern or traditional)[16] over time in Egypt based on the DHS surveys. Starting in 1980 just 24% of married women were using family planning. This rate rose fairly rapidly to 48% of women by 1991. The rate of increase slowed in the 1990s, with 56% of women using family planning by 2000 and 60% by 2003. Since 2003, the rate of family planning use has changed very little, with 59% of married women using family planning in the 2005 DHS, 60% as of the 2008 DHS, and 59% as of the 2014 DHS (El-Zanaty & Way, 2009; Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015). This plateauing may be in part due to policy changes. USAID was a substantial supplier of contraceptives in Egypt for many years. In 2004, USAID began shifting responsibility for contraceptive supply onto the Egyptian government, with the government taking full responsibility by 2007 (USAID, 2011).

[16] Methods of family planning incorporated into this statistic include modern methods (female sterilization, the pill, IUDs, injectables, implants, male condoms, diaphragm/foam/jelly, other), and traditional methods (periodic abstinence, withdrawal, prolonged breastfeeding, other) (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015).

Although there remains some unmet need[17] for family planning in Egypt (12% as of the 2008 DHS and 13% as of the 2014 DHS), there has also been a rise in the "total wanted fertility rate," that is the fertility rate if unwanted births were excluded from the numerator of the TFR. The total wanted fertility rate has risen from 2.4 as of the 2008 DHS to 2.8 as of the 2014 DHS (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015), suggesting that couples are actively deciding to have more children. The reasons for this preference for additional children are likely to be complex, but one potential factor is women's lack of employment opportunities.

6.5 Trends in Employment

The question this paper investigates is whether recent increases in fertility in Egypt might be caused, in part, by decreases in employment opportunities for women due to the shrinking role of the public sector in employment. Figure 7 demonstrates the declining availability of public sector employment by showing the share of the population 25-39 in each year[18] working in the public sector over time based on the labor market histories in the ELMPS 2012. There has been a steady decline in public sector work over the 1991-2012 period, from 24% of 25-39 yearolds employed in the public sector in 1991 to 14% in 2012. Males experienced a more rapid decline, from 33% to 18% over the period, while the share for females fell from a high of 1516% in the 1990s to 10% by 2012. Although this decrement is unlikely to be the sole factor driving increases

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[17] The unmet need statistics presented here are the percentage of fecund women who are (i) not using contraception (neither modern nor traditional methods) and who (ii) wish to postpone the next birth or stop childbearing entirely (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015).

[18] This group is of an age to have finished even a higher education and potentially be working. It is also, for women, peak childbearing ages.

in the fertility, the decline in government employment opportunities could be having important implications for fertility decisions.

6.6 Employment and Family Formation

Public sector work and non-wage work are much more easily reconciled with marriage and family formation. Figure 8 shows how women's market work evolves in the years leading up to and after their marriages. An increasing share of women engage in market work (largely due to finishing school and entering the workforce) in the years leading up to marriage. However, at marriage almost half of those working in the private sector leave private sector wage work, but the shares in public sector work and non-wage work (being an employer, self-employed, or an unpaid family worker) continue to increase. Thus, in addition to public sector opportunities prior to marriage, which may affect the timing of marriage, as well as work and childbearing after marriage, the trends in public sector opportunities will affect fertility after marriage by providing women with more or fewer opportunities for work.

6.7 Patterns of Fertility by Characteristics

Fertility is linked with a number of women's individual and household characteristics. Table 2 shows the relationship between TFRs and different characteristics of women and their households and how these relationships have varied from 2006 to 2012. Differences must be interpreted with some caution since, in addition to sampling variability, different tempo effects could be occurring for different groups. The first characteristic examined is whether women ever worked in a public sector job. In 2006, the TFR for women who had worked in the public sector was 2.6, compared to 3.0 for those who had not. In 2012, the rate had risen for both groups but the gap remained; those women who had ever worked in the public sector had a TFR of 3.2, compared to 3.5 for those who had not. The rise in TFR for both groups suggests that although the decline in public sector work may be one factor contributing to rising TFRs, it is definitely not the only factor. Additionally, a number of other characteristics, such as education, may be behind the observed link between fertility and public sector work.

Fertility is closely linked to education, but the relationship is not monotonic. The TFR is highest for illiterate individuals in 2012, 4.0, while literate but uneducated individuals have a TFR of 3.0. Primary educated individuals have a TFR of 3.7, preparatory educated individuals a TFR of 3.5, vocational secondary graduates a TFR of 3.9, post-secondary institute graduates a TFR of 2.9, and university and above graduates a TFR of 3.2 as of 2012.[19] Looking at the evolution of the relationship between fertility and education over time, it is notable that vocational secondary graduates—the group that previously had guaranteed employment in government and has experienced the largest decrement in government employment opportunities across generations (Amer, 2015; Assaad & Krafft, 2014)—also had the greatest increase in TFR from 2006 to 2012, from 3.1 to 3.9. Still, TFRs have increased for all education levels, even to a similar extent for the illiterate and those with university education.

Looking at geographic differences, urban areas have a lower TFR (3.2) than rural areas (3.7) in 2012, and both experienced increases in fertility over 2006 to 2012, as did all regions, but to varying extents. In 2012, the Alexandria and Suez Canal region had the lowest TFR, 2.8, followed by Greater Cairo and urban Lower Egypt, then urban Upper Egypt and rural Lower Egypt, with rural Upper Egypt having the highest TFR in 2012, at 4.0. Women living in poorer households have higher fertility; those in the poorest 20% of households have a TFR of 3.9, those

[19] Bootstrapped standard errors, estimated with clustering, indicate that, first, the differences in total TFR from 2006 to 2012 are statistically significant. Second, many of the differences by characteristics within a year, such as by education in 2012, are statistically significant. Third, many of the changes that have occurred over time within groups appear to be statistically significant as well.

in the middle three quintiles 3.5-3.6, and those in the richest quintile 2.9. Fertility decreases with both mother's and father's education, but not monotonically. Overall, individual and household characteristics are related to fertility, but increases in fertility have been occurring, albeit to varying extents, across the board.

7 The Relationship between Fertility and Employment

This section presents the results on the impact of employment on childbearing across the different estimation methods. The section begins with the baseline hazards of childbearing by years since previous birth and parity. Then the discrete-time survival analysis (logit) models are estimated to see the impact of public sector work on fertility, incorporating a number of controls. Models are also estimated with women fixed-effects as well as incorporating local employment opportunities instead of own employment to address the likely endogeneity of working in the public sector. Additionally, instrumental variable models using local employment opportunities as an instrument for women's employment are estimated. Lastly, the impacts on fertility of different patterns of employment opportunities are simulated, to assess the impact of changing opportunities for public sector employment on the TFR.

7.1 Baseline Hazards of Fertility

The first discrete-time hazard (logit) model estimated includes only a fully interacted set of parities and years since last birth or marriage. Predicting from the coefficients of this model onto a simulated full set of parities and years allows for an examination of the probability of having a child in a given year, depending on the parity and time since last birth or marriage, and conditional on not yet having shifted to the next parity.[20] Figure 9 presents the hazards for the

[20] Throughout, fifth and higher order parities are coded as a single category for parameter estimation, as are intervals of 10 years and longer.

model with just parities and time since last birth or first marriage. Hazards are highest immediately following marriage. Notably the hazard of having a second or higher order birth in the year immediately following the previous birth is low, which suggests women are actively spacing births. Hazards rise in the second year after the first birth and peak in the third year, with a 0.48 probability of having a second child at that point (if that point is reached). Hazards remain high but decline gradually thereafter. Hazards of a third birth show a less steep increase over time, increasing from year 1 to 2 and 3 but peaking at a hazard of 0.24 before declining slowly. Hazards for the 4^{th}, 5^{th}, and 6^{th} birth onward follow relatively similar trajectories, with hazards peaking a little later, four years after the last birth, and never rising above a 0.15 probability. These interactions between parity and time since last birth or marriage are incorporated into all of the models but not presented in detail hereafter. Using the methods for estimating fertility based on hazard models discussed above, this sample of women entering matrimony from 19912011 has a TFR of 3.5, consistent with fertility patterns over this period (Figure 1).

7.2 Discrete-Time (Logit) Models of Fertility

The first discrete-time hazard (logit) model estimated for the relationship between fertility and a woman working in the public sector is presented in Table 3, specification 1. In addition to women's public sector employment status in each year, this model includes only the baseline hazards by interacted parity and time since last birth (not shown). The results presented for the model are odds ratios. When greater than 1, they mean a greater odds (probability) of birth, and when less than one they mean a lower odds (probability) of birth. Their statistical significance can be evaluated with the standard errors in terms of deviations from 1. In specification 1, the odds ratio of 0.810 for public sector work means that the estimated odds of a woman who is working in the public sector giving birth are 81.0% of the estimated odds for a woman who is not working in the public sector. This is a large effect size, but no other covariates are included and fertility is clearly associated with a host of (omitted) characteristics here.

In specification 2 (Table 3), controls are added for the woman's age group, her education, her parents' education, her place of birth, local characteristics, and the year. Once these are included, the odds ratio for a woman being engaged in public sector work rises to 0.976 and becomes statistically insignificant. The implications for completed fertility (TFRs) of this estimate and other models are discussed in a following section on fertility simulations.

Notably, a number of other characteristics are statistically significant in specification 2. There are significant differences by age compared to the reference age group of 30-34; younger women have significantly higher odds while older women have lower odds, which drop substantially with age. Compared to those who are illiterate, there are some significant differences by education. Those with a primary education have significantly lower odds (0.867), while those with university and above education have significantly higher odds (1.157), which runs counter to the narrative of increases in women's education decreasing fertility. The unexpected relationship between education and fertility may be in part because of the close connection between education and social class; it is in fact mother's education, a marker of social class, that has the strongest relationships with the odds of a birth. Having a university-educated mother has a significant odds ratio of 0.777 compared to having an illiterate mother. Compared to an illiterate father, there is a statistically significant effect of having an above intermediate educated father (0.800) or a university-educated father (0.842).

Although not shown, the birth governorate-residence interactions are often, but not always, statistically significant. Compared to urban Cairo, governorates in urban Greater Cairo and urban Lower Egypt tend to be only insignificantly different. Urban Upper Egypt and rural areas are significantly different, with higher probabilities of giving birth than in Cairo. Turning now to the time-varying local characteristics of individuals' birth places, there are no significant differences by local adult literacy, GDP per capita (in thousands of 2012 LE), or prenatal care. Although not shown, there are some significant differences by year, which appear to reflect fluctuations more than a clear trend.

In specification 2 a woman being engaged in public sector work had an odds ratio slightly less than 1, but was not statistically significant. It is, however, likely that public sector work has potentially differential effects across births. Almost everyone has a birth right after marriage and then fairly promptly a second birth. For instance, in the specification for the baseline hazards, the estimates indicate that 95% of those with first births have second births (Figure 9). The majority of women who have second births go on for a third birth (80%) and most of those (63%) continue on for a fourth birth, but there is clearly more scope for an impact on later parities. Thus, it seems likely that there might be differential impacts of public sector work on different parities, with greater scope for an impact on later parities. This possibility is tested in specification 3, where a woman being engaged in public sector work is interacted with parity (compared to not working in the public sector) and, as before, controlling for parity and time since last birth or marriage, as well as the same set of other controls.

In specification 3, there are higher but statistically insignificant odds ratios for progressing from marriage to a first birth and from a first birth to a second birth when women work in the public sector, lower but statistically insignificant odds of a third birth (when women have had a second birth) and a lower and statistically significant odds ratio (0.686) of progressing from a third to a fourth birth. The odds of going from a fourth to a fifth birth are slightly greater than 1, but statistically insignificant. For the few women who work in the public sector and progress to their fifth birth, the odds of a sixth birth and above are significantly higher (2.222).[21] Thus, the evidence suggests that on what is a particularly relevant margin currently in Egypt, whether to move from three children to four, public sector work can reduce certain dimensions of fertility; however the net effects of these complex patterns on the total fertility rate must be examined through the simulations below. Additionally, although a rich set of controls is included, the relationship identified between fertility and employment is not necessarily causal; problems of endogeneity are a substantial concern.[22]

One potential concern is whether households with individuals who work in the public sector are systematically different in unobservable ways. To a certain extent, this possibility can be checked by adding parity-interacted controls for the spouse's work in the public sector to specification 3. This can be done only for the subset of women with their spouses in the household. Other controls are also added for spouse characteristics (age and education) to check whether these may also be driving forces in childbearing decisions. The results are presented in Table 4. Importantly, the impact of women's public sector work persists with similar odds ratios across births. The impact on moving from the third birth to the fourth birth remains statistically significant. The spouse being employed in the public sector is not statistically significant.[25]

[21] Results estimated separately by parity (not shown), which allow the impact of all covariates to vary by parity, although noisier, have a similar pattern of public sector odds ratios across parities.
[22] Shifting religious values over time or across generations are one potential source of endogeneity. Comparing changes across the Muslim and Christian populations in Egypt could shed light on how shifting religious values in the majority-Muslim country might be contributing to fertility. Unfortunately, religious affiliation is available for only a subset of women (married and 18-39 in 2012), precluding the calculation of a TFR. Models of childbearing

7.3 Discrete-Time Models of Fertility Incorporating Fixed Effects

One way to address endogeneity is to incorporate women-specific fixed effects into estimation using a conditional logit model. As with other types of fixed effects models, the coefficients on fixed characteristics (birth place, education, and parents' education) cannot be estimated but are absorbed into the fixed effect that is conditioned out of the model. These fixed effects will also absorb unobserved time-invariant differences between women (and their households), which are likely to include important dimensions of preferences. Models can be estimated only for women who vary in their outcomes, i.e. have had at least one birth. Since 93% of women who marry ultimately have a first birth, this is unlikely to create substantial bias but may slightly inflate fertility simulations (calculated later). Additionally, the effects of various

estimated for the subset of women with religion data and adding interactions between years and religion are noisy but suggest that fertility has been rising for Muslim women to a greater extent than Christian women. [25] That spouse employment in the public sector is statistically insignificant and relatively small in magnitude compared to the odds ratios for women also suggests that the old-age security rationale for fertility is not driving the impact of public sector work. Having either the husband or the wife in the public sector would secure such a pension.

covariates, such as women's own public sector employment, can be identified only from those women with variation in these characteristics, since fixed effects estimates are based on withinwoman variation. Among the women who are observed working in the public sector at some point in the time period analyzed, 37% varied over time in their public sector status.

In Table 5, specification 4 estimates a similar model to specification 3 with women's public sector work interacted with parities. After adding the fixed effects, a similar pattern to specification 3 is found for the interactions with lower parities. There are higher odds ratios for moving from marriage to the first birth and after the first birth (for the second birth). Lower odds ratios for giving birth after the second, especially third, and fourth birth are found. Only the coefficient for moving from the third to fourth birth is statistically significant (0.630), as was the case for the model without the fixed effects. The odds ratio for moving from the fourth to fifth birth is less than one, but insignificant, and the odds ratio for the fifth birth and above (1.112) is insignificant and is much smaller than in specification 3, where it was significant and very high (2.222).

Including women fixed-effects is likely to address many omitted variable problems but not necessarily issues of simultaneity and joint decision making, such as quitting a public sector job in order to have additional children. Therefore, an additional set of models are estimated for the impact of local public sector employment opportunities, rather than own public sector employment, on fertility.[23] It is important to note that local public sector employment opportunities are in percentage point terms, and so are on a different scale than the binary variable for women's own public sector employment. Figure 10 provides examples of the estimated variation in local employment opportunities over time for eight combinations of governorate and urban/rural. There is a substantial amount of variation in the estimated local employment opportunities over time. Although there is some consistency in overall trends, there are also clearly differences by location. For instance from 2002 to 2012 urban Giza had flat public sector employment rates around 10%, while from 2002 to 2012 urban Cairo had public sector employment rates that declined from 25% to 15%. This variation may be caused by where government jobs are allocated across a variety of different ministries and programs, such as the Social Fund for Development, which targets poor areas (with mixed success), or the national

[23] These are akin to reduced form instrumental variable models. The 2SRI models with women fixed effects were tested but generated implausible estimates. The 2SRI models without fixed effects are presented below.

Youth Employment Program (Abou-Ali, El-Azony, El-Laithy, Haughton, & Khandker, 2010; De Gobbi & Nesporova, 2005).

These conditional logit models retain the women fixed effects and other covariates and are presented as specification 5 (in Table 5). Interacting public sector employment opportunities with births, there is a slightly higher odds ratio for moving from marriage to the first birth (1.012 for each percentage point increase in local public sector employment opportunities). There are lower odds ratios for moving on from the first through fourth births, which are significant for the second to third birth (0.982), third to fourth birth (0.966) and fourth to fifth birth (0.960). For the highest order births, the odds ratio is 1.047 and statistically significant. This suggests that local employment opportunities are affecting women's fertility—potentially through their own employment. It is also quite likely that these effects are under-estimates, since although individuals' own reporting of employment status has relatively small measurement error, annual means for the 38 governorate and urban/rural combinations are based on finite samples and noisy. One additional concern with these estimates is whether the public sector local employment effect suffers from omitted variable bias.[24] The inclusion of additional time-varying local controls suggests that variation in health services and socio-economic characteristics, at least, is not driving the observed effects.

[24] Two additional checks of the robustness of the results based on local employment opportunities were undertaken. Models disaggregating male employment and female employment in the public sector, in case there was gender differentiation in jobs, showed similar effects for public sector work. Models with parity interacted public sector employment opportunities further interacted with education level were estimated as well. The impacts of local employment opportunities should be stronger for women with secondary and higher education. The coefficients provided only mixed evidence of a larger impact on the more educated and were noisy.

7.4 Discrete-Time Models of Fertility Using Instrumental Variables

As an alternative to using local employment opportunities as a reduced form instrument in the fixed-effects models, women's public sector employment can in fact be directly instrumented. If there is random measurement error in the local employment opportunities, this should not be a problem for estimates in the second stage of a two-stage instrumental variables framework. Table 6 presents the linear probability model for a woman working in the public sector in a given year, the first stage of the two-stage residual inclusion model. Public sector local employment opportunities are included in the current year, and lagged one and two years. Each percentage point increase in local opportunities increases the probability of a woman working in the public sector by 0.2% (p-value of 0.001). The one-year lag has a negative effect of 0.1% (p-value 0.068) and the two-year lag has a negative effect of less than 0.1% (p-value 0.615). The instruments together have a p-value of 0.002 and an F-statistic of 4.98. Thus, the instruments are weak. Since controls for both year and location are included in the model, multicollinearity may be an issue. Age and education are statistically significant and substantial predictors in this first stage.

In the second stage of the two-stage residual inclusion model, both the parity-interacted actual values of women's public sector employment and the parity-interacted residuals from the first stage are included in the equation. Table 7 presents the second stage discrete hazard logit model with bootstrapped standard errors. The standard errors around all of the public sector effects are large, and none of the public sector effects is statistically significant. However, the direction of the odds ratios is similar to the pattern in other models, suggesting that public sector work increases the probability of first births, decreases the probability of second, third, fourth, and fifth births, and after a fifth birth increases the probability of additional births.[25]

The residual interactions indicate that those who have unobservable characteristics, captured by the residual, that make them more likely to work in the public sector are in fact significantly more likely to progress from the second birth to the third, as well as to the fourth and fifth births. The plausibility of the unobservable characteristics that make women more likely to work in the public sector also causing higher fertility merits discussion. One explanation may be that couples with moderately conservative values about women's roles accept women working only in the public sector and also have higher fertility preferences, whereas couples with less conservative values accept women working in the private sector as well (and thus, women are somewhat less likely to work in the public sector). Observed relationships between socioeconomic background and women's work provide suggestive evidence of this potential link (Assaad & Krafft, 2014). Overall, although the instruments are weak, the findings at least suggest that the results of models not accounting for endogeneity are likely to be underestimates.

7.5 Fertility Simulations

Based on the various discrete-time hazard models estimated, it is possible to simulate total fertility rates for different profiles. Of specific interest is varying the impact of public sector employment. For a particular specification, profiles are identical except for variation in public sector employment, so that differences in TFRs within a specification are due to variation in public sector employment.[26]

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[25] A similar pattern was found when two-stage predictor substitution was used.

[26] Simulating for profiles with different characteristics would generate different TFR levels and also some variation in differences between TFRs by public sector employment, since the log-odds for the hazards have an additive specification but resulting predicted hazards and simulated TFRs are not simply additive.

For all of the simulations, other characteristics have to be selected. Time-varying local governorate characteristics are set to their mean, ages are increased by one group from 20-24 onwards for each parity in order to simulate an age progression, and the year is fixed at 2002. It is assumed that a male child will be born as the second child so that the dummy for having a male child equals zero for marriage to the first birth and the first birth to the second and equals one thereafter. In the fixed-effects models, results are estimated assuming the fixed effect is zero. In the 2SRI models, the residual is assumed to be zero.

For the models without fixed effects, a relatively typical profile of time-invariant characteristics is used: a vocational secondary educated female, with preparatory educated parents, born in urban Cairo. Vocational secondary graduates are a large group, 35% of women in the sample have attained a vocational secondary degree (Table 1), and also the group that has experienced the greatest decline in public sector employment over time (Assaad & Krafft, 2014). For all models, results are simulated over a full set of parity and birth interval interactions to estimate total fertility rates.

The first set of simulations estimates the impact of public sector work by comparing outcomes for these profiles while varying whether the woman is employed in the public sector. Own public sector employment is essentially set to 1 or 0 throughout a woman's entire fertility simulation. Figure 11 presents the results of these simulations. For the model incorporating a single public sector effect (specification 2), fertility is estimated to be 2.75 with a public sector job and 2.78 without a public sector job, a 0.03 difference in childbearing. After fully interacting public sector work and parities (specification 3), the difference is larger, 0.11; fertility is predicted to be 2.68 with a public sector job and 2.79 without. In the parity-interacted fixed effect model (specification 4) fertility shifts from 2.70 for the public sector employee to 2.76 for a woman who is not employed in the public sector, an effect of approximately 0.06. For the 2SRI model, fertility shifts from 2.34 if a woman works in the public sector to 2.83 if she does not, a difference of 0.49.

Whether these differences in fertility are statistically significant can be assessed based on bootstrapped standard errors. None of the differences is statistically significant at $p<0.05$. The difference for specification 2 (single public sector effect) has a p-value of 0.585 and the difference for specification 3 (public sector interacted with parity) has a p-value of 0.080. The difference for specification 4 (public sector interacted with parity fixed effect model) has a pvalue of 0.235. The difference for specification 6 (2SRI) has a p-value of 1.000. Overall, these potential differences in fertility are suggestive of changes in women's employment opportunities contributing to rising fertility. However, these changes are unlikely to be the sole driver in the shift from a 3.0 to 3.5 fertility rate recently in Egypt, especially since the change in public sector employment opportunities will have impacted only a fraction of women.

Simulating the impact of local employment opportunities on fertility shows a similar pattern (Figure 12). When public sector employment in the governorate and residence of birth is 10 percentage points above the mean (similar to the change over the period of study, see Figure 7) fertility in specification 5 is estimated at 2.81, while when simulating at the mean public sector employment rate fertility is 2.84, an 0.03 difference (the difference has a p-value of 0.239). This is suggestive of the potential impact of declining government employment on national fertility rates, and again indicates that public sector employment opportunities are likely contributing to the rise in fertility in Egypt, but are unlikely to be the sole factor driving trends. Comparing the results in Figure 11 and Figure 12 also indicates that the exact impact is uncertain, as it varies substantially across estimates. The estimation problems inherent to the various models may also be biasing estimates.

8 Discussion and Conclusions

This study contributes important evidence that fertility is on the rise in Egypt. While fertility had been decreasing relatively steadily over time, reaching a low of a 3.0 TFR in 2008, this study demonstrates that fertility in Egypt has risen to 3.5 as of 2012, a pattern continuing in 2014 (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015). Thus, Egypt appears to be reversing its demographic transition, a phenomenon with concerning implications for its society and economy. It is likely that a variety of different factors are contributing to the rise in fertility, but one potential cause, and the focus of this paper, is the decline in employment opportunities for women, specifically in the public sector.

In order to test the relationship between fertility and employment opportunities, this paper united the literature on using duration analysis models for fertility simulations (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010; Van Hook & Altman, 2013) with the literature on addressing endogeneity using fixed-effects in discrete-time duration models (Allison, 2009) and instrumental variables in inherently non-linear settings (Terza, Basu, & Rathouz, 2008; Wooldridge, 2015). Public sector employment was found to be particularly important at the margin of going on from a third to a fourth birth in the logit models. A similar pattern was found in the conditional logit (women fixed effects) models. The impact of local employment opportunities, which are beyond women's control and thus avoid potential issues of simultaneity or reverse causality, further suggested an important relationship between public sector employment opportunities and women's fertility. Instrumental variable estimates, although suffering from weak instruments and statistical insignificance, suggest that other methods are under-estimates. Overall, the evidence presented in this paper suggests that declining opportunities for women can have an effect on fertility, but are unlikely to be the sole driver of recent fertility increases in Egypt.

This study is one of the few to investigate the impact of economic opportunities for women on their childbearing. The findings suggest that labor market opportunities, and especially the type of jobs available to women, impact fertility. Traditionally, declining economic opportunities (i.e. recessions) are associated with declines in fertility (Sobotka, Skirbekk, & Philipov, 2011). However, this research indicates that economic opportunities may interact with gender. This finding also extends the literature on the potentially offsetting impacts of price and income effects from changing economic opportunities on childbearing (Schultz, 1997). These relationships are typically empirically estimated as how rising wages and increasing opportunities for women can decrease fertility (Fang, Eggleston, Rizzo, & Zeckhauser, 2013; Galor & Weil, 1996; Heckman & Walker, 1990; Jensen, 2012;

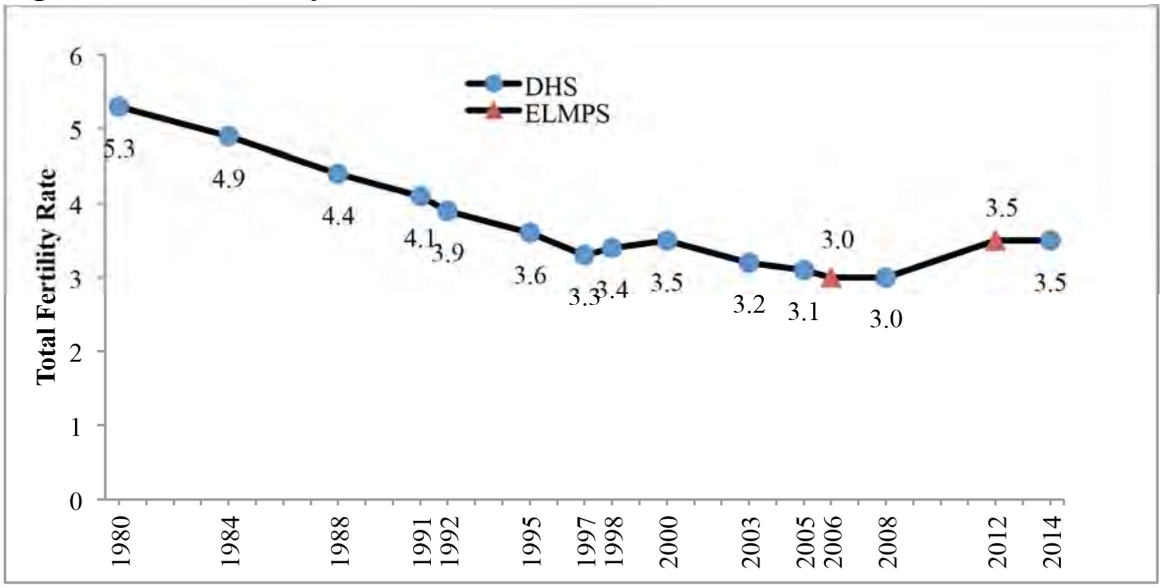
Mukhopadhyay, 1994; Rosenzweig & Evenson, 1977; Schultz, 1985). This paper examines the opposite case. Specifically, as economic opportunities that are particularly appealing to women decline and opportunities that are less appealing increase, so that the value of market work is substantially reduced, women may substitute into childbearing.

The rise in fertility in Egypt is likely to be the result of a multitude of forces, but this paper's findings indicate that the changing economic structure is a contributing factor to the rise in fertility. This impact is an unintended consequence of the attempt to shift from a public-sector led model of employment to a private-sector, market-oriented paradigm. In the wake of structural reform and reductions in the government wage bill and government employment, women have fewer employment opportunities. This is due in part to the failure of the private sector to replace public sector jobs with high-quality, formal private sector jobs with protections and benefits (Assaad & Krafft, 2015b; Gatti, Angel-Urdinola, Silva, & Bodor, 2014). Women choose to leave (or never enter) the labor force rather than undertake the informal jobs that are available (Amer, 2015; Assaad & Krafft, 2014, 2015b; Hendy, 2015). This paradigm could potentially be changed with appropriate labor market reforms (Assaad & Krafft, 2014; Krafft & Assaad, 2015).

Whether Egypt can successfully integrate women into the labor force and again progress in its demographic transition is a question with crucial implications for Egypt's society and economy. The pressures of the youth bulge on institutions such as the education system and labor market were severe (Assaad & Krafft, 2015a; Elbadawy, 2015; Youssef, Osman, & RoudiFahimi, 2014). The "echo" of the youth bulge resulting from the youth bulge forming families along with higher fertility rates is sure to again place pressures on health and education systems as well as on the labor market (Krafft & Assaad, 2014). These findings also have important implications for global population policies and labor markets; increasing access to employment for women and closing wage gaps may be an important part of other countries completing their fertility transitions.

Figures

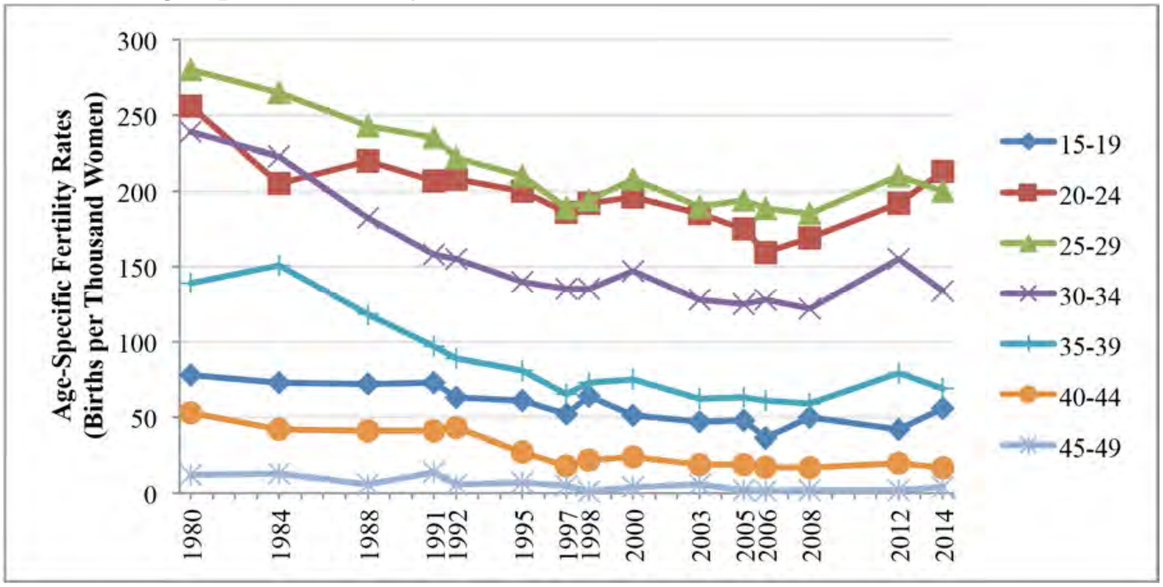
Figure 1. Total Fertility Rates, 1980-2014



Notes: TFRs for 1980, 1984, and 1991 are 12 months preceding the survey. TFRs for 2012 and 2006 are three years preceding the survey, remainder are 1-36 months preceding the survey.
Source: TFRs for 1980-2005 and 2008 are from El-Zanaty & Way (2009) and are primarily Demographic and Health Survey statistics. TFR for 2014 is from the 2014 Demographic and Health Survey (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015). TFRs for 2012 and 2006 based on author's calculations from the ELMPS 2012 and ELMPS 2006.

Figure

2. Age-Specific Fertility Rates, 1980-2014

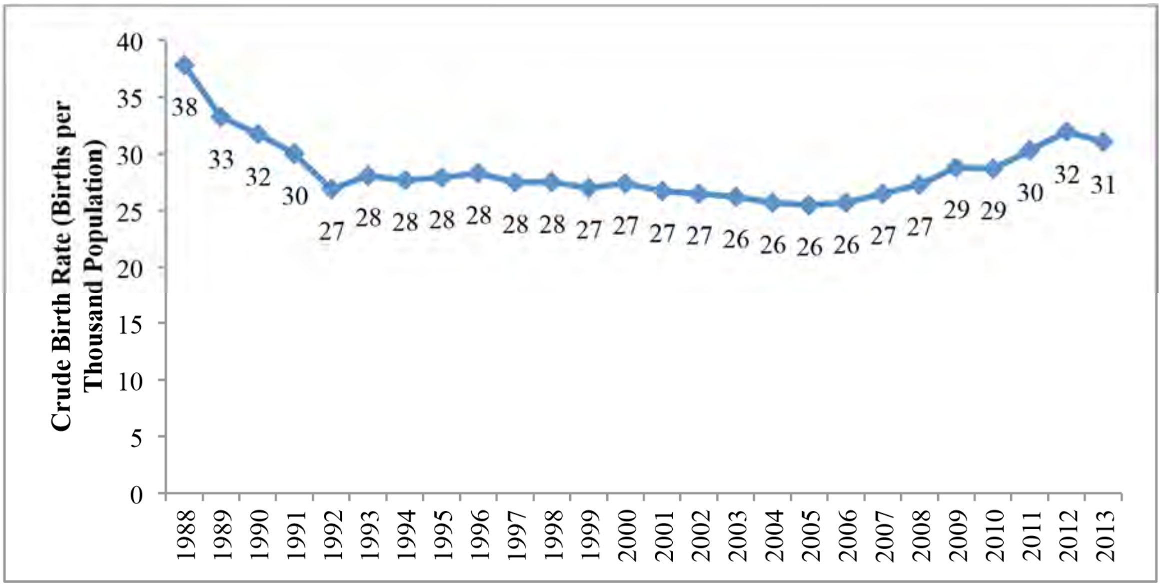


Notes: ASFRs for 1980, 1984, and 1991 are 12 months preceding the survey. ASFRs for 2012 and 2006 are three years preceding the survey, remainder are 1-36 months preceding the survey.

Source: ASFRs for 1980-2005 and 2008 are from El-Zanaty & Way (2009) and are primarily Demographic and Health Survey statistics. ASFR for 2014 is from the 2014 Demographic and Health Survey (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015). ASFRs for 2012 and 2006 based on author's calculations from the ELMPS 2012 and ELMPS 2006.

Figure

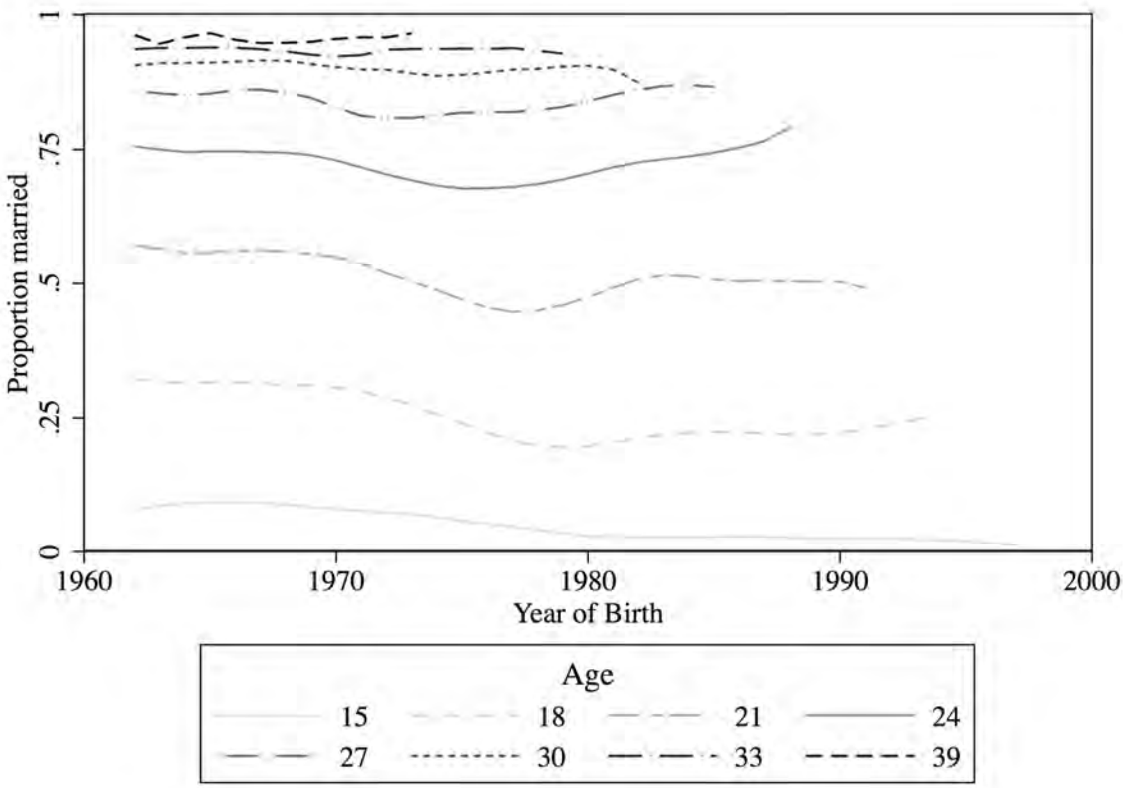
3. Crude Birth Rates, 1988-2013



Source: Central Agency for Public Mobilization and Statistics (2015).

Figure

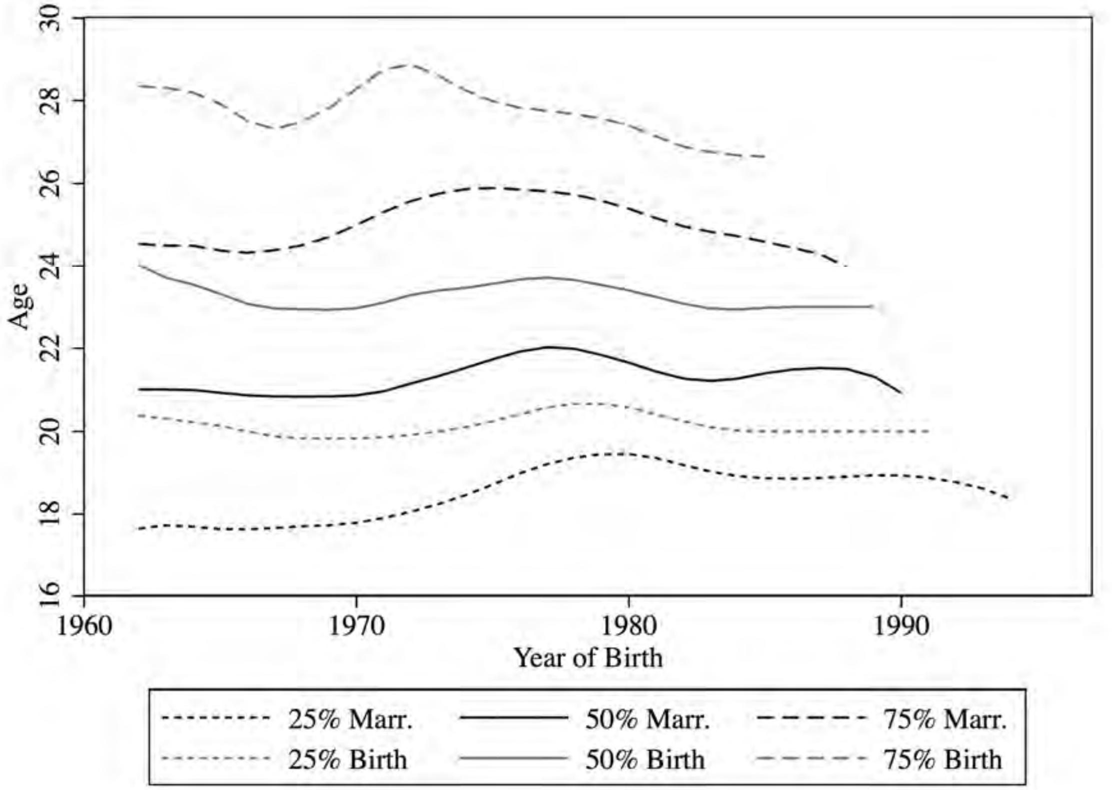
4. Proportion of Women Married by Various Ages by Women's Year of Birth



Notes: Lowess smoothed, bandwidth 0.4.
Source: Author's calculations based on ELMPS 2012.

Figure

5. 25th, 50th, and 75th Percentiles for Age at Marriage and Age at First Birth by Women's Year of Birth

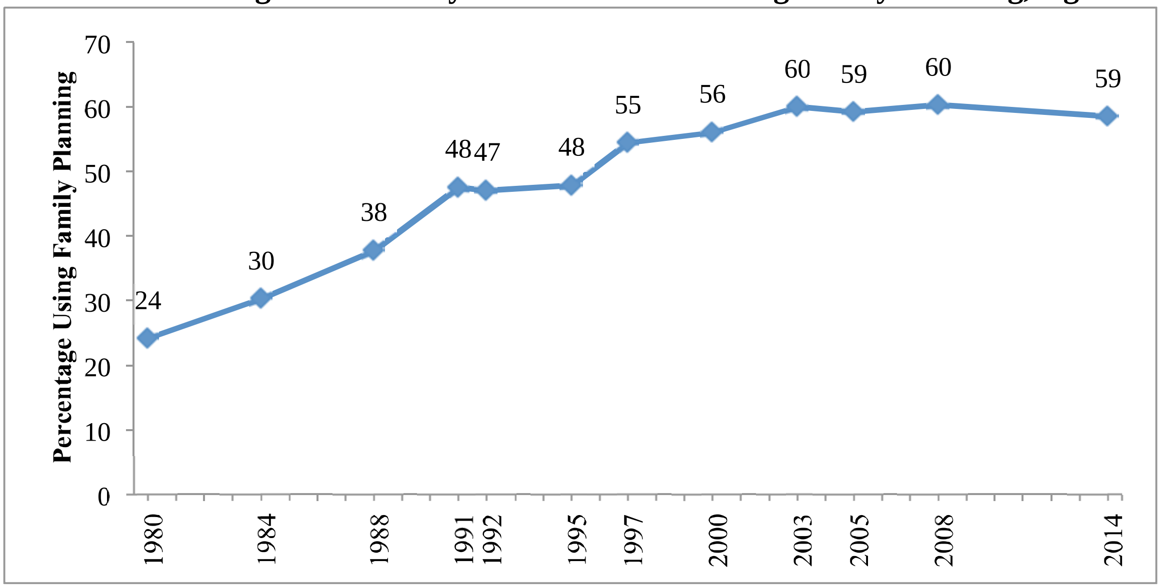


Figure

Notes: Lowess smoothed, bandwidth 0.4.

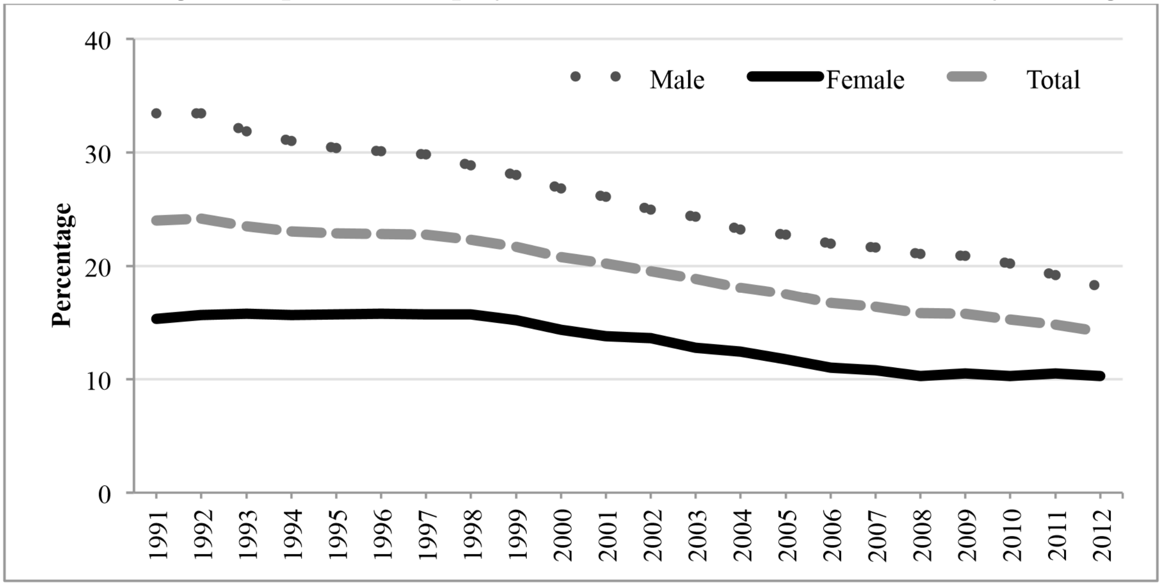
Source: Author's calculations based on ELMPS 2012.

6. Percentage of Currently Married Women Using Family Planning, Ages 15-49



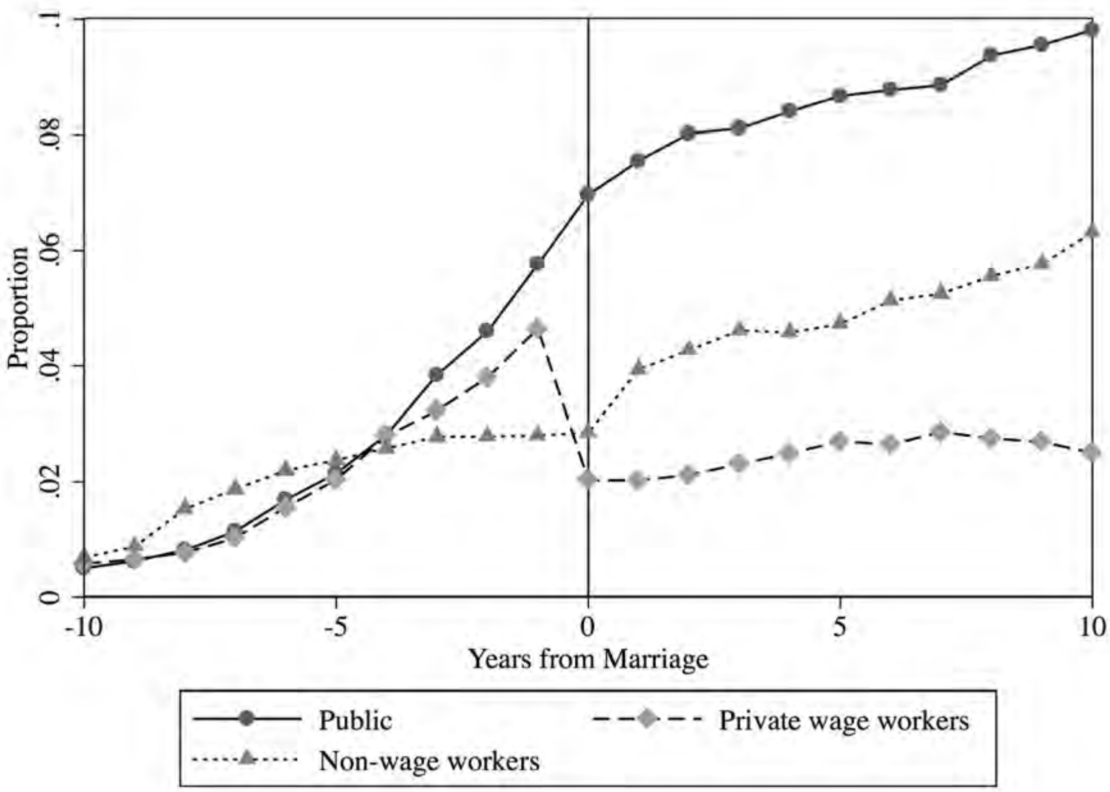
Source: DHS surveys for Egypt (El-Zanaty & Way, 2009; Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015).

Figure
7. Percentage of Population Employed in the Public Sector over Time by Sex, Ages 25-39



Source: Author's calculations based on ELMPS 2012.
Note: Age 25-39 sample is for the year in question, not necessarily the age in 2012.

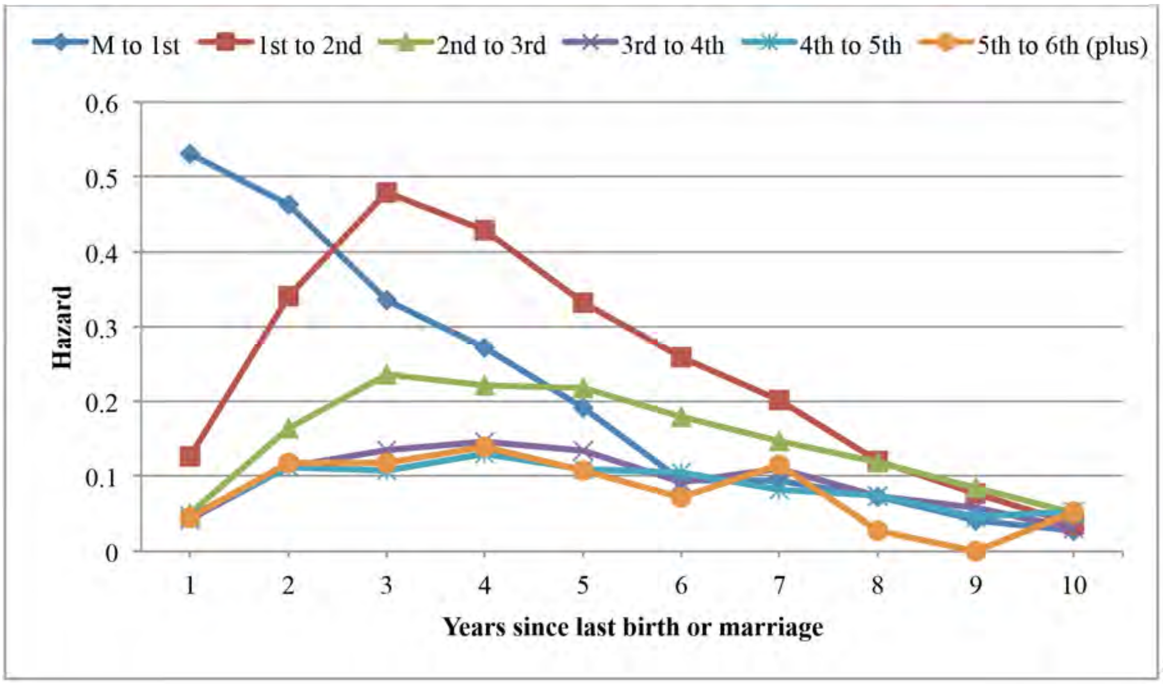
Figure
8. Proportion of Women in Public Sector, Private Sector Wage, and Non-Wage Work by Years from Marriage, Women Married between 1992-2002



Source: Author's calculations based on ELMPS 2012.

Figure

9. Baseline Hazard of Next Birth by Years Since Last Birth or Marriage and Parity, Women Married between 1991 and 2011

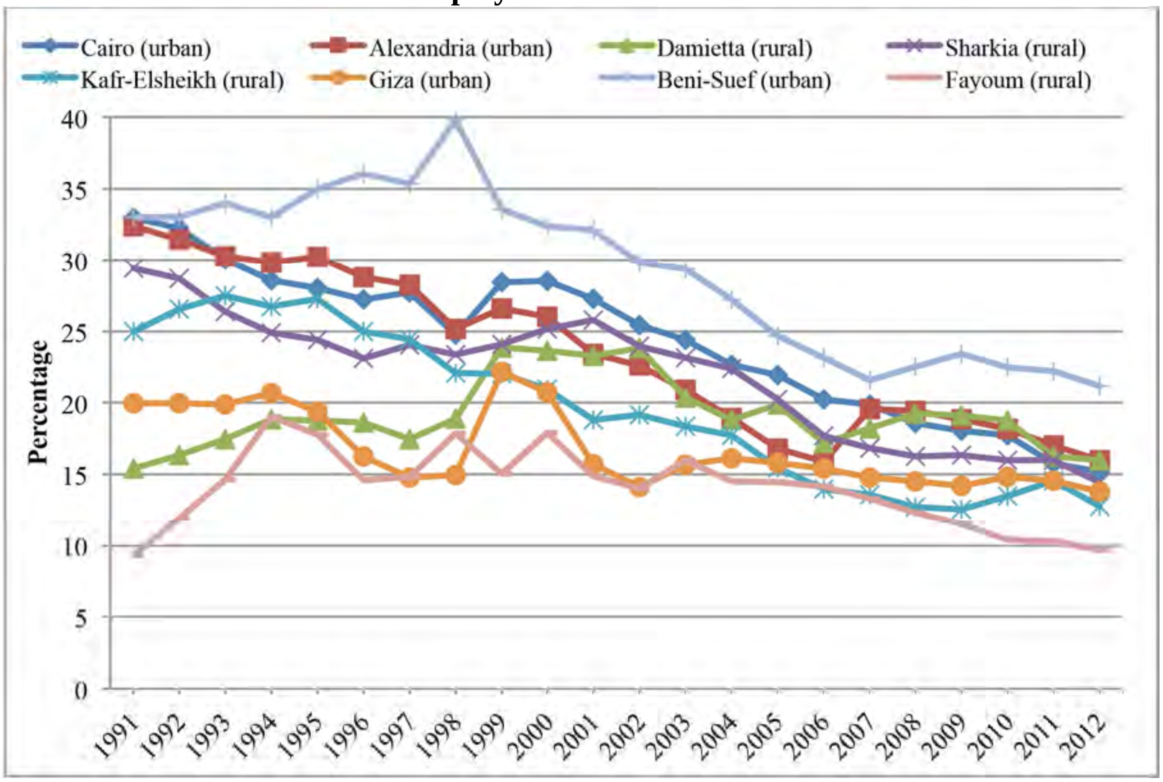


Source: Author's calculations based on ELMPS 2012.

Notes: Based on discrete-time hazard (logit) model with no additional covariates.

Figure

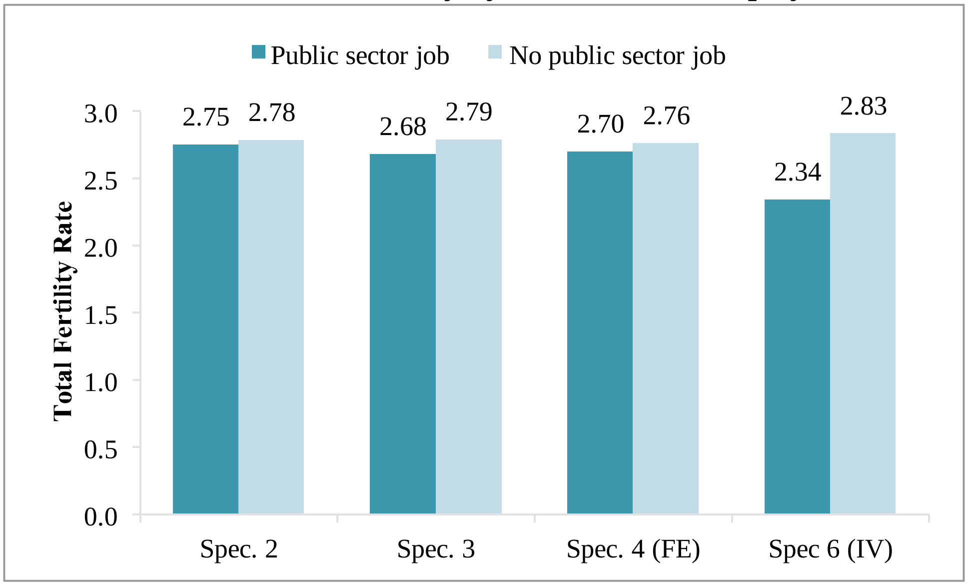
10. Example Urban/rural and Governorate Level Trends in Percentage of 25-39 Year-olds with Public Sector Employment



Source: Author's calculations based on ELMS 1998, ELMPS 2006, and ELMPS 2012.
Note: Age 25-39 sample is for the year in question, not necessarily the age in survey year.

Figure

11. Simulations of Fertility by Public Sector Employment across Specifications

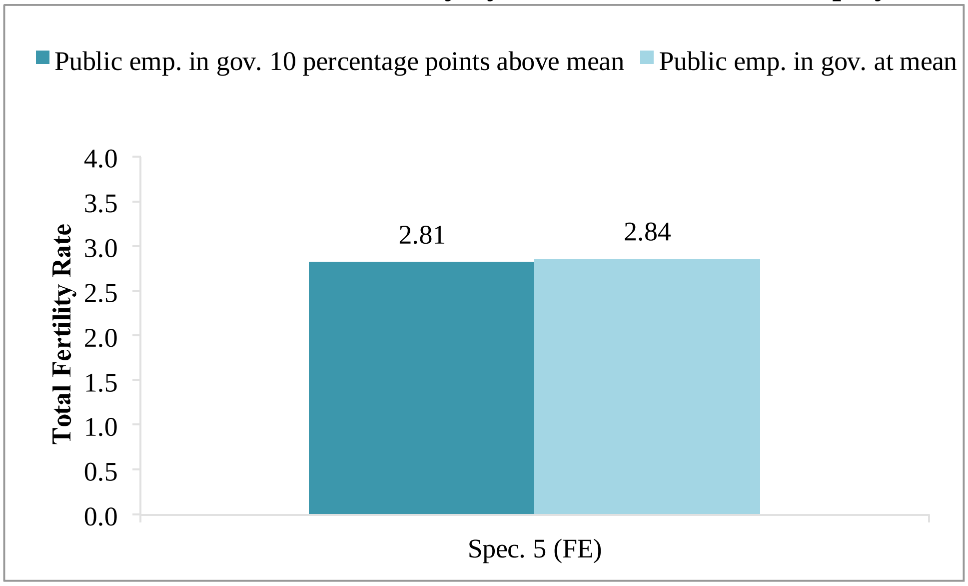


Source: Author's calculations.

Notes: Based on discrete-time hazard models (logits and conditional logits (based on models in Table 3, Table 5, and Table 7).

Figure

12. Simulations of Fertility by Local Public Sector Employment Opportunities



Source: Author’s calculations.

Notes: Based on discrete-time hazard models (conditional logits (based on model in Table 5).

Tables

Table 1. Sample Characteristics

An observation is woman-parity-years since last birth

	Percentage
Woman's educational attainment	
Illiterate (reference)	28.0
Read & write	2.8
Primary	8.4
Preparatory	6.4
General secondary	2.0
Vocational secondary	35.2
Post-secondary inst.	3.5
University & above	13.8
Mother's level of education attained	
Illiterate (reference)	80.8
Read & write	8.2
Less than secondary	5.4
Secondary	3.6
Post-secondary inst.	0.5
University & above	1.5
Father's level of education attained	
Illiterate (reference)	55.3
Read & write	19.6
Less than secondary	11.5
Secondary	7.5
Post-secondary inst.	1.3
University & above	4.6
Woman's residence at birth	
Urban (reference)	40.1
Rural	59.9
Woman's governorate at birth	
Cairo (reference)	11.4
Alexandria	4.9
Port-Said	0.5
Suez	0.8
Damietta	3.1
Dakahlia	6.0
Sharkia	7.2
Kalyoubia	5.8
Kafr-Elsheikh	5.6

Gharbia 6.1 Menoufia 3.8 Behera 6.2 Ismailia 3.4	
Giza	5.0
Beni-Suef 4.0 Fayoum 3.7 Menia 5.4 Asyout 4.5 Suhag 5.2 Qena 4.9	
Aswan	2.5
Have a son	
Not yet (reference)	43.8
Yes	56.2
Public sector employment	
No (reference)	90.3
Yes	9.7
Total	100.0

	Mean	Standard Deviation
Governorate characteristics		
Public employment rate	18.5	6.5
Life expectancy (years)	70.4	2.3
Adult literacy rate (percentage)	68.8	12.1
GDP per capita (in thousands of 2012 LE)	14.7	3.8
Prenatal care (percentage)	71.3	16.7
N	65781	

Source: Author's calculations.

Table 2. Total Fertility Rate by Women's Characteristics in 2006 and 2012

	TFR 2006	TFR 2012	Percentage 2006	Percentage 2012
Ever worked in public sector				
No	3.0	3.5	89.6	88.9
Yes	2.6	3.2	10.4	11.1
Educational attainment				
Illiterate	3.5	4.0	32.2	25.1
Read & write	3.0	3.0	3.6	2.5
Primary	3.0	3.7	6.9	8.0
Preparatory	3.2	3.5	8.3	10.6
General secondary	2.1	3.2	6.2	6.8
Vocational secondary	3.1	3.9	28.0	28.7
Post-secondary inst.	2.7	2.9	3.8	3.1
University & above	2.7	3.2	10.9	15.2
Urban/Rural				
Urban	2.6	3.2	43.7	42.8
Rural	3.2	3.7	56.3	57.2

Region				
Greater Cairo	2.6	3.1	13.2	18.0
Alexandria & Suez Canal	2.5	2.8	8.1	7.9
Urban Lower	2.7	3.4	10.5	9.9
Urban Upper	2.6	3.5	11.9	7.2
Rural Lower	2.9	3.5	32.0	31.7
Rural Upper	3.6	4.0	24.3	25.2
Quintiles of household wealth				
Poorest	3.1	3.9	18.8	17.9
Second	3.2	3.5	20.7	20.4
Third	3.0	3.6	20.8	21.1
Fourth	2.9	3.6	19.7	20.6
Richest	2.5	2.9	20.0	20.0
Mother's level of education				
Illiterate	3.1	3.8	75.5	73.1
Read & write	3.1	3.6	8.9	7.0
Less than secondary	2.6	2.6	6.4	7.5
Secondary	2.6	3.1	5.7	7.8
Post-secondary inst.	2.5	3.4	0.9	0.9
University & above	1.9	3.4	2.5	3.6
Father's level of education				
Illiterate	3.1	3.8	49.6	50.7
Read & write	3.3	3.8	22.7	16.7
Less than secondary	2.6	3.1	11.2	12.5
Secondary	2.8	3.5	8.1	10.5
Post-secondary inst.	3.0	2.8	1.9	1.8
University & above	2.3	2.7	6.5	7.8
Total	3.0	3.5	100.0	100.0

Source: Author's calculations based on ELMPS 2012 and ELMPS 2006.

Note: Because public sector workers are required to have a secondary degree (i.e. be at least 18), the ASFR for the 15-19 age group was inestimable for those who worked in the public sector and treated as zero.

Table 3. Discrete-Time Survival Analysis Models (Logit) for Births

Dependent Variable: Probability (in year) of a birth.

Coefficients have been transformed into odds ratios. Standard errors in parentheses.

		Spec. 2	Spec. 3	Spec. 1
Working in public sector	0.810***	0.976		
	(0.033)	(0.045)		
Public sector work interacted with parity				
Marriage			1.060	
			(0.073)	
First birth			1.046	
			(0.076)	
Second birth			0.863	
			(0.071)	
Third birth			0.686*	

		(0.102)
Fourth birth		1.125
		(0.228)
Fifth birth and above		2.222**
		(0.615)
Age group		
<20	1.155**	1.162**
	(0.064)	(0.064)
20-24	1.498***	1.499***
	(0.064)	(0.063)
25-29	1.372***	1.363***
	(0.049)	(0.048)
35-39	0.575***	0.578***
	(0.032)	(0.033)
40-44	0.207***	0.205***
	(0.026)	(0.027)
45-49	0.025***	0.024***
	(0.014)	(0.014)
Have a male child (not yet omitted)		
Yes	0.751***	0.751***
	(0.023)	(0.023)
Education (illit. omit)		
Read and write	0.991	0.989
	(0.062)	(0.062)
Primary	0.867**	0.866**
	(0.040)	(0.040)
Preparatory	0.926	0.925
	(0.050)	(0.050)
General secondary	1.060	1.064
	(0.088)	(0.089)

Vocational secondary		0.989	0.990
		(0.030)	(0.031)
Post-sec. inst.		1.033	1.036
		(0.063)	(0.064)
University & above		1.157**	1.163**
		(0.053)	(0.054)

	Spec. 1	**Spec. 2**	**Spec. 3**
Mother's ed. (illit. omit)			
Read and write		1.035	1.032
		(0.042)	(0.042)
Less than secondary		0.917	0.914
		(0.046)	(0.046)
Secondary		0.905	0.900
		(0.055)	(0.055)
Post-sec. inst.		0.815	0.809
		(0.129)	(0.129)
University & above		0.777**	0.771**
		(0.072)	(0.072)
Father's ed. (illit. omit)			
Read and write		0.990	0.990
		(0.030)	(0.030)
Less than secondary		0.952	0.953
		(0.036)	(0.036)
Secondary		0.995	0.997
		(0.046)	(0.047)
Post-sec. inst.		0.800*	0.802*
		(0.071)	(0.071)

University & above		0.842**	0.839**
		(0.056)	(0.057)
Governorate chars.			
Life expectancy (years)		0.995	0.996
		(0.029)	(0.029)
Adult lit.		1.003	1.004
		(0.004)	(0.004)
GDP per capita (thousand LE)		0.997	0.996
		(0.005)	(0.005)
Prenatal care		1.000	1.000
		(0.002)	(0.002)
Parity and yrs. since last birth	Yes	Yes	Yes
Birth gov. and urban/rural	No	Yes	Yes
Year dummies	No	Yes	Yes
N	65763	65399	65399

Source: Author's calculations.
Notes: *p<0.05 **p<0.01 ***p<0.001
Standard errors clustered at PSU level.

Table 4. Discrete-Time Survival Analysis Model (Logit) for Births Including Spouse Characteristics

Dependent Variable: Probability (in year) of a birth.
Coefficients have been transformed into odds ratios. Standard errors in parentheses.

Public sector work interacted with parity	
Marriage	1.028
	(0.077)
First birth	1.066
	(0.086)
Second birth	0.868
	(0.076)
Third birth	0.691*
	(0.113)
Fourth birth	1.430
	(0.329)
Fifth birth and above	1.646
	(0.560)
Age group	
<20	1.077
	(0.068)

20-24	1.354***
	(0.063)
25-29	1.256***
	(0.049)
35-39	0.624***
	(0.040)
40-44	0.261***
	(0.036)
45-49	0.039***
	(0.022)
Have a male child (not yet omitted)	
Yes	0.748***
	(0.023)
Education (illit. omit)	
Read and write	1.006
	(0.069)
Primary	0.859**
	(0.044)
Preparatory	0.933
	(0.052)
General secondary	1.036
	(0.098)
Vocational secondary	0.992
	(0.039)
Post-sec. inst.	1.001
	(0.070)
University & above	1.125*
	(0.066)
Mother's ed. (illit. omit)	
Read and write	1.007
	(0.044)
Less than secondary	0.956
	(0.053)
Secondary	0.862*
	(0.054)
Post-sec. inst.	0.721
	(0.122)
University & above	0.762*
	(0.081)
Father's ed. (illit. omit)	
Read and write	1.004
	(0.032)
Less than secondary	0.993
	(0.039)
Secondary	0.986
	(0.048)
Post-sec. inst.	0.825*
	(0.078)
University & above	0.870*
	(0.062)
Spouse public sector work interacted with parity	

Marriage	1.041
	(0.056)
First birth	1.024
	(0.055)
Second birth	0.940
	(0.051)
Third birth	1.000
	(0.081)
Fourth birth	0.794
	(0.118)
Fifth birth and above	1.231
	(0.306)
Spouse education (illit. omit)	
Read and write	1.104
	(0.065)
Primary	0.952
	(0.041)
Preparatory	0.917
	(0.054)
General secondary	0.870
	(0.079)
Vocational secondary	0.955
	(0.039)
Post-sec. inst.	0.886
	(0.056)
University & above	1.016
	(0.052)
Spouse age group (30-34 omit.)	
<20	0.619*
	(0.118)
20-24	0.967
	(0.048)
25-29	1.066*
	(0.033)
35-39	0.934*
	(0.031)
40-44	0.856**
	(0.042)
45-49	0.616***
	(0.044)
Governorate chars.	
Life expectancy (years)	0.993
	(0.031)
Adult lit.	1.004
	(0.004)
GDP per capita (thousand LE)	0.992
	(0.005)
Prenatal care	0.999
	(0.002)
Parity and yrs. since last birth	Yes
Birth gov. and urban/rural	Yes

Year dummies	Yes
N	56945

Source: Author's calculations.
Notes: *p<0.05 **p<0.01 ***p<0.001
Standard errors clustered at PSU level.
Only for sub-sample of women with husbands present in the household.

5. Discrete-Time Survival Analysis Models with Women Fixed Effects (Conditional Logit) for Births

Dependent Variable: Probability (in year) of a birth.
Coefficients have been transformed into odds ratios. Standard errors in parentheses.

	Spec. 4	Spec. 5
Public sector emp. interacted with parity		
Marriage	1.162	
	(0.200)	
First birth	1.090	
	(0.166)	
Second birth	0.868	
	(0.131)	
Third birth	0.630*	
	(0.123)	
Fourth birth	0.768	
	(0.236)	
Fifth birth and above	1.112	
	(0.520)	
Public sector local emp. (percentage) interacted with parity		
Marriage		1.012*
		(0.006)
First birth		0.998
		(0.005)
Second birth		0.982**
		(0.006)
Third birth		0.966***
		(0.008)
Fourth birth		0.960**
		(0.013)
Fifth birth and above		1.047*
		(0.023)
Age group		
<20	0.576***	0.572***
	(0.075)	(0.074)
20-24	1.002	0.988
	(0.091)	(0.089)
25-29	1.254***	1.251***
	(0.071)	(0.071)
35-39	0.490***	0.483***
	(0.037)	(0.036)
40-44	0.119***	0.115***
	(0.020)	(0.019)
45-49	0.008***	0.007***

Table

	Spec. 4	Spec. 5
	(0.006)	(0.005)
Have a male child (not yet omitted)		
Yes	0.548***	0.548***
	(0.027)	(0.027)
Governorate chars.		
Life expectancy (years)	1.206***	1.195***
	(0.046)	(0.046)
Adult lit.	1.022***	1.019***
	(0.005)	(0.005)
GDP per capita (thousand LE)	1.012	1.011
	(0.007)	(0.007)
Prenatal care	1.000	1.000
	(0.003)	(0.003)
Parity and yrs. since last birth	Yes	Yes
Year dummies	Yes	Yes
N	60673	60673

Source: Author's calculations.
Notes: *p<0.05 **p<0.01 ***p<0.001 Standard errors clustered at woman level.

6. Linear Probability Model (First Stage) for Employment in Public Sector in Year

Dependent Variable: Probability (in year) of public sector employment.

Public sector local emp. (percentage)	
In current year	0.002***
	(0.001)
One year lag	-0.001
	(0.000)
Two year lag	-0.000
	(0.000)
Age group (30-34 omit.)	
<20	-0.079***
	(0.006)
20-24	-0.092***
	(0.006)
25-29	-0.052***
	(0.004)
35-39	0.061***
	(0.006)
40-44	0.148***
	(0.015)
45-49	0.226***
	(0.029)
Education (illit. omit)	
Read and write	0.023***
	(0.007)
Primary	0.024***
	(0.006)
Preparatory	0.030***
	(0.007)
General secondary	0.145***
	(0.028)
Vocational secondary	0.109***
	(0.009)
Post-sec. inst.	0.209***
	(0.028)
University & above	0.353***
Mother's ed. (illit. omit)	(0.017)
Read and write	0.008
	(0.015)
Less than secondary	0.003
	(0.019)
Secondary	0.025
	(0.028)
Post-sec. inst.	0.020
	(0.072)

Table

University & above	-0.001
Father's ed. (illit. omit)	(0.046)
Read and write	0.010
	(0.009)
Less than secondary	0.023
	(0.014)
Secondary	0.017
	(0.018)
Post-sec. inst.	0.014
	(0.036)
University & above	0.017
Governorate chars.	(0.029)
Life expectancy (years)	0.009*
	(0.005)
Adult lit.	-0.000
	(0.001)
GDP per capita (thousand LE)	0.001*
	(0.001)
Prenatal care	-0.000
	(0.000)
Constant	-0.103***
	(0.019)
Year dummies	Yes
Birth gov. and urban/rural	Yes
N	64787
R-squared	.227

Source: Author's calculations.
Notes: *p<0.05 **p<0.01 ***p<0.001 Standard errors clustered at PSU level.

7. Two-Stage Residual Inclusion Discrete-Time Survival Analysis Model (Second Stage Logit) for Births

Dependent Variable: Probability (in year) of a birth.
Coefficients are odds ratios. Bootstrapped standard errors in parentheses.

Public sector work interacted with parity	
Marriage	1.145
	(4.771)
First birth	0.918
	(3.832)
Second birth	0.497
	(2.056)
Third birth	0.259
	(1.087)
Fourth birth	0.381
	(1.631)

Fifth birth and above	3.109
	(14.029)
Residual for public sector work interacted with parity	
Marriage	0.895
	(3.726)
First birth	1.247
	(0.326)
Second birth	2.076*
	(0.735)
Third birth	3.602**
	(1.622)
Fourth birth	4.248*
	(3.074)
Fifth birth and above	0.610
Age group (30-34 omit.)	(0.773)
<20	1.150
	(0.383)
20-24	1.438
	(0.556)
25-29	1.305
	(0.292)
35-39	0.600
	(0.160)
40-44	0.221*
	(0.137)
45-49	0.025**
	(0.029)
Have a male child (not yet omitted)	
Yes	0.752***
	(0.024)
Education (illit. omit)	
Read and write	0.999
	(0.128)
Primary	0.873
	(0.096)
Preparatory	0.940
	(0.125)
General secondary	1.114
	(0.725)
Vocational secondary	1.027
	(0.466)
Post-sec. inst.	1.102
	(1.002)
University & above	1.260
Mother's ed. (illit. omit)	(1.847)

Table

Read and write	1.025
	(0.080)
Less than secondary	0.910
	(0.090)
Secondary	0.891
	(0.138)
Post-sec. inst.	0.805
	(0.249)
University & above	0.757
Father's ed. (illit. omit)	(0.204)
Read and write	0.992
	(0.060)
Less than secondary	0.953
	(0.104)
Secondary	1.018
	(0.138)
Post-sec. inst.	0.799
	(0.174)
University & above	0.840
Governorate chars.	(0.174)
Life expectancy (years)	0.969
	(0.051)
Adult lit.	1.004
	(0.005)
GDP per capita (thousand LE)	0.998
	(0.010)
Prenatal care	1.000
	(0.003)
Parity and yrs. since last birth	Yes
Birth gov. and urban/rural	Yes
Year dummies	Yes
N	64769

Source: Author’s calculations.
Notes: *p<0.05 **p<0.01 ***p<0.001
Bootstrapping undertaken with clustering on the PSU level.

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